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Enviromental Economics

SEMESTER-III

ECONOMICS

BLOCK- 1

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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COURSE INTRODUCTION

Environmental Economics is the first course of third semester of the M.A. in Economics programme of this University.This course deals with issues related to enviroment such as nature, scope and significance of enviromental economics, renewable and non-renewable resources, property rights, enviroment and economic development, market failure and externalities etc. So this course basically covers the relevance of these issues of enviroment for a student doing post graduation in Economics and enables the learners with various new knowledge and ideas of Enviromental Economics. This course comprises of 15 units and has been divided into two blocks. The first block comprises eight units and the second block comprises seven units.

BLOCK INTRODUCTION

This is the first block of the course comprising of eight units. The first unit shall discuss basic concepts of enviromental economics such as enviroment and ecology. The second and third unit deals with economics of renewable and non-renewable resources respectively. Second unit basically includes defination and optimal management of economice of renewable resources. Similarly, unit 3 explains defination, difference of renewable and non-renewable resources and optimal management of non-renewable resources. Issues related to various types of property rights and their enviromental implication, common property rights and tragedy of commons are incuded in chapter 4. Unit 5 of this couse basically deals with the relation between environment and economic development. Population and enviromenrt, poverty and enviroment and exogeneous and endogeneous poverty are the issues which are discussed in this chapter. The sixth chapter of this course basically discusees positive and negative impact of international trade on enviroment. Along with that, this unit discusses pollusion haven hypothesis, empirical evidence of industrial concentration among north and the south and latest development. The issues of market failure and externalities is included in unit 7. This unit of the course discusses concept of market failure, enviroment and market failure, concept of externalities, relationship between enviroment and externality. It also discusses internalisation of externalities by Pigou and Coarse. Unit 8 of the course enviromental economics discusses the issue of valuation of enviroment. Various types of values of enviromental goods, use and non-use value, both direct and indirect valuation methods are included in this course.

While going through a unit, you will notice some along-side boxes, which have been included to help you to know some of the difficult, unseen terms. Again, we have included some relevant concepts in “LET US KNOW” along with the text. And, at the end of each section, you will get “CHECK YOUR PROGRESS” questions. These have been designed to self-check your progress of study. It will be better if you solve the problems put in these boxes immediately after you go through the sections of the units and then match your answers with “ANSWERS TO CHECK YOUR PROGRESS” given at the end of each unit.

UNIT- I : BASIC CONCEPTS OF ENVIRONMENT AND ENVIRONMENTAL ECONOMICS

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Environment

1.4 Ecology

1.5 Inter-linkages of Ecology, Environment and Economy

1.6 Environmental Economics vs. Resource Economics

1.7 Objectives of Environmental Economics

1.8 Nature, Scope and Significance of Environmental Economics

1.9 Let Us Sum up

1.10 Further Reading

1.11 Answers to Check Your Progress

1.12 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- define and explain the meaning of ecology
- discuss environment and economy
- derive the relationship between Environmental Economics and Resource Economics
- discuss the nature and scope of Environmental Economics
- highlight the significant aspects of Environmental Economics

1.2 INTRODUCTION

In this universe, the Earth is the only planet, so far known by the human, to have an environment that can sustain life. The physical conditions necessary for the origin and survival of human beings, animals and plants are available in our planet Earth only. All human needs such as food, clothing, shelter, medicines, raw materials and even aesthetic pleasure and a liveable

atmosphere is provided by the environment. Natural resources, both renewable and non-renewable, present in environment form the basis of our very existence on this terrestrial globe. On the other hand, Economics in general, studies the acquirement of resources and their utilisation activities by human beings in the environment to ensure welfare of the society at large. Thus, there is a strong relationship between environment and Economics. Natural resources are essential inputs for production in many sectors of an economy that satisfies human wants. However, production and consumption of goods from the resources gathered from nature leads to pollution and put pressure on the environment. Poor environmental quality affects economic growth and well-being by lowering the quantity and quality of resources or by causing adverse health impacts in the society. Hence, there should be balance between environment and economic activities to avoid environmental problems that have economic and social dimensions.

1.3 ENVIRONMENT

The Webster's Universal College Dictionary (2002) defines the term Environment as "the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism at any time.'' That is, the term "Environment" denotes the total set of circumstances surrounding life. It is everything surrounding us. It can be living or non-living things. The term environment has been derived from a French word 'Environ' which means surrounding. It refers to both abiotic i.e. physical or non-living and biotic i.e. living environment. All living things live in their environment. They constantly interact with it and change in response to conditions in their environment.

The components of environment are broadly classified into two parts which are:

- ❖ Natural environment
- ❖ Manmade or Human environment (Astrosphere)

The natural environment is made up of various units which can be classified in four main segments and they are-

- **Lithosphere:** This is the surface area of the earth which is represented by the earth's crust, soil, rocks etc.
- **Hydrosphere:** This represent all the water resources that are found on the earth which includes oceans, rivers, lakes, ponds, polar ice-caps, underground water etc.
- **Atmosphere:** The atmosphere is the life blanket of earth which is the essential ingredient for all living things. It extends 500 kilometres above the surface of the earth and is composed of many gases. It is the atmosphere that provides air in order to support life, protects the earth from the radiation from the Sun and regulates the climatic conditions on earth.
- **Biosphere:** The Biosphere is the region which includes the Lithosphere, Hydrosphere and the Atmosphere where life exists. It extends from 6,000 meters below sea level to 10,000 meters above sea level.

On the other hand, the part of environment made, modified, or used by humans for their activity is called Anthrosphere. The entire infrastructure made by humans by using the natural components of the environment can be considered a part of Anthrosphere, for example, buildings made with the use of wood, cement or water.

Environment is constituted by an interaction of physical, biological and cultural elements. These elements are inter-related in various ways, individually as well as collectively. These elements may be explained as under:

- **Physical elements:** Physical elements such as space, landforms, water bodies, climate soils, rocks and minerals determine the variable character of the human habitat, its opportunities as well as limitations.
- **Biological elements:** Biological elements such as plants, animals, microorganisms and humans constitute the biosphere.
- **Cultural elements:** Cultural elements such as economic, social and political elements are essentially manmade features, which make cultural ambience.

1.4 ECOLOGY

Ecology is the scientific study of the relationships between organisms and their environment which are complex, varied and hierarchical. The term 'ecology' was first used by a German Zoologist, Ernst Haeckel in 1869. The word is derived from the Greek words, 'Oikos' representing 'house' or 'dwelling place' and 'logos' representing 'study of'. Haeckel defined ecology as 'the study of the natural environment including the relations of organisms to one another and to their surroundings'. Ecology describes the relationships between living organisms and their environments, the interaction of organisms with each other and the pattern and cause of the abundance and distribution of organisms in nature. The environment includes both biotic and abiotic that surrounds an organism. Thus, it is the science that attempts to answer questions about how the nature works.

