College of Social Science and Humanities

Department of Geography and Environmental Studies

Geography of Natural Resource Management (GeSt 3101)

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Chapter 1: Natural Resources

Objectives: Up on the completion of this chapter, students will be able to

- Define the concept of natural resource
- Classify natural resources in to different categories based on different criteria
- Differentiate the major approach in natural resource mamagement

1.1. Definition of Natural Resources

Nature is the original patrimony of humanity and is the source of goods and services as well as of the space in which society develops and evolves. The term "**resources"** is widely used within many contexts to refer to natural resources, financial resources, human resources, etc.

Factors influencing definition of natural resources

Different things are resources to different people at different times and in different places, thus what is considered to be a resource can change over time and can also change according to the context in which the resource occurs. The definitions of natural resources are ultimately influenced by;

- Cultural setting
- The available technology
- The environment in which the resources occurs
- Economic systems and political context

All these factors differ from society to society and over time and space, hence the complexity of defining a resource.

The term *resource* is often taken to be synonymous with *natural resource*, but resource can be extended to embrace human resources, such as the technology, manual skills, the innovative ability or the entrepreneurial talents, culture, beauty, etc of a population (Witherick *et al*, 2001). A resource may be tangible as well as intangible. Anything satisfying human wants – be it tangible or not – can be termed resource. Thus, a resource incorporates much more than material things or wealth. Natural resources, on the other hand, refer to those resources that belong exclusively to the natural environment, but not created by man.

What are natural resources?

It is a naturally occurring, exploitable solid, liquid or gaseous material in or on the earth's crust that society perceives to be useful to its economic and material wellbeing. Its Location, grade, quality, and quantity are known or estimated from specific evidence. In other words, natural resources are all these components of the physical environment:

- ✓ That are used by human beings to satisfy perceived needs or requirements
- ✓ found in nature or produce by nature;
- ✓ Not artificial that have actual or potential value to man.
- ✓ Essential for human survival (e.g. Oxygen, Water etc)
- ✓ That have quantity, quality, time and space dimensions

The study of natural resources is essential because natural resources are unevenly distributed in kind, amount, and quality. They also do not match with the unevenly distributed world population. Besides, with the rise in human numbers all over the world, the demand for resources has also increased. The rising demand coupled with the over-utilization of resources has led to several problems like depletion of resources and environmental degradation. Thus, the study of natural resources is useful for the following major purposes:

- ➢ To identify the type, quality and quantity and classify the resource endowment which represents the natural occurrence of resources in the Earth's crust. Some regions contain many resources, others relatively few. No country, however, has all the resources to sustain itself.
- ➢ To understand the rapid occurrence of natural resource degradation; the causes and consequences of such natural resource degradation; and then properly conserve and manage natural resources, i.e., to efficiently utilize natural resources without disturbing the prospects of the future generation, or to develop environmentally sustainable economy.

Natural Resource Management

Natural Resource Management (NRM) includes the processes and practices relating to the allocation and use of natural resources. Sustainable NRM optimizes the use of resources to meet

current livelihood needs, while maintaining and improving the stock and quality of resources so that future generations will be able to meet their needs.

Specific objectives for sustainable NRM include

- ✓ Improving agro-ecosystem productivity,
- ✓ Conserving biodiversity,
- ✓ Reducing land degradation,
- ✓ Improving water management,
- ✓ Ensuring the sustainability of forests,
- ✓ Managing the sustainability of wildlife and fisheries, and
- ✓ Mitigating the effects of global climate change.

Approaches to the study of Natural resources

In the study of Natural resources, geographers apply the following methodological approaches.

A. Regional Approach: is concerned with assessment, identification and explanation of the natural resources in any given environment, or a given geographical area or region. e.g. The natural resources of Ethiopia, or Africa. Here, specific environments, areas or regions are a central focus concerning their natural resources study.

B. Systematic Approach: is concerned with investigations, analysis and explanations of theories, concepts principles and models about natural resources as a whole. e.g. The Geography of Natural Resources.

C. Topical or Resource Approach: It places emphasis to the study of individual resources or a group of resources as they occur in nature or an environment. Example: Water resources, soil resources, etc

D. Principle approach: in this approach generalizations are made on the basis of analyzing facts at a particular time & point.

- ✓ Deductive method- a method by which a theory that applies to many specific facts is generated from the consideration (study) of large geographic area.

- ✓ Inductive methods- a method by which a single generalization that applies to the whole world or country is generated from the detailed study of small area.

Methods of studying natural resources

- Observation, through field trips, tours, voyage, etc.
- Description of actual (spatial and/or temporal) conditions,
- Investigations and analysis of theories, Concepts, principles, graphs, Charts, maps and models
- Conducting Research and Studying research results and reports.

1.2. Classification of natural resources

How are resources classified?

Natural resources could be classified in to different categories or groups on the basis of certain criteria. Some of these include:

I. On the basis of origin, resources may be divided into:

Biotic - Biotic resources are the ones which comprise of living things. Forests and their products, animals and their products, fish and other marine organisms are important examples. Mineral fuels such as coal and petroleum are also included in this category because they were formed from decayed organic matter.

Abiotic - Abiotic resources comprise of non-living things. Examples include land, water, air and ores such as gold, iron, copper, silver etc.

II. Considering their status of development, natural resources may be classified as:

- ***Potential Resources*** - Potential resources are those which exist in a region and may be used in the future. For example, petroleum may exist in some parts of Ethiopia having sedimentary rocks but until the time it is not actually drilled out and put into use, it remains a potential resource. The development of potential resource depends upon the technology available and the cost involved.

- ***Developed Resources:*** Resources which have been surveyed and their quality and quantity have been determined for utilization.

III. With respect to Utility (renew ability) natural resources can be categorized as follows

- **Renewable resources** are the ones which can be replenished or reproduced easily by nature or through purposeful human intervention. They are also named flow resources. Renewable resources will go on replacing themselves as long as the rate of use is less than their rate of generation & as long as their environment is kept suitable. They can only be used for ever with out exhausting them as long as they are protected & managed. However, they may not be renewing if the way in which we use them is destructive and overuse them beyond its capacity to replenish itself. It includes such resources as sunlight, air, wind, etc., are continuously available and their quantity is not affected by human consumption. Many renewable resources can be depleted by human use, but may also be replenished, thus maintaining a flow. Some of these, like agricultural crops, take a short time for renewal; others, like water, take a comparatively longer time, while still others, like forests, take even longer. **Renewable resources** can also be further grouped in to two:
  - **Inexhaustible resources-** are all those which remain unaffected by human action. They continue to pour onto the earth ether we use them in certain way or not. E.g. the hydrological cycle assures that water, no matter how often used, will return over and over to the land for future exploitation. Biochemical cycle is also a good example.
  - **Exhaustible ones**- those that are vulnerable to abuse. If the rate of exploitation exceeds that regeneration, these resources can be depleted. For example, ground water extracted beyond the replacement rate in arid areas may be permanently dissipated. Soils can be lost by mismanagement that leads to total erosion.
- **Non-renewable resources/ stock or depletable) resources** –consists of finite mass of materials which cannot be replenish themselves or can be replaced only over extremely long periods of natural regenerable time & can easily be depleted if used at the rate which is greater than their natural rate of replacement. These comprises the earth's geologic endowment such as Minerals, non mineral resources, fossil fuels and other materials present in fixed amounts in the environment. Such resources are formed over very long geological periods. Since their rate of formation is extremely slow, they cannot

be replenished once they get depleted & thus, their use is not sustainable because their formation takes billions of years. Although they can not be replaced, many minerals can be reused and recycled. Common examples of non renewable resources are minerals and petroleum where millions of years are required for stocks to naturally form in the earth's crust.

Non-renewable natural resource can further be classified into several categories.

1. **Identified resources**: specific bodies of mineral-bearing material whose location, quality and quantity are known from geological evidence, supported by engineering measurements. To reflect increasing degrees of certainty, these resources can be subdivided into measured, indicated and inferred.
    a. **Measured resources**: material for which quantity and quality estimates are made from geologically known sample sites.
    b. **Indicated resources**: material which quantity and quality have been estimated partly from sample analyses and partly from reasonable geological projections.
    c. **Inferred resources**: material in unexplored extensions of demonstrated resources based on geological projections.
2. **Undiscovered resources**: unspecified bodies of mineral-bearing material surmised to exist on the basis of broad geological knowledge and theory.
    a. **Hypothetical resources**: undiscovered materials reasonably expected to exist in a known mining district under known geological conditions.
    b. **Speculative resources**: undiscovered materials that may occur in either known types of deposits in favorable geological settings where no discoveries have been made, or in yet unknown types of deposits that remain to be recognized.

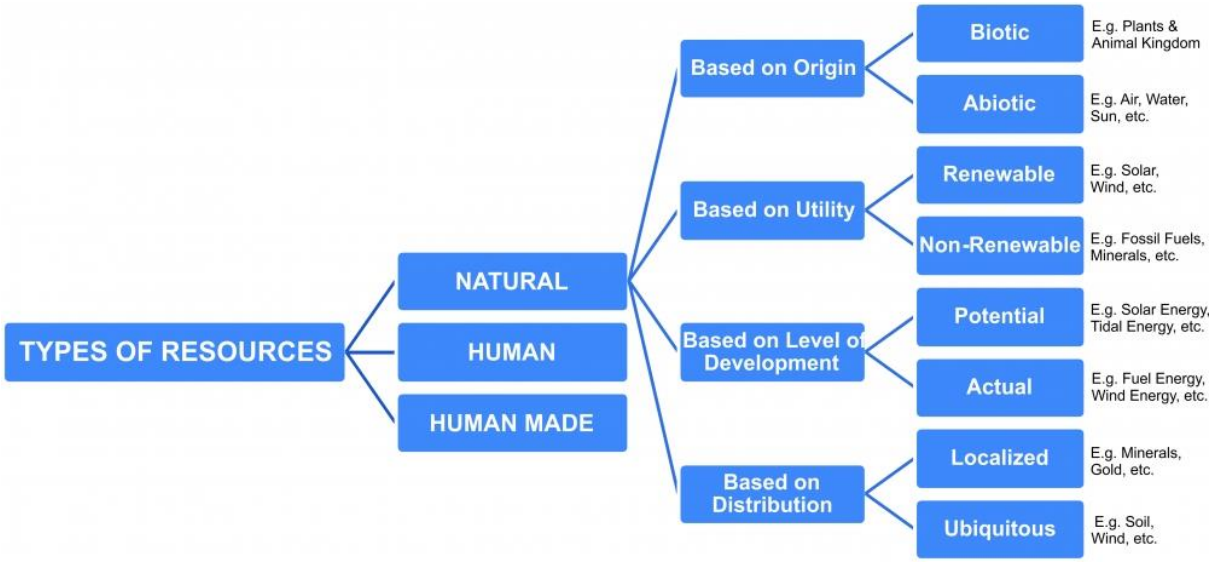
IV. on the basis of nature: resources may be classified as:

- In organic resources- they include air, water & ores.
- Organic resources- they include plants, animals, fossils fuels etc.
- Inorganic + Organic- e.g. soils

V. **On the basis of ownership**

- ***Individual Resources:*** resources owned privately by individuals. For example farm land owned by farmers.

- ***Community Owned Resources:*** resources available to all the members of the community. For example the village common land for grazing, village ponds, public parks, playgrounds are available to all the people living there.
- ***National Resources:*** All the minerals, water resources, forests, wildlife, land within the political boundaries and oceanic area up to 12 nautical miles (19.2 km) from the coast are included in national resources.
- ***International Resources*** The oceanic resources outside of the *Exclusive Economic Zone* (***the area up to 200 nm (***(370 km) ***from the coast line in which the country has the exclusive rights to exploit the natural resources***) belong to open ocean and no individual country can utilize these without the agreement of international institutions.



Exercise on chapter one

1. Differentiate renewable resource from non renewable resource by using examples

2. Elaborate methods of studying natural resources

3. Why do you think that some natural resources are exhaustible

Chapter 2: Soil Resources

Objectives: Up on the completion of this chapter, students will be able to

- Distinguish the different types of soils
- Indicate the problem of soil degradation
- Mention Factors Affecting Water Erosion
- List soil management and conservation techniques

2.1. Major Soil Types and Distribution

What is soil?

