

Reading material for Second year economics students

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Chapter One

An Introduction to Natural Resource and Environmental Economics

Learning objectives

In this chapter you will:

- be introduced to the subject matter of natural resource and environmental economics
- learn about the history of natural resource and environmental economics
- discuss the linkages between the environment and the economy, and different views for the prospects in the environment

1.1 Introduction

Natural resource and environmental economics is a term which composed of economics, natural resource, and environment. A standard definition of economics could describe it as, *a social science directed at the satisfaction of needs and wants through the allocation of scarce resources which have alternative use*. We can go further to state that:

- economics is about the study of **scarcity** and **choice**
- economics finds ways of reconciling **unlimited wants** with **limited resources**
- economics explains the problems of living in communities in terms of the underlying **resource costs** and **consumer benefits**
- economics is about the **co-ordination of activities** which result from specialization

And, natural resource and environment are interrelated. Ever since the earth was inhabited, humans and other life forms have depended on things that exist freely in nature to survive. These things include water (seas and fresh water), land, soils, rocks, forests (vegetation), animals (including fish), fossil fuels and minerals. They are called Natural Resources and are the basis of life on earth and found in the environment. Resources are finite, and people and governments must make choices. By studying the way that people make choices, the better choices we make. By extension of our basic definition, economics as applied to natural resource and environmental issues is concerned with the efficient allocation of natural resources to maximize the welfare of society.

Environmental Economics: As a field of economics, it studies economic basis for pollution problems, as well as the policies designed to resolve pollution. It also studies the application and performance of incentive regulatory practices on pollution control/management, and it estimates the benefits of environmental improvements or the costs of pollution externalities. And, Natural Resource Economics studies the problems of governing common-pool natural resources, finding dynamically optimal rates of resource extraction, the workings of resource and energy markets by applying economics theories to manage naturally occurring resources for human needs/wants.

Natural resource and environmental economics is therefore the combination of the two fields and defined as an applied field of economics in which the principles and theories of economics applied in the use of natural environmental resources. More precisely, natural resource and environmental economics is the study of methods, systems and structures for sustainable utilization of scarce resources. It suggests the ways and means of satisfying unlimited wants from environment within the context of limited environmental resources by suggesting the optimum utilization of natural resources (both renewable and non-renewable).

The three themes that run through this field are ***efficiency, optimality and sustainability***. The concepts of efficiency and optimality are used in specific ways in economic analysis. One way of thinking about efficiency is in terms of missed opportunities. If resource use is wasteful in some way then opportunities are being squandered; eliminating that waste (or inefficiency) can bring net benefits to some group of people. An example is energy inefficiency. It is often argued that much energy is produced or used inefficiently, and that if different techniques were employed significant resource savings could be gained with no loss in terms of final output.

This kind of argument usually refers to some kind of technical or physical inefficiency. Economists usually assume away this kind of inefficiency, and focus on allocative inefficiencies. Even where resources are used in technically efficient ways, net benefits are sometimes squandered. For example, suppose that electricity can be, in technically efficient ways, generated by the burning of either some heavily polluting fossil fuel, such as coal, or a less polluting alternative fossil fuel, such as gas. Because of a lower price for the former fuel, it is chosen by profit maximizing electricity producers. However, the pollution results in damages which necessitate expenditure on health care and clean-up operations. These expenditures, not borne by the electricity supplier, may exceed the cost saving that electricity producers obtain from using coal.

If this happens there is an inefficiency that results from resource allocation choices even where there are no technical inefficiencies. Society as a whole would obtain positive net benefits if the less polluting alternative were used. We show throughout the book that such allocative inefficiencies will be pervasive in the use of natural and environmental resources in pure market economies. A substantial part of environmental economics is concerned with how economies might avoid inefficiencies in the allocation and use of natural and environmental resources.

The second concept – optimality – is related to efficiency, but is distinct from it. To understand the idea of optimality we need to have in mind:

1. a group of people taken to be the relevant ‘society’;
2. some overall objective that this society has, and in terms of which we can measure the extent to which some resource-use decision is desirable from that society’s point of view.

Then a resource use choice is socially optimal if it maximizes that objective given any relevant constraints that may be operating.