The ecological system relies on the close relationship between living organisms and the non-living surroundings which comprises the biosphere. Ecological systems powered by solar energy are called eco-system and these are the basic support to life on the planet earth.

From the biological point of view, the ecosystem has the following constituents:

- Inorganic substances (carbon, nitrogen, carbon dioxide, water, etc.) involved in natural cycles.
- Organic compounds (proteins, carbohydrates, humic substances, etc.)
- Air, water and substrate environment including the climatic regime and other physical factors.
- Producers, autotrophic (i.e., self-sustaining organisms) green plants that can manufacture food from simple inorganic substances.
- Heterotrophic (i.e., that depend on others for nourishment) organisms, mainly bacteria, fungi and animals which live on other organisms or particulate organic matter.

- Micro-consumers, decomposers, mainly bacteria, fungi which obtain their energy by breaking down dead tissues or by absorbing dissolved organic matter, extracted from plants or other organisms. The decomposers release inorganic nutrients that are utilised by producers. They also supply food for macro-consumers or heterotrophic organisms. Bacteria, fungi (and animals) often excrete hormone-like substances that inhibit or stimulate other biotic components of the ecosystem.

The terms "Ecology" and "Environment" are most often used interchangeably in writings of Environmental Economics. However, there are a few differences between these two concepts. The term Ecology refers to the study of relation of organism or group of organisms to their environment. Ecology shows the harmony between the biotic and abiotic segments of the environment. There is interaction of human and other animals with plants and micro-organisms and each depends on the other for their existence. These living or biotic organisms in turn interact with and depend upon the abiotic components like air, water and soil with their all contents. The abiotic segments, to some extent, also depend on biotic segments for their regeneration. The laws of physical science and biology governs the functioning of complex relationship of different organisms. This complex set of interrelations makes up the ecosystem and ecology is nothing but the science of study of the ecosystem.

In contrast to Ecology, environment is an Anthropogenic concept. Mankind enjoy primacy in the anthropogenic concept. It puts man at the centre of the complex functioning of ecosystem and shows the relationship between man and other living and non-living objects. In that sense, ecology is a very broad concept as it encompasses all natural relationships in its sphere. On the other hand, environment is a narrower concept than ecology because environment deals with only those relationships in ecology which affects man. A researcher on environment is mostly interested in the pollutants in air and water, the effects of these pollutants on human health and finding the measures to remove these pollutants.



CHECK YOUR PROGRESS

Q.1. What are the different segments of the natural environment?

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Q.2. What is Anthrosphere?

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Q.3. From where has the term Ecology derived?

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1.5 INTERLINKAGES OF ECOLOGY, ENVIRONMENT AND THE ECONOMY

Environmental sensitivity calls for an interdisciplinary approach. An efficient management of the biosphere requires an equal consideration of Biology, Economics, Physics, Geology and Engineering. Only an integrated approach to environmental problems will help us to identify both curative and preventive aspects. The various social sciences such as Economics, Sociology and Anthropology offer tools for proper environmental planning and management. Professor Larry Ruff states that, there will be little progress in solving the problem of environmental pollution until it is recognised to be an economic problem. He further adds that solutions to pollution problem based on technological, political, legal and ethical approach will have disappointing results, as they ignore the primary fact that pollution is an economic problem. Due to this multidisciplinary nature and linkages of environmental issues, several economists have argued for an integrated study of Economics and Ecology.

The terms “ecology” and “economics” are derived from the same Greek word “Oikos” referring to house or habitat. However, in spite of this common origin, the two sciences became inter-disciplinary subjects only after 1960s. Ecology is the study of the relationship or inter-dependence between living organisms and their environment. It is a system approach to

nature which attempts to describe and analyse the web of life. Hence, according to its Greek root, ecology deals with the "household of nature" while Economics deals with the "household of man".

An ecosystem is governed by distinct laws of growth and decay. These laws operate simultaneously, tending to move the system towards a state of balance or equilibrium. It is the aspirations of better living of humankind that is disturbing the ecological balance and endangering the nature. In a more appropriate sense, there is a conflict between "ecology" and "economy". While ecology studies the harmony between nature and man, the economy in general means disharmony with nature. Resources are collected from nature both directly and indirectly to transform them into final goods. During this production process nature is polluted by emission and wastes. Hence, conflict arises as a result of the incompatibility of the basic ecological principle of stability as a pre-condition for the sustainability of ecological system and economic principles of business profitability, economic growth and expansion of world markets. Thus to restore harmony, to reconcile the interests of human beings and nature, an ecological re-orientation of the economic policy is required. Unless we derive unifying principles of ecology and environment, many of our social and economic policies will fail to provide desired outcome.

Conventional economics presumes that the well-being of a society depends on the flow of material goods and services. The natural resources form the material base of production. But the conversion of resources into consumer or capital goods generate biotic and abiotic substances which are returned to the environment as wastes. Environment serves as supplier of resources and also assimilator of wastes. There are various services of environment for which mankind must be grateful because without them human life cannot survive in this earth. The services of environment to economy are discussed below-

- **Resources for production:** The environment provides the economy with raw materials, which are transformed into consumer products by the production process, and energy, which fuels this transformation. These raw materials and

energy return to the environment as waste products. The environment's function as a supplier of natural resources or raw materials and energy is clearly a pivotal part of the economy-environment relationship. The identification of the natural world as resources reflects human priorities among the many options for satisfying needs. Resources are the social constructs rather than entities in the natural world. These resources provide the necessary inputs for production activities of mankind. Resources can be renewable or non-renewable and take the form of stocks and flows. Some resources can be easily substituted with other resources, but are not substitutable. For some resources such as metals and timber, extraction rates can be slowed through recycling but for some resources recycling is not possible (e.g. in the case of oil and coal).

- **Waste Assimilation:** The environment acts as a sink for the waste products of economic activity. The production from natural resources and consumption activity leads to generation of wastes or residues of different types. The environment helps in the removal, dispersion and degradation of wastes produced on the earth. The environment not only assimilates waste, but also helps in supporting depletable renewable resources like fresh air and clean water. Wastes are classified into two types and they are "Bio-degradable wastes" and "Non-biodegradable wastes". Those wastes which can be broken down by nature's natural processes are called "Bio-degradable wastes" and nature can assimilate such wastes to a great extent. The environment has the physical capacity to assimilate certain quantities of waste.

  How well the environment fulfils this waste sink function depends upon the quantity and quality of waste that is produced and the methods of disposal. The environment's assimilative capacity is not limitless. Assimilative capacity

refers to the ability of the environment to carry waste material without adverse effects on the environment or on the users of its resources. Too much waste of the wrong sort and in the wrong place can reduce the environment's assimilative capacity, damaging not only natural ecosystem but also the protection they afford to humans against the pollution caused by their own wastes. Thus, the natural environment cannot be viewed as a bottomless sink. With respect to its capacity to degrade waste, the natural environment is, indeed, a scarce resource. Again, the assimilative capacity of the natural environment depends on the flexibility of the ecosystem and the nature of the waste. That is, the natural environment will not degrade any and all waste with equal efficiency. For example, the natural environment can deal with degradable pollutants, such as sewage, food waste, papers, etc., with relative ease. On the other hand, it is quite ineffective in dealing with persistent or stock pollutants, such as plastics, glass, most chemicals and radioactive substances. For most of these waste elements there are no biological organisms in existence that can accelerate the degradation process. Thus, a very long period of time is required before these wastes can be rendered harmless. Moreover, the rate at which the waste is discharged greatly affects the ability of the environment to degrade residuals. The implication of this is that pollution has a cumulative ecological effect.