Soils are studied by different disciplines or sciences. The broad science that studies soils is known as *Soil Science*.Soil Science is that science dealing with soils as a natural resource on the surface of the Earth, including **soil formation, classification and mapping, geography and use, and physical, chemical, biological and fertility properties** of soils per se: and those properties in relation to their use and management. Soil Science contains two major sub-disciplines

1. ***Pedology*** : It is the branch of soil science that deals with the origin, description, classification, and mapping of soils. Pedologists consider soil as natural entity, the weathered and synthesized product of nature. They **do not focus** primarily on the soil's immediate practical use. They study, examine, and classify **soils as they occur** in their natural environment.

The findings of pedologists are, thus, useful for all persons or professionals, such as highway engineers, construction engineers, farmers and etc., who need soils for their respective purposes.

2. ***Edaphology***: It is the other branch of soil science that deals with the **influence of soils on living things, particularly plants**, including man's use of soil for plant growth. Edaphologists study soils in relation to plant growth; they focus on

- how soils can determine plant growth
- how it can be conserved and
- managed for plant growth.

They consider soils as natural habitat for plants and focus primarily on the practical use of soil for plant growth. They focus on the fertility and productivity of soils. Their ultimate goal is increasing the production of food, fiber and other products. To achieve this goal, they examine the various physical, chemical and biological properties of soils and find the means of conserving and managing soil.

Besides, soil is one of the various geographic phenomena/elements, and is studied by Geography, particularly by a sub-field of Physical Geography called ***Pedogeography/Soil Geography*** . It is a sub-specialization of Physical Geography that studies about the spatial (areal) distribution of soils/soil types and their relations with other environmental phenomena.

Soil geographers consider soils as one of natural/physical phenomena found on the immediate surface of Earth and have cause and effect relationship with other surrounding environmental phenomena (human and physical/natural activities).

Each of these disciplines study soils with different perspectives and purposes. So there is no single definition about what soil is. As soil is studied by different disciplines, different definitions are given to it. But, the two widely used definitions of soil are those given by pedologists and edaphologists, and these are the following:

- Edaphologists;

Soil is the unconsolidated material or mineral on the immediate surface of earth that serves as a natural medium for the growth of land plants.

- Pedologists

Soil is the unconsolidated mineral or organic matter on the surface of the earth, which has been subjected to and influenced by genetic and environmental factors of parent material, climate, macro- and microorganisms, and topography, all acting over a period of time and producing a product-soil-that differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics.

Soil Classification is grouping of soils into categories based on each soil's morphology/appearance. Different countries have devised and applied their own classification

system. But, the system currently accepted and applied by most countries is that of the US soil classification system, which is called ***soil taxonomy***. This system has grouped all soils into 11 orders. A soil belongs to one of the 11 soil orders

SOIL ORDERS	DESCRIPTION
ALFISOLS	- Soils with a clayey B horizon and exchangeable cation (Ca + Mg + K + Na) saturation greater than 50% calculated from NH_4OAc-CEC at p^H7.
ULTISOLS	- Soils with a clayey B horizon and base saturation less than 50%. They are acidic, leached soils from humid areas of the tropics and subtropics.
OXISOLS	- Oxisols are strongly weathered soils but have very little variation in texture with depth. Some strongly weathered, red, deep, porous oxisols contain large amounts of clay-sized Fe and Al oxides.
VERTISOLS	- Dark clay soils containing large amounts of swelling clay minerals (smectite). The soils crack widely during the dry season and become very sticky in the wet season.
MOLLISOLS	- Prairie soils formed from colluvial materials with dark surface horizon and base saturation greater than 50%, dominating in exchangeable Ca.
INCEPTISOLS	- Young soils with limited profile development. They are mostly formed from colluvial and alluvial materials. Soils derived from volcanic ash are considered a special group of Inceptisols, presently classified under the Andept suborder (also known as Andosols).
ENTISOLS	- Soils with little or no horizon development in the profile. They are mostly derived from alluvial materials.
ARIDISOLS	- Soils of arid region, such as desert soils. Some are saline.
SPODOSOLS	- Soils with a bleached surface layer (A2 horizon) and an alluvial accumulation of sesquioxides and organic matter in the B horizon. These soils are mostly formed under humid conditions and coniferous forest in the temperate region.

HISTOSOLS	- Soils rich in organic matter such as peat and muck.
Andisols	Derived from *andesite*, rock formed from the type of magma in Andes Mountains volcanoes; are soils high in volcanic ash, deposited in relatively recent geological time (between 5000 and 10000 years ago).

2.2. Problems of soil degradation

The term *degradation* is broad and refers to declining in the quality and quantity of resources than their previous status. One of the most critical problems of degradation of natural resources is soil degradation. It occurs when the soil becomes less productive than the previous one, usually because of loss of soil particles by erosion, loss of humus, loss of fertility, or due to accumulation of salts and hazardous wastes. Thus, soil degradation is lowering of the quality and quantity of soil. The quantitative aspects of soil degradation include loss of the amount of soil by erosion, mass wasting, solution, etc. The qualitative aspects include loss of organic matter; reduction of plant nutrients; degradation of soil texture and structure; reduction of soil moisture and aeration; decline of soil micro flora and fauna; change of soil chemistry like acidification, alkalination, and salination; etc., and decline of soil fertility.

Soil degradation has now become a worldwide problem. According to Richter (1998), nearly 20 million km^2 (15%) of the snow free land surface of the earth (of the total 130.31 million km^2 between 72^0N and 57^0S) has been degraded as a result of mainly of human activities. Out of the 20 million km^2, almost 5 million km^2 is in Africa (of the total area of 29.66 million km^2).

Causes of Soil Degradation

Soil degradation is a complex process, mainly caused by inappropriate human activities. The major causes of soil degradation in the world are *deforestation, overgrazing, bad practice of farming, over cultivation,* and *pollution*. According to Richter (1998), deforestation and overgrazing explain 64% of soil degradation worldwide. A change induced into the vegetative cover (be it through either deforestation or overgrazing) is known to be the cause for increase in the rate of soil erosion. As the vegetative cover diminishes, the interception of rain by foliage,

stems, and grass blades will decline, and protection afforded by ground cover of fallen leaves and stems will be removed, exposing the soil to a direct attack by heavy rains or splash, and removal by wind during a dry season. Depletion of forests has also been contributing indirectly to soil degradation as people often burn some important sources of humus like animal dung and crop residues and stubble due to lack of fuel wood.

In Africa as a whole, overgrazing is the major factor contributing almost half (49%) of the soil degradation. It is followed by bad practice of farming (24%), deforestation (14%), and over cultivation (13%).

Forms of Soil Degradation: The dominant forms of soil degradation in the world are:

Soil erosion (removal of soil by water, wind);

Chemical degradation (adverse change of the chemical properties of soil, which include loss of nutrients, salination, accumulation of hazardous wastes, acidification, alkalination, etc.);

Physical degradation (adverse change of soil physical properties, such as change in soil texture, structure, color, aeration, infiltration, temperature, porosity, consistency, etc.); and

Biological degradation (decline of biological activity in and on the soil). Soil erosion is most dominantly occurring form of soil degradation in the world, especially in developing countries.

Soil Erosion: Soil erosion is the process of detaching and physical removal of soil materials from a certain place. Soil erosion involves two processes: detaching and movement of soil by water, wind, glaciers, gravity. Soil erosion is a natural process that could be accelerated by human activities. Based on this, we can divide soil erosion into two: *natural/normal/geological erosion* and *man-made/accelerated/ erosion.*

i. *Natural /Geological/ Erosion*: it is caused by natural factors and processes under natural vegetation cover. It is known that in humid climates with a permanent cover of trees or grasses, slow removal of soil is not only universal, but also inevitable, and hence considered as a geologic norm. This norm, however, is determined by the interplay of factors including the amount and intensity of precipitation, the length and steepness of slope, infiltration capacity of the soil, density and type of vegetative cover, etc. On average, natural erosion occurs at a very slow rate;

mostly it is below the rate of soil formation. So that it does not bring any harmful effect on the soil resources and on the natural environment.

ii. *Man-made/accelerated/ Erosion*: it is caused by human activities, which accelerate the natural soil erosion rate and make it greater than the rate of soil formation. So it creates damage on the soil resources and on the natural environment. The human activities responsible for soil erosion are mainly deforestation, overgrazing, over cultivation, and inappropriate farming practices.

The two dominant agents responsible for soil erosion are water and wind. According to Richter (1998), worldwide, soil erosion by water is accountable for 56% of soil degradation followed by wind erosion, which is responsible for 28%. Water and wind erosion together take 75 billion tones of soil each year (at a rate of 17 tones of soil per hectare in USA and Europe, and 30-40 tones per hectare in South America and Africa). The rate of soil formation, on the other hand, accounts only to 1-2 ton/hectare/year. This indicates how soil erosion by these two agents becomes a serious problem.

In Africa, erosion caused by water is more harmful than caused by wind. About 43% of the degraded land is known to have 'strongly' suffered from soil erosion by water. These two agents are also the major agents of soil erosion in Ethiopia.

Factors Affecting Water Erosion: The rate of water erosion is determined by the following factors:

i. *Rainfall*: it affects soil erosion in terms of its intensity and duration. The higher the intensity of the rainfall, the higher the rate of erosion. The longer the duration of the rainfall, the greater its impact on the soil loss.

ii. *Topography*: it also determines the degree/intensity/ of soil erosion in terms of its slope angle and slope length. The higher the slope angle or the steeper the slope, the greater the soil erosion because soils have no resistance to the force of water. Similarly, the longer the slope, the higher the soil erosion, because water accumulates and increases in speed, collecting more sediment and doing proportionally more damage.

iii. *Soil characteristics (Erodability of the soil):* soil characteristics that determine the erodability of the soil are organic matter, texture, structure, permeability, etc. of the soil. The well/higher/ these properties in the soil, the lesser the soil erosion.

iv. *Practice factor*: it is the human participation to control soil erosion. If a person encourages infiltration through terracing, contour ploughing, strip cropping, etc., there will be minimum erosion.

i. *The type and density of vegetative and crop cover and the associated management***:** Dense forest or tall thick grass with dead residues is the best cover for minimum erosion. The time between operations of weeding, tillage, watering, fertilization, etc. also determine soil erosion.

ii. *Stability of the soil***:** if the soil is stable, it may have resistance to erosion. Stability of the soil is determined by the occurrence of mass wasting, earthquake, slope steepness, etc.

Impacts of Soil Erosion: Soil erosion has various impacts on the environment. These impacts can broadly be classified into *on-site* and *off-site* impacts.

I. *On-site impacts* (impacts at the place where soils are removed) are:
- Loss of soil fertility because of the removal of top soil, which is the most fertile as it consists of nutrients and organic matter, which are indicators of soil fertility.
- Decline of land productivity – decline of crop, grass, and other vegetation yields due to the loss of soil fertility.
- Lowering of runoff, i.e., rivers and springs will be dried up.
- Lowering of water table due to lack of infiltration.
- Shrinkage of agricultural land due to the formation of rills, gullies, and gorges.

II. *Off-site impacts* (impacts at the place where soils are deposited) are:
- Occurrence of siltation and sedimentation due to the deposition of silt and sand. For example, if a dam is affected by siltation, which decreases the HEP generation.
- Occurrence of flooding and damaging of croplands, irrigation projects, roads, houses, etc.
- Drying up of lakes caused by the accumulation of soil particles beneath the water, which dislodges the lake water.

2.3. Management and conservation of soil

Soil conservation is a combination of all management and land-use methods that safeguard the soil against depletion or deterioration by natural or human induced factors. For any form of land use to be sustainable, production must be combined with conservation of the resources it depends on. Soil conservation and management efforts should: (i) be able to control erosion sufficiently, (ii) maintain the organic matter of the soil, (iii) maintain the soil physical properties and (iv) maintain the appropriate level of nutrients in the soil.

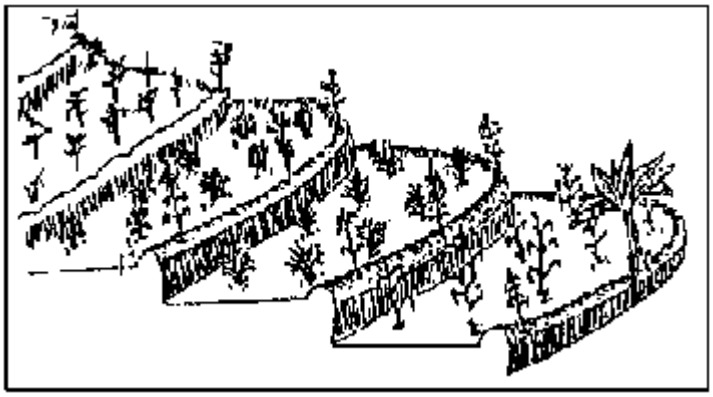
Soil conservation relies on increasing the amount of water seeping into the soil, reducing the speed and amount of water running off, and keeping enough vegetation to the soil surface to bind the soil together, and so on.