The reason efficiency and optimality are related is that it turns out to be the case that a resource allocation cannot be optimal unless it is efficient. That is, efficiency is a necessary condition for optimality. This should be intuitively obvious: if society squanders opportunities, then it cannot be maximizing its objective (whatever that might be). However, efficiency is not a sufficient condition for optimality; in other words, even if a resource allocation is efficient, it may not be socially optimal. This arises because there will almost always be a multiplicity of different efficient resource allocations, but only one of those will be ‘best’ from a social point of view. Not surprisingly, the idea of optimality also plays a role in economic analysis.

The third theme is sustainability. For the moment we can say that sustainability involves taking care of posterity. Why this is something that we need to consider in the context of resource and environmental economics is something that we will discuss in the next chapter. On first thinking about this, you might suspect that, given optimality, a concept such as sustainability is redundant. If an allocation of resources is socially optimal, then surely it must also be sustainable? If sustainability matters, then presumably it would enter into the list of society’s objectives and would get taken care of in achieving optimality. Things are not quite so straightforward. The pursuit of optimality as usually considered in economics will not necessarily take adequate care of posterity. If taking care of posterity is seen as a moral obligation, then the pursuit of optimality as economists usually specify it will need to be constrained by a sustainability requirement.

1.1.1 The Emergence of Resource and Environmental Economics

The field natural resource and environmental economics as a separate discipline is relatively a recent event. But, the concept goes back to 18th. We now briefly examine the development of resource and environmental economics from the time of the industrial revolution in Europe.

A. Classical economics: the contributions of Smith, Malthus, Ricardo and Mill to the development of natural resource economics

While the emergence of natural resource and environmental economics as a distinct sub-discipline has been a relatively recent event, concern with the substance of natural resource and environmental issues has much earlier antecedents. It is evident, for example, in the writings of the classical economists, for whom it was a major concern. The label ‘classical’ identifies a number of economists writing in the eighteenth and nineteenth centuries, a period during which the industrial revolution was taking place (at least in much of Europe and North America) and agricultural productivity was growing rapidly. A recurring theme of political–economic debate concerned the appropriate institutional arrangements for the development of trade and growth.

These issues are central to the work of Adam Smith (1723 –1790). Smith was the first writer to systematize the argument for the importance of markets in allocating resources, although his emphasis was placed on what we would now call the dynamic effects of markets. His major work, *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), contains the famous statement of the role of the ‘invisible hand’:

But it is only for the sake of profit that any man employs a capital in the support of industry; and he will always, therefore, endeavor to employ it in the support of that industry of which the produce is likely to be of the greatest value, or to exchange for the greatest quantity, either of money or of other goods.

As every individual, therefore, endeavors as much as he can both to employ his capital in the support of domestic industry, and so to direct that industry that its produce may be of the greatest value; every individual necessarily labors to render the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. . . . He is, in this as in many other cases, led by an invisible hand to promote an end which was no part of his intention. By pursuing his own interest he frequently promotes that of society more effectively than when he really intends to promote it.

This belief in the efficacy of the market mechanism is a fundamental organizing principle of the policy prescriptions of modern economics, including resource and environmental economics.

A central interest of the classical economists was the question of what determined standards of living and economic growth. Natural resources were seen as important determinants of national wealth and its growth. Land (sometimes used to refer to natural resources in general) was viewed as limited in its availability. When to this were added the assumptions that land was a necessary input to production and that it exhibited diminishing returns, the early classical economists came to the conclusion that economic progress would be a transient feature of history. They saw the inevitability of an eventual stationary state, in which the prospects for the living standard of the majority of people were bleak.

This thesis is most strongly associated with Thomas Malthus (1766 –1834), who argued it most forcefully in his *Essay on the Principle of Population* (1798), giving rise to the practice of describing those who now question the feasibility of continuing long-run economic growth as ‘neo-Malthusian’. For Malthus, a fixed land quantity, an assumed tendency for continual positive population growth, and diminishing returns in agriculture implied a tendency for output per capita to fall over time. There was, according to Malthus, a long-run tendency for the living standards of the mass of people to be driven down to a subsistence level. At the subsistence wage level, living standards would be such that the population could just reproduce itself, and the economy would attain a steady state with a constant population size and constant, subsistence-level, living standards.