- **Life support:** Environment provides 'life support' to human. The environment performs numerous functions in its life-support capacity, many of which also relate to the maintenance of sufficient environmental stability for human survival – e.g. maintenance of the gaseous composition of the atmosphere, the regulation of the earth's temperature and maintenance of the weather pattern. The ability of the

environment to provide life-support services will depend, in part, on the size of the population, state of food production technology and the demand for other environmental services.

Whilst the earth probably still has some way to go in terms of the maximum population it could potentially support, in practice, its carrying capacity depends on the extent to which resources are diverted from food production to other productive activities, and how much of the natural environment is left intact to sustain non-human life. The diversion of resources away from basic life-support functions is clearly problematic for some of the world's poorest people given the existing distribution of income and assets.

- **Amenities:** Environmental and natural resource economics, with their roots in neoclassical welfare economics, follows a utilitarian ethic. This means that the value of things is measured by the utility or satisfaction they bestow upon people, whatever the source of that utility may be. Apart from its life-support, resource reservoir and waste sink functions the environment also provides amenity services like pleasure and satisfaction that includes aesthetic pleasure, recreation, communion with nature and the satisfaction of intellectual curiosity, etc.

There are four basic goals of Economics which are efficiency, equity (both are microeconomic variables), stability and growth (both are macroeconomic variables). For instance, efficiency in production necessitates utilisation of resources at least possible cost. Costs can be lowered only when resources are utilised optimally. But the objective of cost minimisation may lead to environmental damage due to inadequate treatment of effluents. High competition and monopolistic tendencies also pose threat to environmental balance due to overexploitation of resources. The achievement of all these four goals often put immense pressure on the environment

Equity considerations, particularly income distributions are not built in to the economic system. It is the equity which the government must take into account while making various decisions regarding existing environmental problems. The values of human and physical resources are affected by changes in environmental regulations. For example, if a leather tannery unit is forced to shut down, the owner will lose investment and employees will lose their jobs for which their source of income will be stopped.

In case of stability, it can be mentioned that any new environmental measures and controls can have drastic consequences on the performance of the existing industry. For example, imposition of new pollution control measure on already existing industry may lead to increase in the capital and operating costs which is a threat to macroeconomic stability.

Lastly, all economic systems aim for rapid economic growth. Environmentalists often criticise the "high economic growth" goal as it leads to more pollution, a faster depletion of natural resources, less open space and a general decline in the quality of life.

Thus, economic development is the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human wants and to improve the quality of life. For sustainable development, socio-economic, ecological, living and non-living resource base, choice between alternative decisions, short term and long term benefits and limitations are crucial factors in the process.

From the above discussions, it can be concluded that economy is clearly a part of the environment as much as the environment can be seen as part of the economy. Hence, a meaningful solution of environmental problems calls for an interdisciplinary integrated approach.



CHECK YOUR PROGRESS

Q.4. What are the services that environment provides to an economy?

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Q.5. What are the basic goals of every economic system?

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Q.6. What is assimilative capacity of environment?

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1.6 ENVIRONMENTAL ECONOMICS V/S RESOURCE ECONOMICS

Every economic activity influences the environment and creates some environmental issues. Environmental Economics is concerned with the impact of the economy on the environment, significance of the environment to the economy, and the appropriate way of regulating economic activity so that balance is achieved among environmental, economic, and other social goals (Kolstad, 2000). Economic growth of a country puts pressure on stock of natural resources and thus economic growth always carries risk of environmental damage. Various authors define Environmental Economics showing economy-environment relationship as main feature. Some of the important definitions of Environmental Economics are given below-

- It is the study of the 'economy-environment relationships'- (Common,1988).
- "It is a sophisticated field of applied welfare Economics which integrates the market failure concept with scarcity of clean air, water and soil"- (Kneese, 1966).
- "That part of the Economics which deals with the inter-relationship between environment and economic development and studies the ways and means by which neither is the former is impaired, nor is the latter is impeded" -(Eugine, T.,2004).

Environmental Economics is primarily concerned with the impact of the economy on the environment. It is the field of study that studies the

effects of the waste or pollution generated from economic activities which is given back to the nature. Environmental Economics involves the questions of excessive production of pollution by the market or insufficient protection of the natural world, due to market failure. Thus, Environmental Economics studies the effects of economic activity of human being on the nature and environment. It studies how the economic activity of human being can affect, change or modify the environmental quality and how the economic activities of human can be changed or modified in achieving a desired level of environmental quality.

On the other hand, Resource Economics deals with the study of natural resources. It is the field of study that concern with the flow of resources from nature to economic activity. Resource Economics identifies and classifies the existing known resources into a resource taxonomy, which can provide an extensive idea about the availability, scarcity and potentiality of resource base of the nature. Resource Economics also studies the appropriate inter-temporal production and use of natural resources– both renewable and non-renewable.

Both Environmental Economics and Resource Economics are concerned with the study of natural world. It is only the time element that differentiates the two. Generally, Environmental Economics is concerned with the static questions of resource allocation. For example, time is not an important factor in deciding the right amount of air pollution in a particular city. Resource Economics, on the other hand, is concerned with the time-based dynamics of resource allocation and exploitation. Time is the factor that makes renewable and exhaustible resource questions interesting. For example, if a forest is logged slow enough then the forest can regenerate itself and logging can be done for indefinite time. Similarly, the pace of extraction of exhaustible resource will determine its scarcity in the future, and thus its price in the future.

Although, both Resource Economics and Environmental Economics are distinct in nature still there are many areas that overlaps and undoubtedly the common link between these two is that they are concerned with the same natural world. In fact, in most of the cases it has become a tradition

to combine Environmental and Resource Economics into one field of study. The overlaps between these two can be seen in many ways. For example, global warming is a pollution problem with a long time frame that comes under the purview of Environmental Economics but ultimately concerns Resource Economics as the phenomena of global warming starts affecting the various natural resources of our planet. Secondly, most often environmental problems are associated with resources that are renewable but are in danger of exhaustion because of excessive use. Damage to natural environments is often an incidental result of economic activity with a different primary objective. Thus, preservation of natural environment and bio-diversity is the prime issue of environmental economics. However, the issues of preservation of natural environment involve time, so they could be relegated to Resource Economics.