Soil Conservation and Management Techniques

Three types of soil conservation and management methods are recognized. These are described as follows:

1. **Physical and Structural Conservation Methods**: are designed to protect the soil from uncontrolled runoff erosion. These methods are applied across long and steep slopes. Most of them are constructed by Ethiopian farmers. The methods include:

i. *Construction of bench terraces*: Bench terraces are level (or nearly level) steps constructed along the contours, and separated by embankments/rises. They can be formed by excavating a trench along the contour line and throwing the soil uphill to form embankment. The embankments are stabilized with fodder grasses, and the space between embankments is cultivated. This practice is employed to control soil erosion by reducing runoff on steep slopes.



II. Contour farming: is the cultivation/farming (ploughing, planting, and weeding) of hill slopes following the contour lines. This practice prevents the downward flow of water and check soil loss. The furrows in which crops are planted are prepared at right angles to the hill slopes. Experiments show that contour farming alone can reduce soil erosion by as much as 50% on gentle slopes. However, for slopes steeper than 10%, other measures should be combined with contour farming to enhance its effectiveness.


Contour farming

III. Check dams: In this method, small dams/walls/ are made across the bottom of gullies or small rivers to control gully erosion. The smaller dams hold back the water and capture alluvial soil that the water carries along with it. They also prevent the deepening and widening of gullies.


Checkdam

IV. Formation of water ways (channels) on farm lands: channels/water ways are dug across a slop to intercept surface runoff and carry it safely to an outlet such as a canal or stream. They are used to protect cultivated lands, roads, and compounds from uncontrolled runoff, and to divert water from gully heads.


Waterway

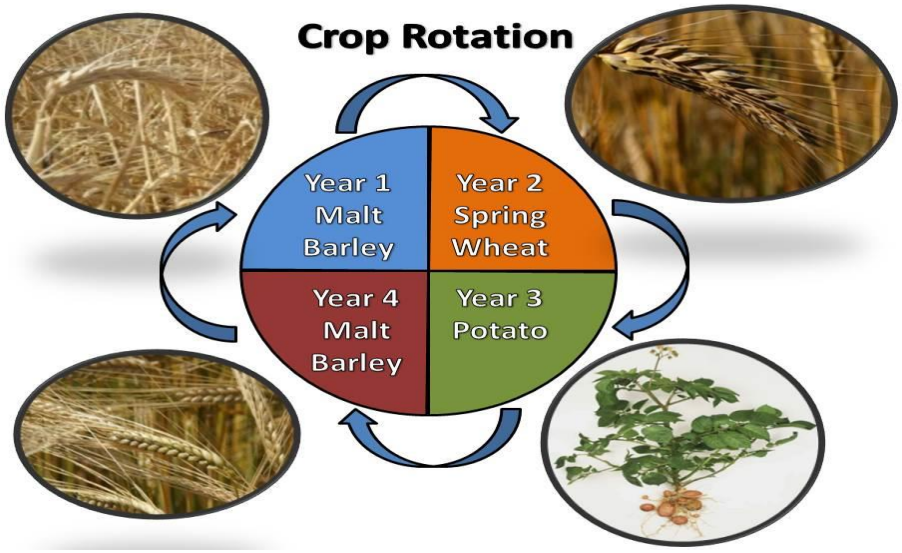
2. Agronomic/ cover conservation/methods: involve covering of the land surface by vegetation, crops, etc. When plants cover the soil surface, the energy of falling raindrop is reduced by the vegetation. As raindrops fall, the vegetation absorbs the energy; then the water gently slides off to be absorbed by and infiltrated into the soil. Vegetation and other coverings also reduce the speed of runoff water and wind, and add organic matter, increasing soil fertility. The major agronomic conservation techniques to be practiced include:

i. *Tree planting (afforestation and reforestation):* is required to improve the vegetation cover on

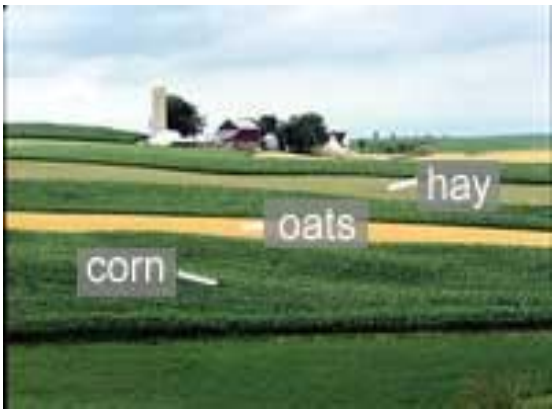
a certain area. Afforestation is planting of trees in areas which were not covered by forest, while reforestation is planting of trees in areas which were covered by forests but such forests become cleared out.

Trees can conserve the soil in many ways. They reduce the impact of raindrops on the soil, reducing splash erosion. Their roots bind soil particles. Planted along the contours, trees can interrupt the flow of water running off the surface. They shade the soil, reducing the soil temperature and cutting the amount of water that evaporates into the air. They break the wind, reducing the amount of wind erosion. They circulate nutrients from deep in the soil, and leguminous trees fix nitrogen that can benefit food crops.

ii. *Crop rotation*: is the growing of different crops in a field alternatively in order to maintain soil fertility. To grow the same crop in the same field for successive years will exhaust one particular kind of soil nutrient. For example, potatoes require much potash but wheat requires nitrates.



iii**.** *Strip cropping*: This is practice of growing crops that require different types of tillage, such as row and sod, in alternate strips along contours or across the prevailing direction of the wind. Some crops are erosion resistant, while others are not. Therefore, growing of different crops alternatively can reduce the speed of water, and thus soil loss.



strip cultivation

iv. *Mulching*: involves covering the soil surface with grass, crop residues, sawdust, leaves or other materials to protect soil and plant roots from the effects of raindrops, soil crusting, freezing, evaporation, and increase infiltration.

Muiching

v. *Area closure/Fallowing*: This is practice of leaving land uncropped for periods of time to accumulate and retain water and mineralized nutrient elements. This is used to improve degraded lands through natural regeneration. In this method, no human interference and no livestock is allowed to graze. The area is kept for three 3-5 years until natural grass cover is regenerated.

vi. *Controlled grazing*: This is a systematic grazing of animals to improve degraded lands through natural regeneration. Major practices that should be taken include the study of the carrying

capacity of the grazing lands and dividing the grazing lands into the fenced plots. Then each plot can be grazed in rotation.

3. Biological Soil Management Technique: This method improves the soil characteristics; allow more infiltration and less runoff; and reduce soil loss and increase soil fertility. Practices included under this method are adding organic matter (like cow dung and crop residues) and artificial fertilizer, and using green manure like beans, peas, and lentils. Before leguminous plants are matured, the field is ploughed and their parts are mixed with the soil adding fertility to it.

Exercise on chapter Two

1. Explain how physical weathering is defferent from chemical weathering

2. Define soil degradation

3. What are biophysical and socioeconomic factors are common in your locality which are responsibility for soil degradation?

4.What kind of soil conservation is practiced in your locality?

5. Differentiate strip cropping, inter cropping and mixed cropping as a means for soil conservation

Chapter 3: Forest resources

Objectives: Up on the completion of this chapter, students will be able to

- Identify the major characteristics of forest vegetation
- List down the importance of forest
- Identify and elaborate the major cause of natural vegetation degradation
- Mention the major consequences degradation of vegetation
- Distinguish forest management in ethiopia

3.1. Characteristics and Use of forest

Forests are defined differently. Three definitions are as follows:

(1) Forests are natural ecosystems or biomes (biological communities) that are dominated by multispecies and multi-age trees and other woody vegetation .

(2) A forest is an assemblage of trees growing closely together so that individual leaf canopies generally overlap.

(3) A forest is plant community, predominantly of trees or other woody vegetation, occupying an extensive area of land.

(4) The FAO definition includes scattered trees and plantations as forests.In its natural state, a forest remains in a relatively fixed, self-regulated condition over a long period of time.

Forests are not evenly distributed in the world; they vary in **density** and **type** of trees they contain. The type and spatial distribution of forest is greatly determined by factors such as climate (especially temperature and precipitation), soil, topography, drainage conditions, altitude, etc.

The Earth's total land area is about 133 million km^2, or about 29% of the surface of the globe, and currently, forests and woodlands cover about 3.8 billion ha or about 29% of the earth's land area. Tropical forests make up 48% of the world's standing forest, and are mainly found in South America, Central Africa, and Southeast Asia. Another 33% are boreal forests, mainly in Siberia and Canada, and 11% are temperate deciduous and coniferous forests, mainly found in Eastern

North America, Europe, and Asia. The remaining 9% is subtropical forest, between tropical and temperate forests, but close to tropical forests.

Forests provide diverse environmental and socio-economic functions/uses. Functions of a forest may broadly be classified into the following three categories.

- *Protective Functions*: - These include the protective role of forests against soil erosion, drought, floods, intense radiation, etc.
- *Productive Functions*: - Forests are the source of wood and many other products like gums, resins, fibers, medicines, honey, pulp, paper, etc.
- *Accessory Functions*: - These include the role of forests in recreation, aesthetics, and as habitat of diverse wildlife.

From this, it can be said that forests are important in two broad ways: ecologically and economically.

1. ***Ecological Importance***: - Environmentally, forests are very important. They play a vital role in regulating climate. They help in balancing O_2 and CO_2 levels in the atmosphere, purifying air, regulating earth's temperature regime and hydrologic cycle. In terms of hydrology, forests are believed to increase local precipitation and water storage capacity of soil, and thus prevent drought situation. The vegetation cover provided by forest also interrupts the velocity of raindrop, runoff and wind on soil surfaces, and thus reducing soil erosion. Forest cover also reduces the occurrence of siltation and sedimentation, landslides, and the danger of flood. The litter derived from fallen leaves maintains soil fertility by returning the organic matter and nutrients. Forests also act as refuge of wild animals and provide food for them. Forests also provide protection to wild life against strong winds, solar radiation, rain, and enemies.

2. ***Economic Importance***: - Economically, forests provide various types of products which have various applications in domestic and industrial processes. For example, wood is a chief product of forest used as a fuel, timber, etc. Wood, when used as fuel, has certain advantages over coal as its sulfur and ash contents are very low but, at the same time, excessive use of fuel wood means pressure on forests, which may have many other functions to serve. Timber is also an important material derived from forest and used in building construction and day-to-day uses. Timber is used in various wood-based industries, to make lumber, plywood, veneer, particleboard, pulp and

paper and chipboard, rayon and other man-made fibers, furniture, boat building, matches, etc. Other products like resins, gums, medicines, etc. are also obtained from forests.

Forest products can generate significant foreign capital that plays important role to strengthen the national economy of a given country. They can be shipped abroad in any form from logs to highly finished products and be exchanged for valuable capital and consumer goods.

3.2. Classification of forest and distributions

Forests biomes, biological communities that are dominated by trees and other woody vegetation, can be classified according to numerous criteria. For example:

1. Based on canopy characteristics, the world's forests can be classified into two – *open canopy* and *closed canopy* forests. *Closed canopy* forest is a forest where tree crown spread over 20% of the ground; has the potential for commercial timber harvest. *Open canopy* forest is a forest where tree crowns cover less than 20% of the ground; also called *woodland*. Of the total 3.8 billion ha of the total forest and woodland of the world, about four-fifths is classified as *closed canopy*, and the rest is *open canopy* forest or *woodland*.

2. Most widely forests are classified into three major types on the basis of latitude and seasonality. These three major forest types are *tropical, temperate,* and *boreal forests (taiga)*. Distinct forest types also occur within each of these broad .

I. Tropical Forests

The richest and most diverse terrestrial ecosystems on the earth are the tropical forests. Tropical forests are the largest forests, making up about half of the world's standing forest, and now they occupy less than 10% of the earth's land surface. They are mainly found in South America, Central Africa, and Southeast Asia. Tropical forests are thought to contain more than two-thirds of all higher plant biomass and at least one-half of all plant, animal, and microbial species in the world.