This notion of a steady state was formalized and extended by David Ricardo (1772 –1823), particularly in his *Principles of Political Economy and Taxation* (1817). Malthus’s assumption of a fixed stock of land was replaced by a conception in which land was available in parcels of varying quality. Agricultural output could be expanded by increasing the intensive margin (exploiting a given parcel of land more intensively) or by increasing the extensive margin (bringing previously uncultivated land into productive use) that is through production based on comparative advantage (based on the abundance of natural resources). However, in either case, returns to the land input were taken to be diminishing. Economic development then proceeds in such a way that the ‘economic surplus’ is appropriated increasingly in the form of rent, the return to land, and development again converges toward a Malthusian stationary state.

In the writings of John Stuart Mill (1857) one finds a full statement of classical economics at its culmination. Mill's work utilizes the idea of diminishing returns, but recognizes the countervailing influence of the growth of knowledge and technical progress in agriculture and in production more generally. Writing in Britain when output per person was apparently rising, not falling, he placed less emphasis on diminishing returns, reflecting the relaxation of the constraints of the extensive margin as colonial exploitation opened up new tranches of land, as fossil fuels were increasingly exploited, and as innovation rapidly increased agricultural productivity. The concept of a stationary state was not abandoned, but it was thought to be one in which a relatively high level of material prosperity would be attained.

Foreshadowing later developments in environmental economics, and the thinking of conservationists, Mill adopted a broader view of the roles played by natural resources than his predecessors. In addition to agricultural and extractive uses of land, Mill saw it as a source of amenity values (such as the intrinsic beauty of countryside) that would become of increasing relative importance as material conditions improved.

B. Neoclassical economics: marginal theory and value

A series of major works published in the 1870s began the replacement of classical economics by what subsequently became known as 'neoclassical economics'. One outcome of this was a change in the manner in which value was explained. Classical economics saw value as arising from the labor power embodied (directly and indirectly) in output, a view which found its fullest embodiment in the work of Karl Marx. Neoclassical economists explained value as being determined in exchange, so reflecting preferences and costs of production. The concepts of price and value ceased to be distinct. Moreover, previous notions of absolute scarcity and value were replaced by a concept of relative scarcity, with relative values (prices) determined by the forces of supply and demand. This change in emphasis paved the way for the development of welfare economics, to be discussed shortly.

At the methodological level, the technique of marginal analysis was adopted, allowing earlier notions of diminishing returns to be given a formal basis in terms of diminishing marginal productivity in the context of an explicit production function. Jevons (1835 –1882) and Menger (1840 –1921) formalized the theory of consumer preferences in terms of utility and demand

theory. The evolution of neo-classical economic analysis led to an emphasis on the structure of economic activity, and its allocative efficiency, rather than on the aggregate level of economic activity. Concern with the prospects for continuing economic growth receded, perhaps reflecting the apparent inevitability of growth in Western Europe at this time. Leon Walras (1834–1910) developed neoclassical General Equilibrium Theory, and in so doing provided a rigorous foundation for the concepts of efficiency and optimality. Alfred Marshall (1842–1924) (see *Principles of Economics*, 1890) was responsible for elaboration of the partial equilibrium supply and demand based analysis of price determination so familiar to students of modern microeconomics. A substantial part of modern environmental economics continues to use these techniques as tools of exposition.

Economic depression in the industrialized economies in the inter-war years provided the backcloth against which John Maynard Keynes (1883 –1946) developed his theory of income and output determination. The Keynesian agenda switched attention to aggregate supply and demand, and the reasons why market economies may fail to achieve aggregate levels of activity that involve the use of all of the available inputs to production. Keynes was concerned to explain, and provide remedies for, the problem of persistent high levels of unemployment, or recession.

This direction of development in mainstream economics had little direct impact on the emergence of resource and environmental economics. However, Keynesian ‘macroeconomics’, as opposed to the microeconomics of neoclassical economics, was of indirect importance in stimulating a resurgence of interest in growth theory in the middle of the twentieth century, and the development of a neoclassical theory of economic growth. What is noticeable in early neoclassical growth models is the absence of land, or any natural resources, from the production function used in such models. Classical limits-to-growth arguments, based on a fixed land input, did not have any place in early neoclassical growth modeling.