1.7 OBJECTIVES OF ENVIRONMENTAL ECONOMICS

Environmental Economics is very important in analysing the impact of economic activity on natural environment and devising policies to protect our natural world. There are some basic objectives of Environmental Economics which are -

- To devise environmental strategies that are directed to achieve goals such as repairing of past environmental damages, shifting from waste management to pollution prevention, efficient utilisation of natural resources, creating a balance between environmental quality and development goals, addressing the issue of market failure, etc.
- To achieve a reasonable and equitably distributed level of economic wellbeing that can be maintained for many generations.
- To minimise the impact of human activities on the environment so that the life cycle of biotic and abiotic components shall be undisturbed.
- To set the achievable growth targets for the short run and long run that can be sustained.

- To develop inter-disciplinary approach towards the protection of the environment, so as to achieve acceptable level of pollution and to increase research and development on finding measures of standard of pollution.
- To undertake cost-benefit analysis of each future project meant for environmental protection and their long term sustainability.
- To enrich the global society through generation of regular updated reports on the different parameters of environmental quality and the direction of changes, if any.



CHECK YOUR PROGRESS

Q.7. What is the main difference between Environmental Economics and Resource Economics?

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Q.8. Write two objectives of Environmental Economics.

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1.8 NATURE, SCOPE AND SIGNIFICANCE OF ENVIRONMENTAL ECONOMICS

Environmental Economics is one of the fastest developing branches in Economics. Many factors are held responsible for the rapid growth of the subject. First, there is a mass consensus that many environmental goods or resources which were once considered as free, have now become scarce resources. If immediate action is not taken to prevent depletion or degradation of these resources, then the goal of sustainable growth may not be feasible. Second, scientific and engineering approaches to environmental problems can help in understanding the two-way linkage between ecological and

economic systems, in identifying the causes of environmental degradation and in obtaining physical measurements of environmental damages but for many decisions making problems an economic approach is needed to obtain monetary value of the damages. Third, in framing environmental protection policy, many developed countries are gradually shifting from command and control approach to economic or market-based instruments to achieve environmental policy goals. It is because, the economic or market-based instruments are incentive based and they provide an opportunity to economic agents to use their private information, which is not often available to the regulator, in their search for least cost option for compliance with the regulations. Fourth, every government have budget constraints. Thus, it requires cost-benefit analysis of environmental policy options with regard to changes in environmental legislations, resetting of environmental standards and introduction of new policy instruments for environmental protection. Fifth, in arriving at a binding international agreement on global environmental issues, economic analysis is very essential to assess the likely impact of different policy options on distributions of costs and benefits among the member nations and in devising a mechanism for sharing the costs and benefits in an equitable manner.

There are many aspects that clearly define the nature and scope of environmental economics. The nature of environmental economics is regarded as both positive and normative science. Furthermore, the nature of environmental economics also covers both micro and macro aspects of distinctive environment problems. The aspects covered by Environmental Economics are discussed below-

- **Positive and Normative Science:** There are two fundamental perspectives of economics and they are positive and normative. Environmental Economics is considered both as positive and normative science. Positive Economics is more value free, aiming to explain why markets and institutions have evolved as they have and how they work. For example, why the price of gasoline increases when Oil Producing and Exporting Countries (OPEC) meets

to restrict production and how the spatial distribution of pollution emissions changes when a marketable permit system is established to regulate sulphur emissions. On the other hand, normative Economics attempts to use economic tools in designing government policies to intervene in the marketplace. When we study the working of Environmental Economics, it is not possible to restrict our attention solely to positive economics. For example, the fundamental issue of Environmental Economics is the notion of market failure. Corrections of market failure require government intervention. The kind of government intervention required to employ is the normative aspect.

- **Micro and Macro aspect**: Environmental Economics covers the micro and macro aspects of the pollution problem. There are many examples of micro and macro aspects of environmental problems in the present times. There are many cities which are crowded with market places, industrial units and even large residential areas, people do not get enough fresh air. Solution of maintaining good air quality lies in micro level planning. On the other-hand, when the pollution problem is related to the economy as a whole such as rise in temperature and other climatic change, then it is related to macro aspect of environmental planning.
- **Static and Dynamic**: Classical and Neoclassical economists have applied both static and dynamic approaches in relation to environment. The application of economic welfare approach to environment is static in nature. The study of optimum allocation of natural resources is a static question. On the other hand, the time based resource allocation and exploitation that focuses regeneration of resources and regulation of resource use of both renewable and exhaustible such as forests, minerals, fossil fuels, water resources, etc. are dynamic issues.

- **As Social Science:** Environmental economics is not exclusively concerned with the natural environment. For example, man-made and cultural or social environments may also be a part of the nature of environmental economics. Environmental economics deals with economic and managerial aspects of pollution and natural resources. It interacts with human beings and their physical surroundings. It studies the impact of pollution on human beings and suggests rational utilisation of resources in a proper way so that there may be an increase in social welfare or minimisation of social costs.
- **Environmental Quality as an Economic Problem:**
  Economic theory studies the aspects of economic life such as what to produce, how to produce, and for whom to produce, so that the scarce resources may be efficiently allocated to maximise human satisfaction. So long as natural resources were available in unlimited quantities, environmental issues were simply social issues. It is only with the transformation of environmental goods into economic goods that economists started applying economic principles and theories to environmental issues. The abuse of environmental resources has transformed environmental resources into economic goods, through a reversal in the demand-supply relationship of environmental quality. While the demand for environmental quality has registered a sharp increase, the supply of clean air, clean water and other resources have declined. At the verge of subsistence, people seldom worry about the quality of the environment in which they live. People think about other less immediate wants like enjoyment of environment quality and the expectation of healthier and longer life only after assuring the basic needs– food, clothing and shelter. Thus the demand for environmental quality is highly income elastic and is a luxury

item. On the other hand, economic growth and development, accompanied by population growth have reduced the available supply of environmental resources transforming it into economic commodity. As a result, society can have more of the environmental quality only by giving up significant amount of other desirable consumption goods and services and thus the provision of environmental quality involves opportunity cost. The trade-off between the environmental quality and other goods and services is illustrated in the figure-1.1.