***Subdivisions of Tropical Forests*:** The tropical forests are further sub-divided on the basis of seasonal distribution of rainfall into four. These are:

i. *Evergreen rainforest*: - No dry season.

ii. *Seasonal rainforest*: - It has short dry period in a very wet tropical region. The forest exhibits definite seasonal changes as trees undergo developmental changes simultaneously, but the general character of vegetation remains the same as in evergreen forests.

iii. *Semi evergreen forests*: - It has longer dry season. The upper tree story consists of deciduous trees, while the lower story is still evergreen.

iv. *Deciduous forests (monsoon)*: - The length of the dry season increases further as rainfall decreases (all trees are deciduous).

Diminishing of Tropical Forests: Tropical forests have being destroyed at alarming rate. Generally, more than ½ of the tropical forests have already been destroyed, and they now occupy less than 10% of the earth's land surface.

II. Temperate (or mid-latitude) forests are located in the temperate zone above the tropical forests and below the boreal forests. They occur both in the Northern and Southern Hemispheres – in eastern North America, northeastern Asia, western and central Europe, and parts of South America, New Zealand and Australia. These forests are characterized by the well-defined seasons with a distinct winter. Moderate climate with 4-6 frost-free months distinguish temperate forests. The temperature ranges from -30^0c to 30^0c and precipitation ranges from 750-1500mm.

Subdivisions of Temperate Forests: Temperate forests are sub-divided on the basis of seasonal distribution of rainfall into five. These are:

i. *Moist conifer and evergreen broad-leaved forests*: - They have wet winters and dry summers (rainfall is concentrated in the winter months and winters are relatively mild).

ii. *Dry conifer forests*: - These forests dominate higher elevation zones; low precipitation.

iii. *Mediterranean forests*: - In these forests precipitation is concentrated in winter, less than 1000mm per year.

iv. *Temperate coniferous forests*: - They have mild winters, high annual precipitation (greater than 2000mm).

v. *Temperate broad-leaved rainforests*: - These forests have mild, frost-free winters, high precipitation (more than 1500mm) evenly distributed throughout the year.

***Diminishing of Temperate Forests*:** The temperate forests are become one of the most altered forests on the earth. Humans have long utilized the trees for fuel wood, construction, industrial timber, and art projects. They have also cleared the trees for farming. These activities have led to the decline or loss of the temperate forests throughout most of the world. Thus only scattered remnants of original temperate forests remain.

III. Boreal Forests or Taiga

The boreal forest or taiga is also referred to as the ***northern coniferous forest*** biome and occupies a vast area below the tundra. Boreal forests are the second largest forests, making up about one-third of the world's forests. Particularly, the boreal forest is found in the Northern Hemisphere between 50^0 and 60^0N latitude where the winters are long and cold. They are found in the broad belt of Eurasia (across Siberia and Scandinavia) and North America (across Canada and into interior Alaska): two-thirds in Siberia with the rest in Scandinavia, Alaska, and Canada.

3.3. Problem of deforestation

Deforestation is defined differently by different scientists and politicians as discussed earlier, but most define deforestation as the conversion of forest land into another land cover. Deforestation is the removal of forests through the intervention of man, forest fire, forest disease, and so on.

Factors behind Deforestation: The world's forests have been removed due to various, mainly human-induced factors/causes. The major causes of deforestation of the world's forests are the following:

i. *The increasing demand for land for agriculture as a result of high population growth:* -.

ii. *The increasing demand for forests for fuel wood and construction materials as a result of increase in population size*

iii. *Large-scale Resettlement*

iv. *For Commercial Purposes*

v. *Development of large-scale construction projects*

vi. *Warfare*

vii. *Fire*

viii. *The Spread of Forest Diseases and Insect Pests*

Effects of Deforestation: The continuous and rapid rate of deforestation that has occurred in the world has resulted in wide ranging detrimental effects/problems. The adverse effects are many and are complicated or interrelated to one another. They might be environmental, economic, and social problems. The major effects of deforestation are as follows:

i. *Climate change, particularly global warming (increase in global temperature):*

ii. *Desertification*

iii. *Soil Degradation*

iv. *Loss of water resources*

v. *Fragmentation of agricultural lands and the subsequent effects*

vi. *Extinction/loss of Biodiversity (both plant and animal species*

vii. *Scarcity of fuel wood and building materials*
viii. *Deterioration of local and national income*

3.4. Forest conservation

It is unlikely that deforestation could be halted altogether, but it is possible to reduce the rate of deforestation by applying the various measures. Some of them are the following:

i. *Tree Planting (Afforestation and Reforestation)*:

ii. *Reduce the demand for forest products*

iii. *Introduction and implementation of sustainable forestry management, by using, for example, restrained falling of trees*

iv. *Agro-forestry*

v. *Control forest fires, forest diseases and pests*

vi. *Environmental education to raise public awareness on the use and management of natural vegetation.*

3.5. Forest Management in Ethiopia

Diverse physiographic, altitudinal, climatic and edaphic resources, enables Ethiopia to have various types of vegetation ranging from alpine to desert plant communities (Sahle, 1984) which provide economical, socio-cultural and environmental benefits.

Three main forest development periods are identified:

- pre-derge environmental protection,
- derge regime environmental protection and frontiers economics, and
- post-derge resource management and environmental protection**.**

During Emperor Haile Selassie I (1930-1974)

In the past, large forests were **managed as crown property by emperors and kings** basically as sources of fuel wood and timber for the royal households. According to Sisay (2008), the first elaborate and modern legislation on forest resources came during emperor Haile Selassie I (1930-1974) in 1965 which gave recognition for three forms of forests namely

- state forest,
- private forest and
- protected forest.

The main objective of the forest legislation during the 1960s was **not so much to promote resource conservation** but rather **to enlarge the sources of state revenue** (Dessalegn, 2001).

Forest resource management system during *derge regime (1974-1991)*

In 1980, Derge proclaimed a new law called **forest and wildlife conservation and development proclamation No. 192/1980** .

forest management system during the Derge period was ***again the environment protection*** *type.* ***Forests were protected mainly for their economic value****.*

- Area closure,
- construction of check dams,
- establishment of national parks,
- gully control and
- reafforestation

schemes undertaken were some instances that show how the strategies were corrective in practice rather than being preventive. The majority of these 'community forests' were destroyed during the conflict and transition after the downfall of the Derge (1991)

Forest resource management system (since 1991)

In 1994, a new proclamation came into picture, namely, "forest conservation, development and utilization" procla-mation no. 94/1994 and another great endeavor was the establishment of **Ethiopian forestry action program (EFAP)**, which is a working document that has direct relation with forest development and conservation.

- EFAP set forth as objectives of
  - forestry development,
  - to sustainably increase production of forestry products,
  - to increase agricultural production by reducing land degradation and increasing soil fertility,
  - to conserve forest ecosystems and to improve the welfare of rural communities.

The policy put general direction wherein, among others, **expansion of forests and agro-forestry is** needed to accelerate economic development of the country. The objectives mentioned here (both in EFAP, forest development, conservation and utilization Proclamation and EIA proclamation), **have both economic as well as environmental out comes.** From this, one can say the objectives have been designed based on **resource management type of paradigm .**

Exercise on Chapter three

1. List down the economic and ecological significance of forest

2. What are the major cause of forest degradation

3. What will be the consequence of forest degradation

4. Explain how forest could managed? Did you noticed any difference how people in your locality manage from what have so far learned?

5. Identify the factors that determine the types of natural vegetation in an area?

Chapter 4: Range land resources

Objectives: Up on the completion of this chapter, students will be able to

- Define range land
- Explain the major characteristics of range land
- Identify the major range land of the world
- Indicate the conservation methods of rangelnad

4.1 Definition, characteristics and uses of rangelands

Like the natural resources we discussed in the preceding units, rangelands are defined in different ways. Some of the definitions of rangelands are:

(i) Rangeland include any extensive, uncultivated land occupied by native herbaceous or shrubby vegetation that is grazed and browsed by domestic or wild animals and is managed as a natural ecosystem and

(ii) Rangelands are grasslands and open woodlands suitable for livestock grazing.

Rangelands have similarity as well as difference to pasturelands. Pastureland refers to grazing lands suitable for domestic livestock. They are enclosed and managed grasslands. Rangelands are similar to pastureland in that both are uncultivated lands, contain grasses, and used for grazing animals. Rangelands are distinguished from pastureland in that rangelands are unfenced, natural grasslands and open woodlands or they contain native vegetation, rather than of plants established by man; they provide food/leaves and twigs/ for browsing animals (both domestic and wild) in addition to grass for grazing animals; and their management is principally through the control of the number of animals grazing or browsing on them, as opposed to the more intensive agricultural practices of seeding, irrigation, and the use of fertilizers to manage pasturelands.

According to Cunningham et al (2005), rangelands and pasturelands make extensive areas of the earth's land surface. Of the total land area of the earth (which is about 133 million km^2), rangelands and pasturelands make up 27%, which is more than twice the area of the world's croplands, which is 11%.

Rangelands are found in different parts of the world. They found widely scattered everywhere in the world, except in areas permanently covered by ice. They are primarily arid and semiarid lands, predominantly grassy, where other land uses, such as rain-fed crop cultivation and industrial forestry, are not economically feasible. Rangelands are unsuitable for rain-fed crop cultivation and forestry because of the limitations by their physical characteristics, such as low precipitation, very shallow soils, very steep and rough topography, poor drainage, and hot or cold temperatures.

Although most rangelands are arid and semiarid and predominantly grassy, at least some rangelands also occur in sub-humid and humid zones and in areas with predominantly woody vegetation or which support shifting cultivation. Thus, rangelands include grasslands; shrub lands, woodlands, portions of forest and tundra, etc., and the vegetation of rangelands include grasses, grass-like plants, forbs, shrubs, bushes, etc. Vegetation is one of the major rangeland resources. Rangeland vegetation changes across place and time due to various natural and human-induced factors. Besides vegetation, livestock and wildlife are important rangeland resources. Each of these rangeland resources is a source of multiple products of value to mankind and the balance of the environment/ecosystem.

Uses of Rangelands: Rangelands have many uses. Some of them include:

- ✓ *Source of food for animals:* Rangelands provide forage (food) for domestic and wild animals. In most developing African and South American countries, rangelands provide over 85% of the total feed needs of domestic ruminants (cattle, sheep, and goats). On the world basis rangelands contribute about 70% of the feed needs of domestic ruminants. Rangelands provide wild ruminants with over 95% of their feed needs in the world.

- ✓ *Production of Animal Products*: Rangelands play a major role in supplying human population with animal products (meet, milk, skin, hide, wool, horn, etc). The animals also do serve as a "cash crop" that can be used to buy other commodities.

- ✓ *Habitat for Wildlife*: Rangelands provide shelter for the various rare and endangered wild animals, birds, insects, etc. These animals are highly valued for meet, hunting, aesthetic viewing, and scientific purpose. The economic value of wild animals on rangelands is

becoming increasingly recognized in many developed and developing countries. In many countries income from tourists viewing wild animals is of critical importance to the national economy.

- ✓ *Recreational Products*: People have made rangelands increasingly important places for recreational activities. Ranchers are finding more and more opportunity to market recreational values from rangelands. Marketable recreational products include hunting, fishing, camping privilege, horseback riding, etc.

- ✓ *Water*: In arid and semi-arid areas, water is becoming of greater importance than any other rangeland products. Rangeland natural vegetation in such areas play vital role in increasing infiltration and the availability of groundwater and surface waters (e.g. oasis).

- ✓ *Plant products*: Rangelands provide a wide variety of plant species that could be very important in meeting our needs (e.g. medicine, food, landscaping, etc.). Many rangeland shrubs are being developed and used for landscaping purpose. Many rangeland plants have the potential to be developed into valuable domestic food and forage species using new genetic engineering.

- ✓ *Wood and Mineral Products*: Wood and Minerals are also important products obtained from some rangelands. Wood products include fuel wood, charcoal, timber, etc. and mineral products include gum.

4.2 Classification and distribution of rangelands

Rangelands are the most diverse category of the world's open land resources. The major types of rangelands of the world are grasslands, savanna woodlands, desert shrub lands, and tundra.