The introduction of natural resources into neo-classical models of economic growth occurred in the 1970s, when some neoclassical economists first systematically investigated the efficient and optimal depletion of resources. This body of work, and the developments that have followed from it, is natural resource economics. The models of efficient and optimal exploitation of natural resources that we present and discuss in the next chapters are based on the writings of those authors.

i. Welfare economics

The final development in mainstream economic theory that needs to be briefly addressed here is the development of a rigorous theory of welfare economics. Welfare economics is the study of how the structure of markets and the allocation of economic goods and resources determine the overall well-being of society. It seeks to evaluate the costs and benefits of changes to the economy and guide public policy toward increasing the total good of society, using tools such as cost-benefit analysis and social welfare functions. Welfare economics depends heavily on assumptions regarding the measurability and comparability of human welfare across individuals, and the value of other ethical and philosophical ideas about the wellbeing. Welfare economics attempts to provide a framework in which normative judgments can be made about alternative configurations of economic activity. In particular, it attempts to identify circumstances under which it can be claimed that one allocation of resources is better (in some sense) than another.

Not surprisingly, it turns out to be the case that such rankings are only possible if one is prepared to accept some ethical criterion. The most commonly used ethical criterion adopted by classical and neo-classical economists derives from the utilitarian moral philosophy, developed by David Hume, Jeremy Bentham and John Stuart Mill. Utilitarianism has social welfare consisting of some weighted average of the total utility levels enjoyed by all individuals in the society.

Economists have attempted to find a method of ranking different states of the world which does not require the use of a social welfare function, and makes little use of ethical principles, but is nevertheless useful in making prescriptions about resource allocation. The notion of economic efficiency, also known as allocative efficiency or Pareto optimality (because it was developed by Vilfredo Pareto (1897)) is what they have come up with. It can be shown that, given certain rather stringent conditions, an economy organized as a competitive market economy will attain a state of economic efficiency. Where the conditions do not hold, markets do not attain efficiency in allocation, and a state of ‘market failure’ is said to exist. One manifestation of market failure is the phenomenon of ‘externalities’. These are situations where, because of the structure of property rights, relationships between economic agents are not all mediated through markets. Market failure and the means for its correction will be discussed in Chapter 3.

Ronald Case is the one who explain the importance of well designed and transferable property rights for the efficient allocation of resources. And, Hotelling and Gray have also discussed about the optimal depletion of exhaustible natural resources.

The problem of pollution is a major concern of environmental economics. It first attracted the attention of economists as a particular example of the general class of externalities. Important early work in the analysis of externalities and market failure is to be found in Marshall (1890). The first systematic analysis of pollution as an externality is to be found in Pigou (1920). However, environmental economics did not really ‘take off’ until the 1970s.

Environmental economics is also concerned with the natural environment as a source of recreational and amenity services, which role for the environment can be analyzed using concepts and methods similar to those used in looking at pollution problems. Like pollution economics, it makes extensive use of the technique of cost–benefit analysis, which emerged in the 1950s and 1960s as a practical vehicle for applied welfare economics and policy advice.

The modern sub-disciplines of natural resource economics and environmental economics have largely distinct roots in the core of modern mainstream economics. The former emerged mainly out of neoclassical growth economics, the latter out of welfare economics and the study of market failure. Both can be said to effectively date from the early 1970s, though of course earlier contributions can be identified.

ii. Ecological economics

Ecological economics is a relatively new, interdisciplinary, field. In the 1980s a number of economists and natural scientists came to the conclusion that if progress was to be made in understanding and addressing environmental problems it was necessary to study them in an interdisciplinary way. Ecological economics most directly concerned with what was seen as the central problem of sustainability.

Ecology is the study of the distribution and abundance of animals and plants. A central focus is an ecosystem, which is an interacting set of plant and animal populations and their abiotic, non-living, environment. The distinguishing characteristic of ecological economics is that it starts from the recognition that the economic and environmental systems are interdependent, and

studies the joint economy–environment system in the light of principles from the natural sciences, particularly thermodynamics and ecology since economic system is part of the larger system of planet earth. Kenneth Boulding (1966) is widely regarded as one of the ‘founding fathers’ of ecological economics. He explained the importance of ecosystem given the laws of nature and their implications for economic activity.

In general the field Natural Resource and Environmental Economics developed in its present form in the 1960s as a result of the intensification of pollution and the heightened awareness among the general public in Western countries about the environment and its importance to our existence.