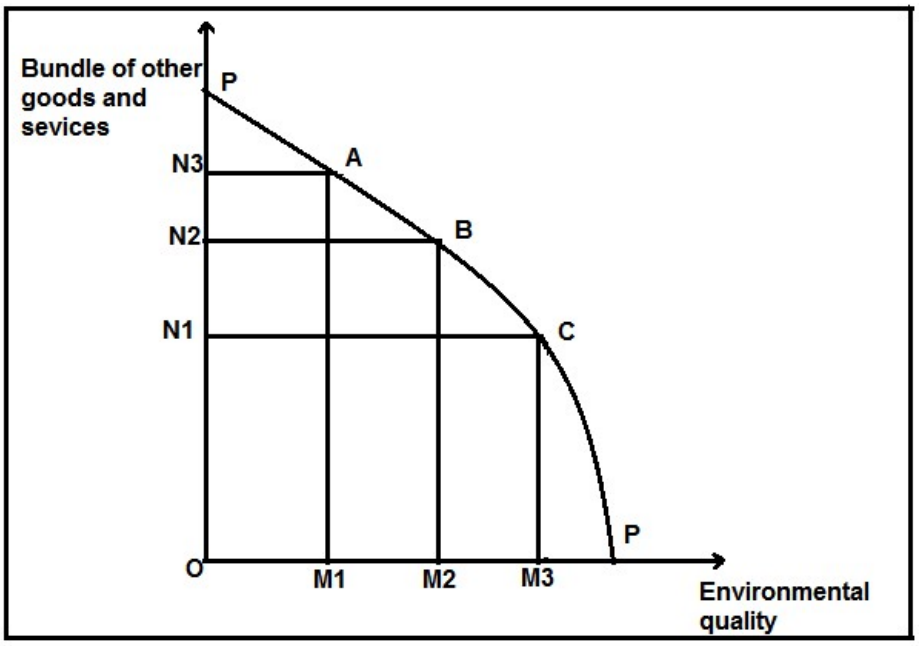


Figure-1.1: The production possibility frontier

In Fig. 1.1, different combinations of environmental quality and other goods and services that can be produced with the given technology are shown by the production possibility curve PP. it is observed that an increase in the provision of other goods and services from N1 to N2 results in a deterioration of environmental quality by M2M3. Thus N1N2 is the opportunity cost of supplying additional unit of environmental quality. The presence of opportunity cost in the provision of environmental quality makes environmental

issues an economic problem and necessitate integration of economic mechanism and environmental issues, for efficient management of environmental resources.

The environment has got a very close relation with economics. The relation deals with the welfare of the society and the growth theories of economics. The economic analysis of environmental problems yields an understanding of the complex relationships among the different parameters of the economic system, inter-relationship between environment and economic development. With the emergence of many new areas the scope of Environmental Economics is getting enriched and extended, some of which are discussed below:

- **Economic growth and Environmental Balance:** Economic growth and environmental balance move in the opposite direction. Higher economic growth requires higher amount of resource exploitation which lead to increased harmful impact on the environment. Environmental balance can be achieved only if resources are not exploited and pollution is not generated. But, un-exploitation of natural resources will lead to lower economic growth. The only solution to achieve balance is to control the scale of pollution and optimal use of environmental resources. Nowadays, nations are concerned about sustainable development which implies controlled use of resources without endangering the future generations. Thus, all economic projects have to undergo a cost-benefit analysis with regard to environmental consequences. An economic project is undertaken only when the benefits are larger than the costs but one cannot say that a benefit for today is better than harming the future.
- **Pollution Control and Environment:** Economic activities of human being result in pollution that has serious impact on the environment and the society. The cost of pollution resulting from production and consumption activities never gets through market mechanism. Pollution resulting from

production and consumption activities is called negative externalities. The costs of clean-up and control of pollution today is rising which has to be ultimately borne by the consumers. The producers, who are the major polluters simply shift the cost of pollution to the consumers. On the other hand, consumers' sacrifices environmental standards and pollution control to avoid payment for the cost of achieving good environmental quality. There are various tools which are used to control such environmental market failure. The Command and Control (C&C) legislations involving identification of the type of environmentally harmful activity, imposition of specific conditions or standards on that activity and prohibition of forms of the activity that fail to comply with the prescribed standards are the direct method of regulating environmental pollution. On the other hand, imposition of pollution tax, provision of subsidies and incentives for clean technologies and practices and the creation of markets in either environmental protection or pollution are market based instruments.

- **Conservation of Resources:** Environmental Economics deals with conservation of natural resources also. The environment is the provider of all the resources– renewable and non-renewable. Each of these resources sometimes require centuries to form under conditions that cannot be duplicated. In today's fast moving economic scenario of every country resources are being exploited in a rapid pace and can be exhausted very soon. Every natural resources are scarce and therefore they must be conserved. Optimal use of resources must be ensured and wastage must be avoided because absence of these resources means economic activities will not be there.
- **The Greening of National Income Accounts:** Now a days depletion of capital includes not just depreciation of physical

capital but also depletion of natural resources, along with deterioration of environmental quality. There is an emerging measure of economic growth known as 'Environmentally Adjusted Domestic Product' referring to drawing up of national income accounts that subtracts environmental losses during the accounting year.

- **Population and Environment:** Another area that Environmental Economics covers is the relationship of population growth and environment. The Inter Academy Panel Statement on Population Growth has stated that rapid population expansion, resulting in many environmental problems such as rising levels of atmospheric carbon dioxide, global warming and pollution. There are some other associated problems of overpopulation. They are increased demand for resources such as fresh water, air and food, extraction and exploitation of natural resources faster than the rate of regeneration, starvation and malnutrition of the poor section, deterioration in the living conditions, etc. However, many thinkers believe that it is the overconsumption and generation of industrial wastes especially by the developed countries which exerts more pressure on the environment than population growth.
- **International Cooperation in Environmental Protection:** International cooperation among nations is very essential in dealing with many international issues such as hazards of trans-boundary shipments, unwanted substances and common property resources that includes sharing of river water, marine resources, forest land etc. There are many negative effects of inadequate toxic waste generated within countries and hazardous goods exported to other countries. Environmental protection is inherently a cross border issue and thus it leads to the creation of transnational regulations via multilateral and bilateral treaties. The United Nations

Conference on the Human Environment held in Stockholm and the Earth Summit were the keys in the development of various international instruments for environmental protection.

- **Multi-Disciplinary Base:** The scope of Environmental Economics is multi-disciplinary in nature. Environmental Economics deals with sustainability which replaces growth as primary objective of modern Economics. The study of Environmental Economics needs trans-disciplinary or inter-disciplinary approach. It encompasses varied disciplines like Biology, Ecology, Physical Sciences, Ethics and mainstream Economics.



CHECK YOUR PROGRESS

Q.9. "Environmental Economics covers both micro and macro aspects". Justify.

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Q.10. What makes environmental issue an economic problem?

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1.9 LET US SUM UP

- *The Webster's Universal College Dictionary* (2002) defines the term Environment as "the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism at any time.''
- The components of environment are broadly classified into two parts, namely, natural environment and manmade or human environment (Anthrosphere).

- Ecology is the scientific study of the relationships between organisms and their environment which are complex, varied and hierarchical. Ecology describes the relationships between living organisms and their environments, the interaction of organisms with each other and the pattern and cause of the abundance and distribution of organisms in nature.
- The terms “ecology” and “economics” are derived from the same Greek word “Oikos” referring to house or habitat. Ecology deals with the “household of nature” while Economics deals with the “household of man”.
- Environment provide different services to the economy such as supply of resources, assimilation of waste, life support and amenities etc.
- Every economic system concerned with the four basic goals which are efficiency, equity (both are microeconomic variables), stability and growth (both are macroeconomic variables). The achievement of all these four goals often put immense pressure on the environment.
- Economic development is the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human wants and to improve the quality of life.
- Environmental Economics is concerned with the impact of the economy on the environment, the significance of the environment to the economy, and the appropriate way of regulating economic activity so that balance is achieved among environmental, economic, and other social goals. On the other hand, Resource Economics deals with the study of natural resources. It is the field of study that concern with the flow of resources from nature to economic activity.
- As Environmental Economics covers diverse aspects relating to environment and the economy, its scope is very extensive.