1. Grasslands: Grasslands are those lands dominated by grasses, rather than large shrubs or trees. Grasslands are found on every continent except Antarctica. **About one quarter of the Earth's land is in the grasslands biome.** Grasslands have different names in different countries, such as pampas (South America), prairies (North America), savannas (Africa), or steppes (Asia). Grasslands are the most productive grazing lands. Grasslands are divided broadly into two: ***Tropical grasslands (Savanna)*** and ***Temperate grasslands***.

i *Tropical grasslands (Savanna)*: Savanna is grassland dominated by large grasses with scattered individual trees and shrubs. Savannas cover about half of the surface of Africa (about 5 million square miles, dominantly found in central Africa) and large areas of Australia, South America, and India. They are close to the equator.

Climate is the most important factor in creating a savanna. Savannas are always found in warm or hot climates where the annual rainfall is on average from about 76.2-101.6cm per year. However, certain savannas can receive as little as 15.24 cm. It is crucial that the rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur. If the rain were well distributed throughout the year, many such areas would become tropical forest.

ii. *Temperate grasslands*: Temperate grasslands are characterized as having grasses as the dominant vegetation. Trees and large shrubs are absent. They are found further from the equator, close to temperate zones. Temperatures vary more from summer (hot) to winter (cold), and the amount of rainfall is less in temperate grasslands than in savannas. Precipitation in the temperate grasslands is usually occurs in the late spring and early summer. The annual average is about 50.8 to 88.9 cm. The temperature range is very large over the course of the year. Summer temperatures can be well over 38° C, while winter temperatures can be as low as -40° C. The amount of annual rainfall influences the height of grassland vegetation, with taller grasses in wetter regions.

The major manifestations of temperate grasslands are the veldts of South Africa, the puszta of Hungary, the pampas of Argentina and Uruguay, the steppes (grasslands with short grasses) of the former Soviet Union, and the plains and prairies (grasslands with tall grasses) of central North America. These are called the five major temperate grasslands of the world.

2. Savanna Woodlands: These are dominated by scattered, low-growing, trees and short grasses**,** and are characteristic of the higher tropical latitudes. They are found in wet and dry tropical climates of northern Africa, Asia, and Latin America. Tropical woodlands typically form a belt adjacent to the tropical forests. Annual precipitation ranges from 500mm to1500mm. Large trees are found scattered over continuous grass covered plains. The trees are of medium

height, the crowns are flattened or umbrella shaped, and the trunks have thick rough bark. The barks of the trees adopt the fire incidence during the dry season. The African woodland savannas are known by their enormous herds of grazing and browsing animals, such as zebras, giraffes, buffalos, gazelle, lions, leopards, cheetahs, etc.

3. Desert Shrub lands: These are lands covered with sparse vegetation, mainly shrubs, with less than 2 meter in height. They primarily occupy the semi-desert climate belt, bordering the tropical savanna woodlands. They receive annual average rainfall of less than 250mm. They have major grazing value as precipitation allows considerable growth of annual grasses and other fodder plants (shrubs). They make up the world's largest rangelands, and they comprise the greatest degradation by heavy grazing of the rangeland vegetation. Oases are very productive in these areas.

4. Tundra: Tundra is a treeless area in Arctic or high elevation regions. It is an area characterized by extremely cold climate (very low temperature, seasonally or permanently ice cover – the land is frozen for over 7 months of a year), poor soil, and low biotic diversity. Plants are short and grouped together to resist the cold temperature. Plants species include tussock grasses, dwarf shrubs, mosses, lichens, etc. Except for a few birches in the lower altitudes, no trees grow in the tundra. Developing over thousands of years, most of the vegetation have adapted to the conditions in the tundra by growing in a dense mat of roots. Except where the soil is fertilized by animal droppings, the soil is low in minerals and nutrients. Tundra is estimated to cover about 5% of the world's total land surface, and constitute the smallest rangelands. Tundra is divided into two types: ***Arctic Tundra*** and ***Alpine Tundra***.

i. ***Arctic Tundra***: is found in the northern hemisphere, encircling the North Pole and extending south to the coniferous forests of the taiga, between latitudes 55 degrees to 70 degrees north. In North America, it occurs in Greenland, Canada and Northern Alaska, in northern Europe, it is mainly found in Scandinavia, and in northern Asia, it is found in Siberia.

The arctic tundra is known for its cold, desert like conditions. There are no deep root systems in the vegetation of the arctic tundra; however, there are still a wide variety of plants that are able to resist the cold climate. There are about 1,700 kinds of plants in the arctic and subarctic, and these include: (i) low shrubs, sedges, reindeer mosses, liverworts, and grasses, (ii) varieties of flowers,

and (iii) crustose and foliose lichen. All of the plants are adapted to sweeping winds and disturbances of the soil. Plants are short and group together to resist the cold temperatures and are protected by the snow during the winter.

The fauna in the arctic is also diverse, including (i) Herbivorous mammals: lemmings, voles, caribou, arctic hares and squirrels; (ii) Carnivorous mammals: arctic foxes, wolves, and polar bears; (iii) Migratory birds: ravens, snow buntings, falcons, loons, sandpipers, terns, snow birds, and various species of gulls; (iv) Insects: mosquitoes, flies, moths, grasshoppers, blackflies and arctic bumble bees; and (v) Fish: cod, flatfish, salmon, and trout.

ii. ***Alpine Tundra***: The Alpine tundra can be found at very high elevations on frozen mountaintop regions. In North America, it occurs in Mexico, USA, Canada, and Alaska. In South America, it is found in the Andes Mountains. In northern Europe, it is found in Sweden, Russia, Norway, and Finland. In Africa, it can be found in Mt. Kilimanjaro. And in Asia, it occurs in the Himalayan Mountains, which is located in Southern Asia, and in Mt. Fuji, in Japan. The plants are very similar to those of the arctic ones and include tussock grasses, small-leafed shrubs, and heaths. Plants here also have to contend with harsh conditions: cold temperatures (nighttime temperature is below freezing), high winds, and heavy snowfalls. Animals living in the alpine tundra include (i) Mammals: pikas, marmots, mountain goats, sheep, elk; (ii) Birds: grouselike birds; and (iii) Insects: springtails, beetles, grasshoppers, butterflies.

4.3 Problems of rangeland degradation

The problems of rangeland resources (causes of rangeland degradation) are more or less similar to that of other natural resources (forest, soil, and water). They can be classified into two: natural and human causes/problems/. The human problems are associated with the increasing number of the world's human population and the increasing demand for land for different purposes and inappropriate human activities, such as crop cultivation, overgrazing and under grazing, man-made fires, etc. The natural problems are drought and desertification, wildfire, spread of poisonous plant species, soil degradation, etc. The major problems related to rangeland degradation are the following:

i. *Reoccurring Drought*: Drought is a period of low precipitation in relation to a long term average amount. Drought is one of the major problems on the rangelands, and it results in

shortage of water to meet the demands of growing plants, livestock and wild animals. Shortage of water reduces the vigor of plants and ultimately results in plant mortality. This condition results in declining of forage quantity and quality and then animal productivity.

ii. *Expansion of Desertification*: Desertification is the formation of desert-like conditions largely through human activities in areas that had not experienced desert climate. The human activities considered as causes of desertification include overgrazing, cutting and burning of vegetation (deforestation), shifting cultivation, etc. Desertification also occurs due to natural causes, primarily recurrent drought.

Desertification is the major world environmental problem. However, it is more prominent in the Sahel region of Africa. This region is known for the recurrent drought. African Sahel is a sub-humid to semiarid region on the southern margin of the Sahara desert. It occupies parts of 10 countries from the Atlantic Ocean on the west to the Ethiopian highlands on the east. It has an east-west expanse of more than 4800kms and a north-south extent that varies from 480 to 800kms (McKnight and Hess, 2000).

iii. *Prevailing of Poisonous Plants*: Poisonous Plants cause decline of animal reproduction and animal death on many rangelands. The average annual range of livestock death by Poisonous Plants is estimated from 2 to 5%. Livestock deaths from poisonous plants are often related to poor management of rangelands, which results in poor range condition, and type of livestock. Poisonous plants lack nutritional value and are unpalatable and livestock commonly graze poisonous plants when they are hungry.

iv. *Incidence of Insects*: insects can more severely overgraze ranges than can domestic livestock. The range vegetation damage by insects occurs through destruction of plant roots, direct consumption of forage nutritional value and palatability, and destruction of seeds and pollens of plants. Among insects, grasshoppers cause the greatest damage on range vegetation.

v. *Problems related to Predators*: predators have considerable influence on the range animal (livestock and other non-predator wild animals) reproduction. They kill livestock. Predators as well as non-predators also overgraze the range vegetation and then result in rangeland degradation.

vi. *Problems related to Livestock Number and Distribution*: Too large number of livestock on a small rangeland can result in overgrazing because it is beyond the forage capacity. Too few livestock on a large rangeland can result in under-grazing and then rangeland degradation because livestock trample the range vegetation. Besides, weeds not suitable for livestock can grow on the under-grazed rangeland.

In relation to livestock distribution, livestock usually tend to avoid ridges and concentrate on parts of the rangeland, such as on the margins of water holes and shaded fields. This makes part of the rangeland (e.g. around the ridges) under-grazed and another part (e.g. water holes) overgrazed, and thus damage the healthy condition of rangelands.

4.4. Conservation and management of rangeland

To reduce the degradation of rangelands and improve the condition and productivity of rangelands resources (vegetations, livestock and wild animals) different range management techniques can be applied. Some of the techniques are the following:

I. *Range Rehabilitation*: In many places of the world, many hectares of rangelands have been severely degraded. In these areas, range management starts with the rehabilitation of the range. Rehabilitation involves three methods: *Closing the rangeland*, *Reseeding*, and *Fire.*

A. *Closing the rangeland from use*: This system involves closing of the rangeland and protecting it from grazing and other uses for some time until the destroyed range vegetation are recovered. This can be successful where the best forage species are not severely reduced.

B. *Artificial Reseeding*: reseeding the rangeland with the best fodder species is needed where forage species have been severely reduced. Ranges that have been properly reseeded support a greater number of livestock in better condition over a longer period than equivalent ranges that have not been reseeded. Reseeding can be carried out by using two techniques: *broadcasting* and *drilling.*

- *Broadcasting technique*: In this case, seeds are broadcasted over the land by hand or airplane. This technique is applied for uneven lands. The limitation of this technique is that the uncovered seeds may be blown away by strong rain or wind, or they may be eaten by birds and animals.

- *Drilling technique*: In this case, sowing is performed along furrows at uniform depth and distance using mechanical drills, like tractors. This technique is applied for even lands.

C. *Use of Fire/Burning of the Range*: Use of fire on, or burning of, the rangeland has both advantages and disadvantage. This compels us to decide whether we use fire or not. We use fire on the rangelands if the advantages are greater and if we properly utilize and control fire.

The advantages of using fire on the rangelands are:

- Fire can remove old plants with poor nutritional value, poisonous plants, and weeds
- Fire can remove pests and insects that can endanger animals and forage plants.
- Fire can increase the quantity and quality of forage vegetation by re-growth. By using fire, new nutritive plant growth is initiated. The re-growth of annual grass for livestock will be fast.

The disadvantages of fire are the following:

- Fire can cause loss of vegetation cover and wild animals (biodiversity), deterioration of soil quality or soil properties such as loss of soil organisms and organic matter, decreasing of soil permeability, and so on.

II. *Grazing Management*: Lack of proper grazing management has caused overgrazing and under-grazing and rangeland degradation, such as depletion of valuable forage species, increasing of undesirable plant species, and decreasing the productivity and carrying capacity of rangelands. To reduce this problem the following two grazing systems should be used: *mixed livestock grazing system* and *controlled grazing system*

- *Mixed livestock grazing system*: It involves grazing of two or more kinds of livestock in the same rangeland. As different kinds of animals have different kinds of feed habits, they may not destruct the specific type of forage vegetation. This method helps equal utilization of forage vegetation. For example, cows prefer grazing of legumes and grasses, and camels and goats prefer browsing of shrubs and tree leaves. Grazing and browsing should be carried out at the same time, or at different times during the same season.

- *Controlled grazing system*: This method involves studying the carrying capacity of the rangeland (i.e., the size of rangeland with the number of livestock), dividing the land into plots and grazing the plots of land in rotation. This method helps all places of the rangeland to be grazed and reduce continuous grazing of animals at one place (reduce overgrazing), initiate re-growth of forage vegetation on the grazed land, and hence provide sustainable forage for livestock.