Economists became aware that, for economic growth to be indefinitely sustainable, the economic system needs to take into account the uses of the environment that we have already mentioned, so that natural resources are not depleted and so that the environment is not overused as a waste sink. Environmental economists view the environment as a form of natural capital which performs life support, amenity, and other functions that cannot be supplied by man-made capital. This stock of natural capital includes natural resources plus ecological systems, land, biodiversity, and other attributes.

The growth of environmental economics in the 1970s was initially within the neo-classical paradigm. In general, this approach to the environment is concerned with issues of market failure, inappropriate resource allocation, and how to manage public goods. There was little concern for the underlying relationships between the economy and the environment. Concerns about the limits of this approach to environmental economics led some environmental economists to develop what is now referred to as **ecological economics**.

Ecological economics views the relationship of the economy and the environment as central. Thus, any analysis places economic activity within the environment. This distinction is best illustrated with reference to debates concerning sustainable development and the difference between weak and strong sustainability. Ecological economics supports the notion of strong sustainability. This view of sustainability assumes that not all forms of capital (ie human and natural) are perfectly substitutable.

Over the last decade or so, the community of scholars dealing with the role of the economy and the environment has settled into two camps: ecological economics and environmental economics. Although they share many similarities, ecological economics is consciously more methodologically pluralist, while environmental economics is based solidly on the standard paradigm of neoclassical economics. While neoclassical economics emphasizes maximizing human welfare and using economic incentives to modify destructive human behavior, ecological economics uses a variety of methodologies, including neoclassical economics, depending upon the purpose of the investigation.

1.2 Linkages Between the Environment and the Economy

Economic activity takes place within, and is part of, the system which is the earth and its atmosphere. This system we call 'the natural environment', or more briefly 'the environment'. The environment and the economy are interlinked through two main perspectives: production and consumption. These two sectors use the environment in three main ways; as a supplier of natural resource inputs, as a supplier of environmental or amenity goods, and in its capacity as waste sink.

Supplier of resource inputs

Environment provides land, water, air, energy resources, coal, oil, forests, minerals and metals and so many other natural resources which are essential for the economic development of the economy. It provides services which are directly used by the consumers i.e. air we breathe and water we drink as a liquid of life. It provides forests, water reservoirs, rivers etc. and wildlife sanctuaries which also play economic roles for the mankind.

Environment provides natural resources like land, water, and stocks of raw materials which are important inputs to the production of goods and services that are useful for consumers. These resources frequently vary between countries and so will affect the country's economy. Some countries will have large stocks of minerals, while others have good arable land. Natural resources are either renewable (eg trees) or non-renewable (eg crude oil). This distinction influences the way the resources have to be managed in production. In addition, pollutions can be created, resources may be under or over utilized.

Environmental problems as a general are basically man-made and economics has solution for them. Economics develops some controlling mechanisms and basic standards for the use of natural resources.

Supplier of environmental or amenity goods

Economic benefits (i.e. increased utility) may be directly derived from the consumption of the flow of services that are forthcoming from a stock of environmental goods. There are many examples of where the environment provides amenity benefits for society too. For example,