1.10 FURTHER READING

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Hussen, A. M. (2000). *"Principles of Environmental Economics-Economics, Ecology and Public Policy",* ROUTELDGE, London & New York.

Karpagam, M. (2007).*"Environmental Economics-A Textbook",* Sterling publishers Private Limited, New Delhi.

Kolstad, C.D. (2003). *"Environmental Economics",* Oxford University Press, New York, Oxford.

Purkayastha, G. (2014). *"Environmental Economics-Theory, Problems and Solutions",* Kalyani Publishers, New Delhi.



1.11 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No. 1: Lithosphere, Hydrosphere, Atmosphere and Biosphere.

Ans to Q No. 2: The part of environment made, modified, or used by humans for their activity is called Anthrosphere. The entire infrastructure made by humans by using the natural components of the environment can be considered as a part of Anthrosphere. For example, buildings made with the use of wood, cement or water.

Ans to Q No. 3: The terms "ecology" is derived from the Greek word "Oikos" referring to house or habitat.

Ans to Q No. 4: Environment provide different services to the economy such as supply of resources, assimilation of waste, life support and amenities etc.

Ans to Q No. 5: Every economic system is concerned with the four basic goals which are efficiency, equity (both are microeconomic variables), stability and growth (both are macroeconomic variables).

Ans to Q No. 6: Assimilative capacity of the environment refers to the ability of the environment to carry waste material without adverse effects on the environment or on the users of its resources.

Ans to Q No. 7: Environmental Economics is concerned with the impact of the economy on the environment, the significance of the environment to the economy, and the appropriate way of regulating economic activity so that balance is achieved among environmental, economic, and other social goals. On the other hand, Resource Economics deals with the study of natural resources. It is the field of study that concern with the flow of resources from nature to economic activity.

Ans to Q No. 8: Two objectives of Environmental Economics are-

a. To achieve a reasonable and equitably distributed level of economic wellbeing that can be maintained for many generations.

b. To minimise the impact of human activities on the environment so that the life cycle of biotic and abiotic components shall be undisturbed.

Ans to Q No. 9: Environmental Economics covers the micro and macro aspects of the pollution problem. For example, there are many cities which are crowded with market places, industrial units and even large residential areas, people do not get enough fresh air. Solution of maintaining good

air quality lies in micro level planning. On the other hand, when the pollution problem is related to the economy as a whole such as rise in temperature and other climatic change, then it is related to macro aspect of environmental planning.

Ans to Q No. 10: The presence of opportunity cost in the provision of environmental quality makes environmental issues an economic problem. The opportunity cost refers to the sacrifice of other goods and services to enjoy additional unit of environmental quality.



1.12 MODEL QUESTIONS

Short Questions: (Answer each question in about 150 words)

Q.1: Write a note on ecology and environment.

Q.2: Define environment. What is the difference between environment and ecology?

Q.3: Write a note on Environmental Economics and Resource Economics.

Q.4: Write the objectives of Environmental Economics.

Q.5: "Environmental Quality or Problem is an economic problem." Justify.

Q.6: Briefly discuss the significance of Environmental Economics.

Long Questions: (Answer each question in about 300 to 500 words)

Q.1: Distinguish between Environmental Economics and Resource Economics. Discuss the relationship between Environment and Economics.

Q.2: Define environment and ecology. "A meaningful solution of environmental problems calls for an interdisciplinary integrated approach." Justify the statement.

Q.3: Define Environmental Economics. Discuss the nature and scope of Environmental Economics.

Q.4: What are the objectives of Environmental Economics? Discuss the significance of Environmental Economics.

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UNIT 2: RESOURCE ECONOMICS-I

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Environment and Economy-The Material Balance Model

2.4 Natural Resource and Classification of Resources

2.5 Renewable Resources and its Optimal Management

2.6 Let Us Sum up

2.7 Further Reading

2.8 Answers to Check Your Progress

2.9 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- describe the relationship between environment and economy through Material Balance Model
- discuss the meaning and classification of resources
- explain renewable resources and its optimal use.

2.2 INTRODUCTION

In the previous unit, we have dealt with the inter-linkages of environment, ecology and economy. It has been observed that environment provides different types of services for the existence of life in this planet earth. Among the different services of environment, one important service is the supply of natural resources. Resources are used as inputs in production and consumption of different commodities required for the society. However, the supply of resources by the environment is not unlimited. If it is unlimited, then there would not be any necessity of studying resource allocation and consequent issues relating to extraction of natural resources. The supply of natural resources is limited and scarce. Resource Economics thus, studies the allocation of scarce resources. Resource Economics is

mainly concerned with the flow of resources from nature to economic activity and provide information about the availability, scarcity and potentiality of resource base of nature.

2.3 ENVIRONMENT AND ECONOMY- THE MATERIAL BALANCE MODEL

Before we proceed to Resource Economics, it is very essential to understand the relationships between environment and the economic system. As stated in the previous unit, environment serves as supplier of natural resources on the one hand and act as sink of waste disposal generated from the utilisation of these resources on the other. Thus there is a very close relationship between environment and economic activity of humankind. The relationship between environment and economy can be best explained with a model that is called the “Material Balance Model”. The material balance approach of Allen Knees (1970) and R.V. Ayres (1969) visualises the total economic process as a physically balanced flow between inputs (resources) and outputs (waste/residuals).

The Material Balance Model is based on the first and second law of Thermodynamics. According to the first law, matters and energy can neither be created nor destroyed. In this model, it implies that in the long run the flow of materials and energy extracted from nature for production and consumption must be equivalent to the flow residuals into the environment from these activities. The environment has got a fixed amount of mass which takes the form of soil, plants, minerals, etc. This mass changes from one form to another due to environment or man-made influences but the entire mass does not change. For example, water takes different forms like ice, snow, vapour, etc. Even though water is split into oxygen and hydrogen, the total quantum of the elements is the same as that of the original water. Similarly, every resources drawn from nature for economic activities ends up as residual at different stages and the mass of these residuals is same as that of the original resources. Higher economic growth requires higher level of production and consumption which ultimately leads to increased extraction of resources from nature and disposal of wastes/

residuals into the environment. The wastes or residuals when discharged causes significant amount of environmental damage. The second law of Thermodynamics known as Entropy law states that, nature's capacity to convert matter and energy is not without bound. During the conversion process some of the energy become unusable in another process although it still exists. Thus, the transformation of materials and energy is an irreversible transformation of useful materials into waste. Entropy is a measure of unavailability or disorderliness that describes the extent to which matter or energy is organised or structured. Higher the entropy lesser will be the organised or structured form of materials or energy and vice versa. Economic activities of production and consumption transforms matters and energy from low entropy to high entropy and the overall entropy of the system increases over time. Hence the fundamental process upon which economic activity depends is finite.