III. *Water Development in the Rangeland*: If water holes in the rangeland are found in few places and are highly scattered, animals are forced to move far distances in search of water. This situation leads to excessive trampling of the range vegetation, overgrazing of the area around the water holes and under-grazing of vegetation where water holes are absent. Animals may also spend excessive time and energy while wandering in search of water. This in turn reduces their feeding time and appetite. In order to solve such problems there should be development of uniform water points/holes. In this case, animal distribution will be uniform, grazing pressure on specific places will be reduced, and the damage of vegetation by animals will be reduced.

IV. *Control of Poisonous Plants and Weeds, Pests, and Predators*: Effective control of weeds and poisonous plants, pests and insects, and predators on the rangelands is essential to maintain the productivity of rangeland recourses (forage plants and animals). Weeds and poisonous plants can be controlled by using fire, mechanical and biological methods, and chemicals. Insects and pests can be controlled by using insecticides and pesticides. Livestock predators can be exterminate from the rangelands by poisoning, shooting, or trapping. However, predators are wild animals that have aesthetic, economic and other values. So, the rancher is advised not to kill the predator unless it kills many livestock.

Exercise on chapter four

1. Define rangeland

2. Explain the characteristics of range lands

3.indicate the use of rangeland

4. List and elaborate the different types of rangeland of the world

Chapter 5: wildlife resources

Objectives: Up on the completion of this chapter, students will be able to

- Define wildlife
- Elaborate the management of wildlife
- Identify the approach of wildlife conservation
- Distinguish wildlife habitat of Ethiopia

5.1. Concepts of Wild life

Wildlife is a word whose meaning expands in contracts with the viewpoint of the user. Sometimes it is used to include all wild animals and plants. More often it is restricted to terrestrial vertebrates. In the discipline of wildlife management it designates free-ranging birds and mammals and that is the way it is used here. Until few decades wildlife was synonymous with "game," those birds and mammals that were hunted for sport. The management of such species is still an integral part of wildlife management but increasingly it embraces other aspects such as conservation of endangered species. In the recent past, before the expansion of wildlife promotion and education, some people also defined "wildlife" is only large mammals; such as elephants, lions, cheetah, hyena, leopard, buffalo and other related species. However, Wildlife refers to the variety of all living organisms inhabiting in the wild.

Wildlife management

Wildlife management is a general term for the process of keeping wild species at desirable levels which are determined by the **wildlife managers**. **Wildlife management** is the art and science of reaching goals by manipulating and/or maintaining **wildlife** habitats and populations.

Wildlife management takes into consideration the ecological principles such as

- Carrying capacity of the habitat,
- Preservation and control of habitat,
- Predator control,
- re-introduction of extinct species,

- capture and reallocation of abundant species and
- Management of desirable or undesirable species.

- The profession of wildlife management was established in USA during 1920-1930 by **Aldo Leopold** (1887-1948) and others

Types of wildlife management

- There are two general types of wildlife management:

Manipulative management involves regulating numbers of animals directly by harvesting or by influencing numbers by altering food supply, habitat, density of predators etc.

Custodial management is preventive or protective and minimizes external influences on the population and its habitat. It is done by setting up national parks where ecological conditions are protected and threatened species are conserved by law.

Regardless of whether manipulative or custodial management is called for, it is vital that

- The management problem is identified correctly;
- The goals of management explicitly address the solution to the problem; and
- Criteria for assessing the success of the management are clearly identified.

A wildlife population may be managed in one of four ways(option available to managers)

- make it increase;
- make it decrease;
- harvest it for a continuing yield;
- Leave it alone but keep an eye on it.

5.2. Management approach of wild life

Wild life management approach

Traditional Management

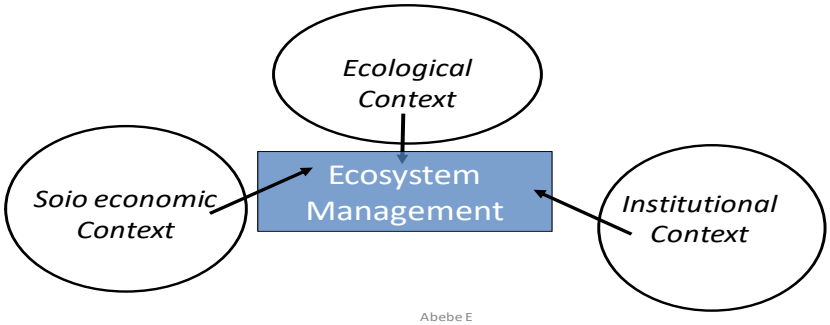
- Emphasis on commodities and natural resource extraction
- Stable and "equilibrium" perspective
- Reductionism, site specificity
- Predictability and control
- Solutions developed by resource management agencies
- Confrontation, single-issue polarization, public as adversary

Ecosystem Management

- Emphasis on balance between commodities, amenities, ecological integrity
- Dynamic and resilient
- Holism
- Uncertainty and flexibility
- Solutions developed through discussions with stakeholders
- Consensus building; multiple issues, partnerships

Ecosystem Management

An approach to maintaining or restoring the composition, structure, and function of natural and modified ecosystems for the goal of long-term sustainability…that integrates ecological, socioeconomic, and institutional perspectives…"



Wildlife Conservation

Today, wildlife conservation has evolved into a science, but its goal remains essentially the same: **to ensure the wise use and management of renewable resources.**

Given the right circumstances, living organisms that we call renewable resources can replenish themselves indefinitely.

Conservation: Is the wise use of natural Resources, without wasting them.

Preservation: (Saving natural resources, but with no consumption of them), is another means of protecting or saving a resource, such as outlawing hunting of endangered species. Both preservation and conservation are necessary to sustain resources for future generations.

Habitat Management: Most critical aspect of wildlife conservation is habitat management. *Habitat loss presents the greatest threat to wildlife.*

Habitat management principles

1. The need for food and water is obvious.

2. Cover is needed for shelter as well as to protect animals while feeding, breeding, roosting, nesting, and traveling.

3. Space is necessary to avoid over-competition for food. Some animals also need a certain amount of territorial space for mating and nesting.

4**.** Balancing Act**;** Habitats must be in balance in order to support wildlife. Remove a certain population of plants or animals from a community, and the community may not survive. This typically happens when urban development pushes into wildlife areas.

5**.** Carrying Capacity**,** Resources in any given habitat can support only a certain quantity of wildlife. As seasons change, food, water, or cover may be in short supply. Carrying capacity is number of animals habitat can support all year long. Carrying capacity of a certain tract of land can vary from year to year. It can be changed by nature or humans.

Limiting Factors

Factors that limit potential production of wildlife include:

- Disease and starvation
- Predators and hunting
- Pollution
- Accidents
- Old Age

- Hunting

The Hunter's Role in Wildlife Conservation

Since wildlife is a renewable resource with surplus, hunters help control wildlife populations at a healthy balance for the habitat. *Regulated hunting has never led to threatened or endangered wildlife populations.* Hunting is effective wildlife management tool. Hunters play important role by providing information from the field that wildlife managers need.

Management/Conservation Principles

Wildlife manager's job is to maintain number of animals in a habitat at or below habitat's carrying capacity, **so no damage is done to the animals or to their habitat**.

In addition to looking at the total number of a species in a habitat, wildlife managers also monitor breeding stock ─ correct mix of adult and young animals needed to sustain a population.

To manage a habitat, wildlife managers must consider

- historical trends,
- current habitat conditions,
- breeding population levels,
- long-term projections and
- breeding success.

Wildlife Management Practices

1. Monitoring Wildlife Populations:

Wildlife managers continuously monitor birth and death rate of various species and condition of their habitat. This provides data needed to set hunting regulations and determine if other wildlife management practices are needed to conserve wildlife species.

2. Habitat Improvement

As succession occurs, change in habitat affects type and number of wildlife habitat can support. Wildlife managers may cut down or burn forested areas to promote new growth and slow down the process of succession. This practice enables them to increase the production of certain wildlife species.

3**. Hunting Regulations:**

- Hunting regulations protect habitat and preserve animal populations.
- Regulations include setting daily and seasonal time limits, bag limits and legal methods for taking wildlife.

Wildlife Management Tools

1. Laws: Wildlife laws must be flexible, based on biological facts, and used in combination with other management tools. These game laws are necessary to protect the safety of people, to protect the game, and to insure a fair share for future generations.

2. Habitat Management: Ideal goal is manipulate vegetation so necessities for life for variety of wildlife are provided. Generally this is done by controlled burning, selective forestry, food planting where feasible and appropriate, and other practices to maintain proper mix of habitat requirements.

3. Stocking: Purpose of stocking is release wildlife species in areas that have suitable habitat but no animal population.

4. Hunting and Trapping: Valuable tools for maintaining wildlife populations at or below carrying capacity for the habitat. Goal is regulate hunting so only excess animals in a population are removed.

5. Public Education:Necessary for public understanding of wildlife management programs. The more people know and understand wildlife and its needs, the more likely they will support management programs.

Wildlife as Resources in Ethiopia:

The biogeographic of the country characterized by two features; namely the arid horn of Africa (Ogaden) and mosaic highland plateau and results extremely rich and distinctive flora and fauna. This wildlife diversity is a great attraction of tourists; nature based tourism to support the country's economy and for future protected area management to the country. The country has a diverse and contrasting from the desert of the Dankil Depression, the lowest dry land points on earth at 116 m below sea level to Ras Dashen Mountain (the second peak and roof of Africa) at 4543 m above sea level. Therefore, Ethiopia has one of the most diverse mammalian faunas in Africa and the great attractions of it wildlife heritage. Traditionally, many people simply represented Ethiopia as "*Home of the Unique Seven" which refers to seven distinctive and* large endemic mammals found only in Ethiopia.

- Those seven large mammals are;
    - the Ethiopian wolf (*Canis simensis),*
    - Mountainnyala (*Tragelaphus buxtoni),*
    - *Walia ibex (Capra walle),*
    - *Menelik's bush buck,*
    - *Swayne's hartebeest* (*Alcelaphus buselaphus swaynei),*
    - *Gelada baboon*
    - *(Theropithecus gelada) and Bale monkey*

Exercise on chapter Five

1. Explain the concept of wildlife
2. Indicate which type of wildlife management is more sitable in your locality>
3. List wildlife management tools and their suitability in tour local context

Chapter 6: Water resources

Objectives: Up on the completion of this chapter, students will be able to

- Identify the characteristics of water
- Indicate the major cause of water stress in the world
- Identify the major cause of water pollution
- Elaborate the water resource management

Water Characteristics/Properties

Water is the most distinctive, inorganic substance on earth. It is unique among other substances in various properties. The properties of water can be divided into physical and chemical. Some important properties are the following:

CLASSIFICATION AND DISTRIBUTION OF WATER RESOURCES

Classifications of Water Resources

Water resources of the world can be classified in different ways based on different criteria. The three major classifications are based on the physical state, on total amount of TDS or salinity, and on geographic location

1. Based on the physical state, water can be divided into three: - *liquid water*, *solid water* (ice), and *gaseous water* (water vapor). Liquid water is the most abundant in terms of amount followed by solid water (ice) and gaseous water (water vapor). Of the total amount of earth's water (about 1.4 billion km^3), slightly less than 98% is liquid, almost 2% is solid, and the remaining (slightly less than 0.001%) is gaseous water.

2. Based on salinity, the world's water can broadly be divided into two – *saline water* and *fresh water*. Saline water is the most abundant, making up about 97.6%, which is found in oceans although insignificant saline water is also found in some lakes and underground. Ocean water is too salty for drinking, growing crops and most industrial user except cooling. It is the remaining 2.4% of the total earth's water that is fresh. Of the 2.4% of all water that is fresh, nearly 90% is tied up in glaciers, ice caps, and snowfields. These ices and some deep groundwater are remote and cannot be accessed by human being. The amount of fresh water

directly accessed by human beings is only about 0.3%. Such usable fresh water is mainly stored as rivers and streams, lakes and ponds, and groundwater.

3. On the basis of geographic location, the world's water resources can be classified into three – *surface water*, *subsurface water*, and *atmospheric water*. Surface water, water existing on the earth's surface, is the largest, and it includes oceans, lakes, rivers and streams, glaciers and ice sheets. Surface water covers more than 70% of the earth's surface and more than 99% of the total earth's water. After surface water, subsurface water, water below the earth's surface, is the second, containing about 0.29% of the total earth's water, and it includes soil moisture and groundwater. Atmospheric water is the least, making up 0.001% of the earth's water, and it included water vapor and clouds.