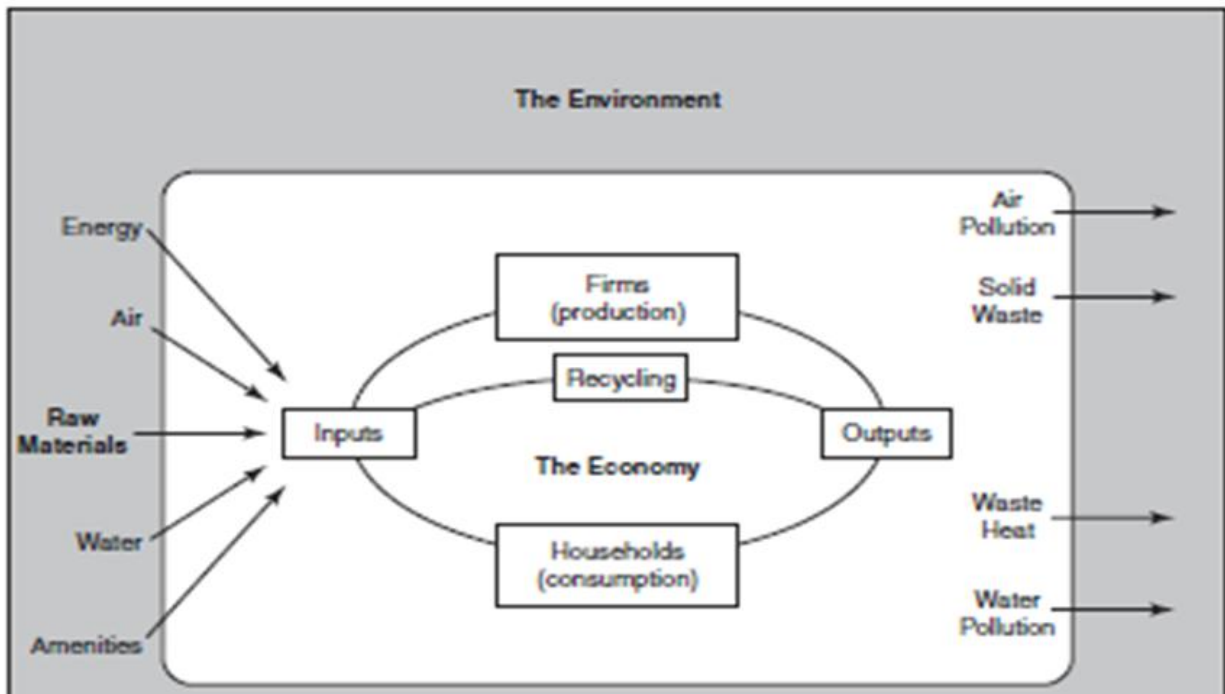
- Some countries enjoy beautiful landscapes and the public benefit from these via their associated recreational services and tourism.
- Many people get enjoyment from the biodiversity that exists in the world, and this can also be considered as a form of public consumption of an environmental good.

Waste sink capacity

Natural resources are input to the economic system and natural wastes are recycled. For example, trees dispose of their leaves, decompose and are converted into an organic fertilizer for plants. Whatever we use up for way of resources, must end up somewhere in that environment system and cannot be disappeared or destroyed.

Environment takes the non cyclical wastes and converts them back into harmless or ecologically useful products. It acts as a sink for all the waste products that are the result of the process of production and consumption. The environment is not a passive sink; it acts upon the waste products to clean up the environment. Environmental stocks of trees can offer global services such as climatic regulation because the trees absorb carbon dioxide, which might otherwise contribute to climate change. This is the capacity of the environment to assimilate the waste products of production and consumption and convert them into harmless or ecologically useful products. This use of the environment is the one we are most concerned with in this course, as we look at the introduction of policies which affect how, and at what level, the environment is used as a waste sink.

The Economic System and the Environment



1.3 Views for the prospects in the Environment

There are two distinct views towards the environment and its capacity in realizing the sustainable development.

1. Limit to Growth

This view is pessimist and based on two facts. First, natural environmental resources are available in limited quantity. Second, economic activities largely use natural resources to proceed. Hence, this view concludes that, economic activities eventually deplete the natural resources. For these reasons, there will be upper-limit on the perpetual sustainable growth of the economy.

2. Optimists View

This view is based on the functioning of the economy in which economic agents forced to seek the solution for the problems that may face to sustain their production. That is, the price induced substitution effect will result as a solution for the environmental problems. More precisely, as

economic activities proceed, natural resources deplete and more residuals produced. These situation increases the real resource price and waste management costs. Accordingly, increase in resource price forces producers to generate new technologies that use less environmental resources or they try to engage in the recycling process. Similarly, rise in waste management cost forces producers to develop production technologies that emit less residual. As a result, price induced substitution effect decreases the input-output emission ratio and therefore, environment can be sustained and hence economic activities and growth can be extended infinitely.

3. Compromising View

This view is weak view, and neutral of the above two extreme views. It be of the same opinion with the optimists view; but is in doubt of its realization. It argues that, price induced substitution effect works imperfectly because of market failures and non-existence of market for some goods. Thus, there will be a need for intervention to correct the market failures and for the provision of goods that cannot be provided by the market.

Discussion Questions

1. Briefly explain the similarities and differences between natural resource and environmental economics.
2. Discuss the environmental economy linkages. How does economic development affect the environment?