The Material Balance Model can be explained by simply dividing the economy into two sectors i.e. production sector and household or consumption sector. It is the production sector where resources or factors of production are combined to produce a finite quantum of goods. On the other hand, the consumption sector consumes the goods produced in the production sector.

To understand the material balance model, let us assume that the production sector uses R units of resources/ raw materials from the environment to produce F units of the final product. In the process the production sector produces W_1 amount of waste. Thus, in the production sector-

$$R = F + W_1$$

The consumption sector on the other hand, consumes all the F units produced in the production sector. The consumption activity also generate waste and the waste can be packaging, by-products, etc. The entire amount of waste is returned to the atmosphere and thus in the household sector, $F = W_2$

Ultimately, in the economy, $R = W_1 + W_2$

This implies that the entire mass of inputs i.e. raw materials equals the entire mass of output i.e. waste which is the case of the first law of thermodynamics.

The environment acts as a waste sink or waste assimilator. The waste generated from production and consumption activities returned back to the nature. Some of the waste can be recycled and can be used as resources. However, majority of waste cannot be recycled and used further. This is explained by the second law of thermodynamics which states that nature's capacity to convert matter and energy is finite and transformation of matter and energy is an irreversible transformation of useful matter into waste.

The waste or residual which is dumped in to the environment is converted to ecologically harmless or economically useful products by the nature through its crucial assimilative capacity. So long the quantity of waste disposed commensurate with nature's waste assimilative capacity there will be balance in the flow of resources and the flow of waste. The unplanned disposal of wastes and residuals can damage the waste assimilative capacity of the environment. Thus, the waste assimilative capacity of the environment is a resource which is finite. So long we keep it within the limits, the environment will assimilate waste and essentially return it back to the economic system.

With the above discussion, the complete material balance model may be represented as under-

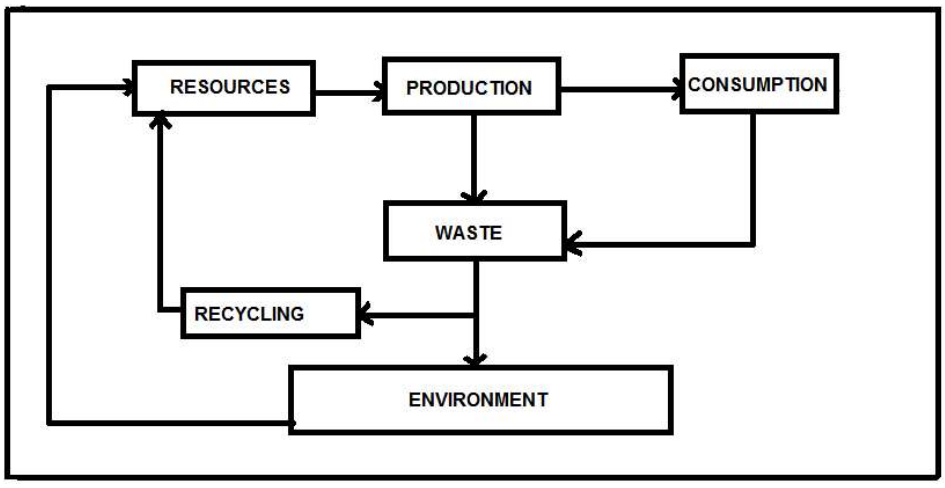


Figure-2.1: Material Balance Model



CHECK YOUR PROGRESS

Q.1. Who propounded the Material Balance Model?

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Q.2. What are the laws on which Material Balance Model is based?

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2.4 NATURAL RESOURCE: DEFINITION, CLASSIFICATIONS AND CHARACTERISTICS

The Organisation of Economic Co-operation and Development (OECD) defines natural resources as the natural assets (raw material) occurring in nature that can be used for economic production or consumption. It is anything derived from the nature that is directly used by human beings. Broadly, natural resources include all the "original" elements that comprise the earth's natural endowments or the life-support systems: air, water, the earth's crust and radiation from the sun. Some representative examples of natural resources are arable land, wilderness areas, mineral fuels and non-fuel minerals, watersheds, and the ability of the natural environment to degrade waste and absorb ultraviolet light from the sun.

There are numerous ways to classify natural resources. On the basis of regeneration capacity natural resources are classified into two major categories: renewable and non-renewable natural resources.

- **Renewable Resources:**

  Renewable resources are those resources that are capable of regenerating themselves within a relatively short period, provided the environment in which they are nurtured is not unduly disturbed. Examples include plants, fish, forests, solar radiation, wind, tides and so on. These renewable resources can be further classified into two distinct categories: biological resources and flow resources.

  - Biological resources consist of the various species of plants and animals. They have one distinctive feature that is important for consideration here. While these resources are

capable of self-regeneration, they can be irreparably damaged if they are exploited beyond a certain critical threshold. Hence, their use should be limited to a certain critical zone. Examples of this type of resource are fisheries, forests, livestock, and all forms of plants.

- Flow resources include solar radiation, wind, tides and water streams. Continuous renewal of these resources is largely dictated by atmospheric and hydraulic circulation, along with the flow of solar radiation. Although these resources can be harnessed for specific use (such as energy from solar radiation or waterfalls), the rate at which the flows of these potential resources are regulated is largely governed by nature. This does not, however, mean that humans are totally incapable of either augmenting or decreasing the amount of flow of these resources. A good illustration of this would be the effect of greenhouse gas emissions (in particular carbon dioxide emissions) on global warming.

- **Non-Renewable Resources:**

Non-renewable resources are resources that either exist in fixed supply or are renewable only on a geological time scale and the regenerative capacity of non-renewable resources are assumed to be zero for all practical purposes. Examples of non-renewable resources include metallic minerals like iron, aluminium, copper and uranium; and non-metallic minerals like fossil fuels, clay, sand, salt, phosphates, etc. Non-renewable resources can be classified into two broad categories- Recyclable and Non-recyclable.

- The non-renewable resources which can be recycled for re-use although sometimes not completely are recyclable non-renewables. For example, metallic minerals.
- The non-renewable resources which cannot be recycled for re-use are non-recyclable non-renewable resources. Fossil fuels are example of non-recyclable resources.

Resources are classified on the basis of their source of origin also. They are- biotic resources and abiotic resources.

- **Biotic Resources:** Biotic resources are derived from living and organic material such as plants and animals. It also includes fossil fuels such as coal and petroleum which are formed from organic matter that has decayed.
- **Abiotic Resources:** Abiotic resources are derived from the non-living world e.g. land, water and air. Mineral and power resources are also abiotic resources as some are derived from nature.

Resources are classified on the basis of their stages of development. They are potential, actual, reserve and stock resources.