Distributions of Water Resources

As stated above, the earth's total volume of water is estimated to be around 1.4 billion km^3, but this water is distributed very unevenly on, in, and above the earth's surface. The distribution of water around the globe depends mainly on climatic factors, including high-pressure zones and prevailing winds, and topography. Human activities, such as deforestation also affects regional water supplies. The distribution of water often is described in terms of interacting reservoirs/compartments in which water resides for short or long times. Table 1 shows the major water reservoirs in the Earth.

Table 1: Distribution of water in Earth's Reservoirs – Estimated Volume of Water in Storage, Percent of Total, and Average Residence Time

Water Reservoirs	***Volume (Thousands of km^3)***	***% Total Water***	***Average Residence Time***
Ocean	1,370,000	97.6	3,000 years to 30,000 years*
Ice and Snow	29,000	2.07	1 to 16,000 years*
Groundwater down to 1km	4,000	0.28	From days to thousands of years*
Fresh Lakes and ponds	125	0.009	1 to 100 years*
Saline lakes	104	0.007	10 to 100 years*
Soil moisture	65	0.005	2 weeks to 1 year
Biological moisture in plants and animals	65	0.005	1 week
Atmosphere	13	0.001	8 to 10 days
Swamps and marshes	3.6	0.003	From months to years

Rivers and streams	1.7	0.0001	10 to 30 days
Total Earth's Water	***1,403,377***	***100***	***2,800***

Source: Cunningham *et al*, 2005

* Depends on depth and other factors

Freshwater Availability and Use

The readily accessible, renewable water supplies are very large, amounting to some 1,500 km^3 (about 400,000 gallon) per person per year worldwide, but the amount of freshwater supply varies regionally and locally due to various factors.

***Water Use*:**We can divide water use into three major purposes/sectors: agricultural, domestic, and industrial.

I. ***Agricultural Water Use***: Of the three major water uses, agriculture, predominantly irrigation, accounts for by far the greatest use and consumption. Worldwide, crop irrigation is responsible for two-third of water withdrawal and 85% of consumed

II. ***Domestic Water Use***: Worldwide, domestic water use accounts for about one-fifth of water withdrawals. Water is used domestically for personal consumption (drinking, cooking), flushing toilets, showers and baths, laundry, dishwashing and for general hygiene. Because little of this water evaporates or seeps into the ground, consumptive water use is slight, about 10% on average.

III. ***Industrial Water Use***: Industry accounts for about 20% of freshwater withdrawn globally. Water is used by industries for variety purposes, such as power production, including hydropower, nuclear and thermoelectric power. Industrial processes also require water as a coolant for machinery, as a lubricant, as a component of the product being made, etc.

5.3 Degradation of water resources (water shortage and pollution)

As stated earlier, water is finite and fixed resource, and is a basic necessity for life on earth. Globally, freshwater supplies are abundant but unevenly distributed in space and time, and are under pressure. The combination of both naturally occurring conditions and humanity's actions creates pressure on our water resources, resulting in shortage and pollution and then degradation of the ecosystem in general.

Water Shortages

Water shortage has becoming the major problem in the world. The World Health Organization considers 1,000m^3 of water per person per year to be the minimum level below which most countries are likely to experience chronic shortages on a scale that will impede development and harm human health. Currently, some 45 countries – most of them in Africa and Middle East – are considered to have serious *water stress*, and cannot meet the minimum essential water needs of all their citizens. (Water stress occurs when consumption exceeds 20% of the available, renewable water supplies.) About 20% of the world's population (about 1.5 billion people) currently lacks access to adequate quantity and quality of drinking water, while 50% lacks access to a safe sanitation system.

Causes of Water shortage: The reasons for water shortages are many.

In some cases deficits are caused by **natural forces**: the rains fail; hot winds dry up reservoirs that normally would carry people through the dry season; rivers change their courses, leaving villages stranded.

In other cases, shortages are **human in origin**: too many people compete for the resource; urbanization, overgrazing, and inappropriate agricultural practices allow water to runoff before it can be captured; a lack of adequate systems causes contamination of local supplies; and lack of economy – without money for wells, storage reservoirs, delivery pipes and other infrastructure, people can't use the resources available to them.

Water Pollution

Water pollution refers to any physical, chemical, or biological change in water quality that adversely affects living organisms or makes water unsuitable for desired uses. It is the degradation of water quality as measured by biological, chemical, or physical criteria. Water pollution is generally judged in terms of the intended use, departure from the norm, effects on public health or ecological impacts. Although fresh water is a potentially renewable resources it can become so contaminated by human and natural activities that is no longer useful for many purposes. The following are eight common types of water pollutants:

1. *Disease causing agents*: bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and animal wasters.
2. *Oxygen demanding wastes*: organic wastes, which when degraded by oxygen consuming bacteria can deplete water of dissolved oxygen gas.
3. *Water soluble inorganic chemicals*: acids salts and compounds of toxic metals such as lead and mercury.
4. *Inorganic plant nutrients*: water soluble nitrate and phosphate compounds that can caused excessive growth of algae and other aquatic plants which then die and decay depleting water of dissolved oxygen and killing fish.
5. *Organic chemicals*: oil gasoline plastics pesticides clearing solvents detergents and may other water soluble and insoluble chemicals that threaten human health and harm fish and other aquatic life.
6. *Sediment or suspended matter*: insoluble particles of soil silt and other solid inorganic and organic materials that become suspended in water.
7. *Radioactive substances*: radioisotopes that are water soluble or capable of being biologically amplified in food chains and webs.
8. *Heat:* excessive inputs of heated water used, for example, to cool electric power plants. The resulting increases in water temperature lowers dissolved oxygen content and make aquatic organisms more vulnerable to disease parasites and toxic chemicals

Water pollution has many sources. Pollution-control standards and regulations, usually distinguish between *point pollution sources* and *non-point pollution sources. Point sources* are specific locations of highly concentrated pollution discharges, such as factories, power plants, sewage treatment plants, underground coal mines, and oil wells. They discharge pollution from drain pipes, ditches, or sewer outfalls. These sources are discrete and identifiable, so they are relatively easy to monitor and regulate. In contrast, *non-point sources* are scattered or diffuse, having no specific locations where they discharge into a particular water body. They include runoff from farm fields and feedlots, golf courses, lawns and gardens, construction sites, logging areas, roads streets, parking lots, etc. The contaminated runoff eventually flow into surface water and seep into ground water

The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture, and industry. It diminishes the aesthetic quality of lakes and rivers. More seriously, contaminated water destroys aquatic life and reduces its reproductive ability. Eventually, it is a hazard to environment.

5.4 .Water resources conservation and management: A number of water management and conservation techniques can be used to reduce water shortage and pollution. Some of them are the following:

A. *Reducing Agricultural waste*: Most irrigation systems deliver water to crops by flooding the land surface, diverting water to fields via open channels, or by sprinkler systems. In general, these methods are very inefficient as only 50% of the water applied is absorbed by the plants. The rest is lost to the atmosphere by evaporation. Improved irrigation methods and other strategies are beginning to reduce some consumptive losses and the overall agricultural water use. These include:

- *Drip irrigation*: This technique can reduce irrigation water use. Drip irrigation systems release carefully regulated amounts of water just above plant roots, so that nearly all water is used by plants.
- The cultivation of food crops that require less water for growth.
- The use of lined or covered irrigation canals to reduce infiltration and evaporation losses
- Irrigating crops at night or early morning when evaporation potentials are low.
- Reduce water subsidies and encourage the proper pricing of water for this purpose.

B. *Reducing Industrial Waste*: Industry is the second largest user of water supplies. Reducing the amount of water used in industry not only makes more water available for other purposes but it can also reduce the volume of pollution. Industrial waste reductions can be achieved by:

- Designing industrial processes to recycle water. For example, water used for industrial cooling purposes can be cooled down in a cooling tower and then reused.
- Increasing the cost of water to industries to encourage water recycling.
- Recycling materials themselves can also greatly reduce water demand. For example, manufacturing a ton of aluminum from scrap rather than from virgin ore can reduce the volume of water used by 97%.

C. *Reduce Domestic Waste/consumption*: Some of the measures for reducing domestic consumption include:

- Education can encourage people to reduce the amount of personal consumption
- Encourage the use of efficient irrigation systems for home garden and lawn use.
- Manufacture and legislate the use of more efficient dishwashers, washing machines, and bathroom showers and toilets.
- Encourage leak detection and repair for distribution systems. Distribution systems in many of the world's urban areas are losing between 25 and 50% of their water supplies due to leaks in pipes.
- Properly price water for domestic use. This price must reflect the environmental cost of overconsumption and resource degradation.

D. *Encourage water harvesting*: water harvesting is collecting and utilizing water from surfaces on which rain falls and from surfaces on which runoff/stream moves.

i. *Rainwater harvesting*: collecting rainwater is one of the easiest and most effective ways to have a safe supply of water. Rainwater can be collected and stored from rooftops, land surfaces or rock catchments using simple techniques such as jars and pots as well as engineered techniques, and the process is called rainwater harvesting. Rainwater harvesting has been practiced for more than 4,000 years, owing to the temporal and spatial variability of rainfall. It is an important water source in many areas with significant rainfall but lacking any kind of conventional, centralized supply system. It is also a good option in areas where good quality fresh surface water or groundwater is lacking. The application of appropriate rainwater harvesting technology is important for the utilization of rainwater as a water resource.

Advantages of Rainwater Harvesting: Rainwater harvesting systems can provide water at or near the point where water is needed or used. The systems can be both owner and utility operated and managed. Rainwater collected using existing structures (i.e., rooftops, parking lots, playgrounds, parks, ponds, flood plains, etc.) has few negative environmental impacts compared to other technologies for water resources development. Rainwater is relatively clean and the quality is usually acceptable for many purposes with little or even no treatment. The physical and chemical

properties of rainwater are usually superior to sources of groundwater that may have been subjected to contamination.

Some Other Advantages of Rainwater Harvesting Include:

- ✓ Rainwater harvesting can co-exist with and provide a good supplement to other water sources and utility systems, thus relieving pressure on other water sources.
- ✓ Rainwater harvesting provides a water supply buffer for use in times of emergency or breakdown of the public water supply systems, particularly during natural disasters.
- ✓ Rainwater harvesting can reduce storm drainage load and flooding in city streets.
- ✓ Users of rainwater are usually the owners who operate and manage the catchment system, hence, they are more likely to exercise water conservation because they know how much water is in storage and they will try to prevent the storage tank from drying up.
- ✓ Rainwater harvesting technologies are flexible and can be built to meet almost any requirements. Construction, operation, and maintenance are not labor intensive.

ii. *Surface runoff harvesting*: surface runoff (streams) can also be diverted and collected by constructing dams and reservoirs, and the water can be used for domestic water supply, irrigation, hydropower, fishing, etc. Dams can also control downstream flooding and siltation.

E. *Watershed Management and conservation**:*** these are often more economical and environmentally sound ways to prevent flood damage and store water for the future use than building dams and reservoirs. A *watershed****,*** or catchment, is all the land drained by a river and its tributaries. Watershed Management involves retaining vegetation and ground cover in a watershed, practicing of forest and soil conservation techniques such as planting of trees and protecting them, terracing and applying appropriate agricultural systems. This helps hold back rainwater, by increasing infiltration, increase the quality and quantity of water sources (both surface and subsurface waters) and reduce downstream floods.

F. *Reduce Water Pollution*: appropriate land-use practices and careful disposal of industrial, domestic, and agricultural wastes are essential for control of water pollution. The cheapest and most effective way to reduce water pollution is source reduction – avoid producing it or releasing it to the environment. Often, industrial wastes can be recycled or reclaimed rather than

released. Agricultural practices can reduce field runoff, and sediment barriers at construction sites can reduce sediment releases. Land-use planning can greatly reduce pollution. The polluted water can be treated through chemicals and other purification techniques.

Exercise on Chapter six

1. What is the main source of fresh water

2.Identfiy the point and nonpoint source of water pollution? Which one is the most prevalent in your locality?

3. Identify and discuss the major water resource management methods

4. Explain the impacts of agricultural activities, industry, mining, municipalities and residence on water resource

Chapter 7: Mineral resources

Objectives: Up on the completion of this chapter, students will be able to

- Explain how minerals are formed
- Distinguish between mineral resource and reserves
- State the importance of mineral
- Indicate the management of mineral resources

6.1 The nature and use of minerals

Definition and characteristics of minerals: Minerals are defined differently by different people. For example, geologists defined that a mineral is naturally occurring inorganic crystalline solid substance with definite chemical composition. According to this definition, four conditions/characteristics of minerals/ must be fulfilled for a substance to be mineral.

i. *Natural Occurrence*: It must occur naturally. Elements or compounds invented by human beings are not considered minerals.
ii. *Inorganic Substances*: It must be made up of inorganic substances or processes. The substance produced solely by living organisms or biological processes is not a mineral.
iii. *Crystalline Solid*: It must contain atoms in a regular, repeating pattern and forming solid units called crystals. Crystalline substances have definite structure (crystal form). The pattern may not be apparent to the naked eye, but most solid compounds are crystalline, and their crystal structures can be recognized and studied using x-rays and other techniques.
iv. *Specific Chemical Composition*: It must have the same chemical composition, wherever found and whenever analyzed. Chemically, minerals either consist of one element – like diamond which is pure carbon – or compounds of two or more elements, example halite. Some mineral compositions are very complex, consisting of ten or more elements. The presence of certain elements in certain proportions is one of the identifying characteristics of mineral.

On the other hand, non-geologists define mineral as: “a mineral is any naturally occurring organic and inorganic substance that form part of natural substances”. According to this definition, substances that are not formed of inorganic, solid, crystalline materials such as coal, petroleum, and natural gas are also mineral resources (Yadav and Sinha, 2005). Coal and

petroleum or mineral oil owe their origin to the fossils of plants and animals (buried vegetation and animals) and hence are organic in nature. Since they are used as fuel, they are also known as *fossil fuels* or *mineral fuels*, and included under non-metallic minerals. Geologists do not include coal, petroleum, and natural gas as minerals, rather they include these as one of geologic resources called *energy resources or fossil fuels*.

Nature and Use of Minerals

Minerals exist in different forms. A few minerals may occur as discrete elements in nature. But, majority of minerals exist in compound. (Compound is a substance formed by the chemical combination of elements in fixed proportions.) Minerals can be organic (according to non-geologists) or inorganic in nature. Majority of the minerals are inorganic in nature. Minerals can be metallic or non-metallic in nature. But all minerals are non-renewable resources. In geology, minerals are regarded as being the 'building blocks' of rocks.

Minerals are found at and beneath the earth's surface, and they occur in different types of formations e.g. igneous intrusions, sedimentary ore deposits, alluvial deposits and oceanic deposits. Many important mineral deposits are contained within igneous intrusions and are found at different depths as they solidified at different temperatures. As such some of them are often found in association with the other such as silver with lead and zinc because they solidify at a similar temperature. Other minerals may be found at different levels e.g. tin is found at a greater depth than copper. Minerals are generally found in the form of ores, which contain several impurities. Minerals are separated from the ores involving a number of distinct processes.

The importance of minerals to human beings is extremely high. The mineral resources provide man with economic well-being and enable people get sources of *energy* and other *nonfuel minerals* for different purposes. Although minerals are used for various purposes, they are *economic substances*. The economic development of a country depends to a great extent on the availability and extraction of minerals. Mineral production is extremely important in the economies of many developing countries. Several countries in Africa and a few in South America and Asia have over 50% of their export earnings from minerals alone.

6.2 Classification of mineral resources

Mineral resources can be classified in different ways, but usually they are classified into two: *metallic mineral* resources and *non-metallic mineral* resources based on the nature of minerals.

A. *Metallic mineral Resources*: are those minerals of metallic in nature, or are those which yield metals. A *metal* is any chemical element with a metallic luster, ductility, and the ability to conduct electricity and heat. About 40 metals are commercially important. Some, such as iron, lead, copper, aluminum, silver, and gold are familiar. Others, such as vanadium, titanium, and tellurium, are less well known but are vital to industry.

Metallic minerals/metals are found in ores. The concentration of a mineral in a mineral deposit or in an ore is critically important in determining whether it can be mined profitably. (A *mineral deposit* is a local enrichment of one or more minerals. *Ore* is rock sufficiently enriched in one or more minerals to be mined profitably. Geologists usually use the term *ore* to refer to metallic mineral deposits, and the term is commonly accompanied by the name of the metal – for example, iron ore or silver ore. *Mineral reserves* are the known supply of ore in the ground. The term can refer to the amount of ore remaining in a particular mine, or it can be used on a global or national scale. *Mining* is the extraction of mineral resources, but not including the working of building stone, which usually is referred to as *quarrying.*)

B. Non metallic mineral Resources: A nonmetallic resource is any useful rock or mineral that does not have metallic properties, such as salt, sulfur, sand and gravel. Of course, most rocks and minerals contain metals, but when non-metallic resources are mined it is usually to use the rock (or mineral) as at is (example using gravel and sand for construction projects); whereas metallic ores are processed to extract metal. As stated above, coal, petroleum and natural gas are included under the non-metallic group by non-geologists.

Distribution and Production of Some Commercial Minerals

Minerals are distributed unevenly. Commercially viable mineral deposits are found only in selected places. However, because of the extensive use, many of the world's richest mineral deposits have either been depleted or are on the verge of depletion. Globally, the mineral use has increased over time. Since the industrial revolution, associated technological developments and growing population have increased the use of minerals at very high rates, which is greater than the rate of their formation. During last century, mineral use increased 13 times or more. Economically important minerals include iron, manganese, lead, aluminum (bauxite), copper,

nickel, tin and zinc. We will now discuss the distribution and production of a few important mineral resources (Table 2). While iron, copper and bauxite are metallic minerals, coal and mineral oil are fossil fuels.

Table 2: Commercial Minerals: World Reserves, Uses and Major Producers

Mineral Resources	***Uses***	***World Reserves (Metric Tons)[a]***	***Major Producing Countries***
Bauxite	Ore of aluminium	21,559,000	Australia, Guinea, Jamaica, Brazil
Chromium	Alloys, electroplating	418,900	South Africa, CIS[b], India, Turkey, Zimbabwe
Copper	Alloys, electric wires	3,21,000	Chile, USA, Canada, CIS
Gold	Jewellery, circuitry in computers, communications equipment, dentistry	42	South Africa, USA, CIS, Australia, Canada
Iron ore	Iron and steel	64,648,000	CIS, Brazil, Australia, China, Canada, Venezuela, Mauritania
Lead	Storage batteries, solder, pipes	70,440	CIS, USA, Mexico, Canada, Peru
Manganese	Iron and steel production	812,800	CIS, South Africa, Gabon, Australia, Brazil, France.
Nickel	Stainless steel	48,660	CIS, Canada, New Caledonia, Norway, Dominican Republic
Silver	Jewellery, photography, dentistry	780	Mexico, USA, Peru, CIS, Canada
Tin	Coating on metal, tin cans, alloys, solder	5,930	China, Brazil, Indonesia, Malaysia
Titanium	Alloys; white pigment in paint, paper, and Plastics	288,600	Australia, Norway, CIS
Zinc	Iron and steel, alloys, rubber products, medicines	143,910	Canada, Australia, CIS, China, Peru, Mexico, Spain

(a) One metric equals approximately 1.102 British tons.
(b) Commonwealth of Independent States (includes much of the former Soviet Union).

Source: Yadav and Sinha, 2005

Sustainable Use of Nonrenewable Minerals

- Do not waste mineral resources
- Recycle and reuse 60–80% of mineral resources
- Include the harmful environmental costs of mining and processing minerals in the prices of items (full-cost pricing).
- Reduce subsidies for mining mineral resources.
- Increase subsidies for recycling, reuse, and finding less environmentally harmful substitutes
- Redesign manufacturing processes to use less mineral resources and to produce less pollution and waste.
- Have the mineral-based wastes of one manufacturing process become the raw materials for other processes.
- Slow population growth.

Exercise on chapter seven

1. Define mineral

2. Differentiate metallic and noon metallic minerals

3. How do distinguish inferred, indicated and measured minerals

4. How mineral could be conserved to use it sustainably?

Chapter 8: Human resources

Objectives: Up on the completion of this chapter, students will be able to

- Define human resource
- Identify the characteristic s of huan resource
- Indicate the distribution human resource in the world

8.1. Characteristics of human resources

Human resources include the numbers, skills, abilities and wealth of the human population of an area. Human resources are the *human labor, the physical abilities, and mental abilities* that produce the goods and services of businesses.

Human beings are considered as ultimate resources, because it is the ability of humans that helps to change the gifts of nature into valuable resources. While taking into account human beings as resources, the following things have to be kept in mind: - the quantity (numbers) and quality (e.g. age, manual skill, innovative ability and wealth) of the population. The number and quality of human population are the major characteristics or factors that determine various aspects of a country, such as environment/natural resource/ management and economic development.

Labor along with skill or ability is an important human resource characteristic, and many economists distinguish between *productive and unproductive labor*. The former consists of those kinds of exertion that produce utility embodied in natural objects. Unproductive labor, like that of the musician, is useful but does not add to the material wealth of the community. Highly skilled human resources are essential for the development and diffusion of knowledge and constitute the crucial link between technological progress and economic growth, social development and environmental well-being. While the number and distribution of scientists and engineers were recognized as important indicators of a nation’s development. Hence, the strength of the nation is dependent on the quality of human resources but not the number. Excellent health, high skills and effective in situational organization taken together are fully as important as any of other factors of production and natural resources. On the other hand, the economic development of a region is the function of its population growth if it has to absorb its entire manpower.

Human characteristics such as labor, skills, expertise and finance also determine the conservation and management natural resources. Studies show that the higher the number and capacity of 'willing, qualified, capable and productive people', the higher the management of natural resources and sustainable utilization of these resources (Dwasi, 2002; cited in Sherbinin, 2006), and the greater the economic development of the country or region.

Human resource has a great variety of functions, and in industry and other economic activities, it may be classified as follows: production of raw materials, as in mining and agriculture; manufacturing in the widest sense of the word, or transformation of raw materials into objects serviceable to humans; distribution, or transference of useful objects from one place to another, as determined by human needs; operations involved in the management of production, such as accounting and clerical work; and personal services such as those rendered by physicians and teachers.

8.2. Distribution of human resources

The geographical distribution of man as the originator of all economic activities in a region gives a general idea of the intensity of economic activities and exchange or trade patterns resulting from the grand pattern of economic activity. The distribution and density of population is closely interlinked with the physical environment which have both restrictive and permissive relations to human activities.

The distribution of labor force among various occupation, its size difference in participation rates by age, literacy, and sex-wise participation in different economic activities are the fair indices of the nature of economy prevailing in an area. In fact, the occupational pattern of an area unfolds its diverse economic, demographic, and cultural attributes and provides a background for formulating the plans for its socio-economic development.

There is a clear distinction between economically active and not active population. The human resource is thus divided into two categories: *workers* and *non workers*. Worker is the person whose main activity is participation in any economically productive work by his physical and mental activity. Work involves not only the actual work but effective supervision and direction of work also. The magnitude of working force in an area depends up on a variety of economic,

demographic and social factors. The division of working force into various activities is another significant aspect of economic composition. UN has been recommended nine fold classification of workforce:

1. Cultivators
2. Agricultural laborer
3. Livestock, forestry, fishing, hunting, plantation, orchids and allied activity
4. Mining and quarrying
5. Manufacturing, processing, servicing and repairing
6. Construction
7. Trade and commerce
8. Transport, storage and communication
9. Other services

Human resources distribution varies from nation to nation and occupation. For instance, in 2003, 44% of the world's labor force was employed in agriculture. The distribution ranged from 66% of the economically active population in Sub-Saharan Africa to less than 3% in the United States and Canada. In Asia and the Pacific the workforce engaged in agriculture was 60%; in Latin America and the Caribbean, 19%; and in Europe, 9%.

Health care personnel are not evenly distributed among the world's population. Wealthy industrialized countries have more physicians per person than poorer developing countries. In the mid-1990s, the United States had one physician for every 400 people and Canada one per 454 persons. In comparison, the African country of Malawi had one physician per 45,736 people; Nigeria had one per 5,207 people; and India had one physician per 2,459 people.

Exercise on chapter eight

1. Explain how the pandemic of COVID-19 affect human resource in the world, Africa and Ethiopia. Use substantial evidence to support your details .