- **Potential Resources:** The resources which exist in a particular region and may be exploited and used in future are called potential resources. For example, petroleum in sedimentary rocks in a country or a region.
- **Actual Resources:** The resources which are surveyed, the quantity and quality of which have been assessed and are in use are called actual resources.
- **Reserve Resources:** The part of the actual resources that can be developed profitably in future are called reserve resources. For example, identification of a coal field in a country which is not yet exploited or water resources for hydro-electric power generation and so on.
- **Stock Resources:** The resources which are surveyed but cannot be used due to lack of technology are stock resources. For example, stock of hydrogen.

These classifications have two dimensions– one, economic and the other, geological. The economic dimension reflects movement from cheaply extractable resources to those extracted at substantially higher costs. On the other hand, the geological dimension reflects increasing geological uncertainty about the size of the resource base.

Resources have three main characteristics and they are-

- **Utility:** Every natural resource possesses utility. Natural resources are used as inputs for production and consumption of goods and some resources are directly used for consumption activity.
- **Scarcity or limited availability:** Scarcity is the fundamental economic problem of having humans who have unlimited wants and needs in a world of limited resources. It states that society has insufficient productive resources to fulfil all human wants and needs.
- **Potential for depletion:** Resource depletion is an economic term referring to the exhaustion of raw materials within a region. Resource depletion is most commonly used in reference to farming, fishing, mining, and fossil fuels. Although the renewable resources are regenerative in nature, excessive exploitation may lead to exhaustion. Again exhaustible resources are present in certain amount, so over-exploitation may result in depletion of stock.



CHECK YOUR PROGRESS

Q.3. What are the three important basis of classification of natural resources?

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Q.4. What are the characteristics of natural resources?

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Q.5. Give two examples of renewable and non-renewable resources.

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2.5 RENEWABLE RESOURCES AND ITS OPTIMAL MANAGEMENT

As stated in the previous section, renewable resources are regenerative in nature but the ability to regenerate is not unlimited. The natural process of regeneration requires a time frame and it has a certain limit. The increase or decrease in the stock of renewable resources during a time period depends upon the rate of resource exploitation by humankind. The stock of renewable resource will decline if the rate of exploitation is higher than the rate of growth of the resource persistently. Even renewable resources may become extinct and disappear if their population decline to a critical minimum level due to over exploitation or some other reasons not directly linked with the direct use of the resource. Otherwise, renewable resource can remain productive or regenerative indefinitely. It is to be noted that catching fish or cutting tree may reduce the population of fish or tree at any time but unless the level of reduction reach to a critical minimum, natural growth will replenish the loss within a time period. Such resources must be managed in a sustainable way so that only additions to stocks, or the 'sustainable yield' are harvested. Thus, optimal management of renewable resources is a crucial concern of resource economics i.e. to determine the optimum rate of use of renewable resources over time or over generations.

To understand the optimal use of renewable resources we can take the concept of growth function of a renewable resource, say a particular fish species. The natural growth path of any biological resource is a function of time. The growth path of stock of fish is shown in figure 2.2.

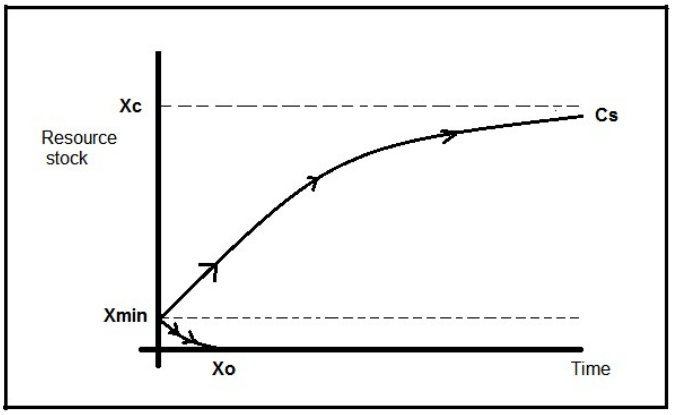


Figure-2.2. Logistic growth curve of renewable resource

In Fig. 2.2, the curve Cs represents the size of the fish stock as a function of time. At low level of stock, the population of fish increases but as the population start growing there arises competition for food and space among the fish population for which the growth rate slows down and eventually the stock converges to a maximum level Xc that represent maximum carrying capacity of the ecosystem. The growth curve starts from a critical minimum level of population Xmin. If the size of the population goes below the population level Xmin, then the species will eventually become extinct which is shown by Xo.

We can look at the growth curve of the renewable resource fish from another way in which the growth rate of the fish stock is taken to be the function of the size of the fish stock/population itself and the growth curve is shown in the figure-2.3.

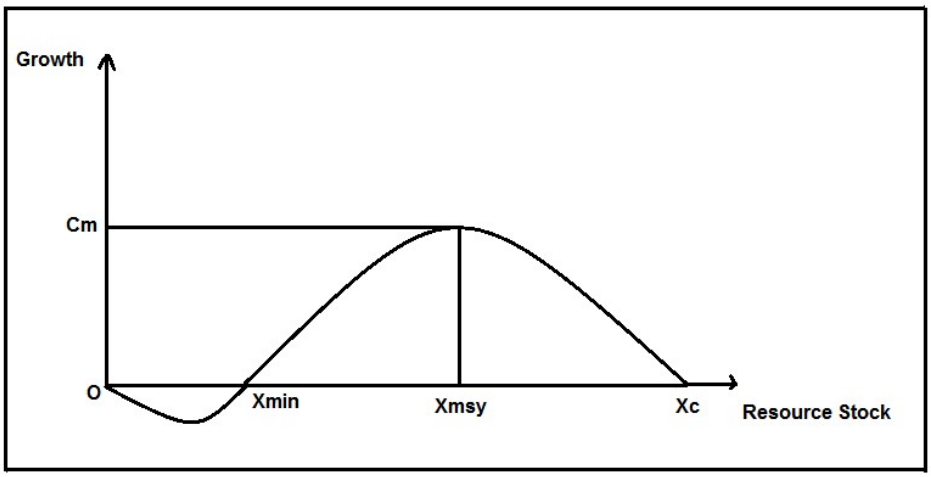


Figure-2.3: Resource stock and growth

The growth of fish stock cannot exceed a given level, such as Xc in Figure 2.3 because of environmental constraints. The growth rate is slow at low stock levels because of the difficulties of fish finding other fish to breed with. It increases to a maximum level Cm at the turning point of the curve, then declines to Xc, the maximum carrying capacity. The growth of fish stocks slows down as fish compete for food supplies until the maximum population is reached. At this point the fish stock cannot grow any further because of the constraint of non-availability of food. Unless the natural environment become more favourable Xc is the maximum size to which

the fish stock can grow and thus Xc is the natural equilibrium level because at this level the stock replaces itself. This is completely a natural situation, which does not depend on human interference. However, humans want to know the maximum sustainable yield (MSY) which is the number of fish which can be caught or harvested without depleting the stock. In Fig. 2.3, the stock size associated to maximum sustainable yield (MSY) is shown by Xmsy. A 'sustainable yield' would be a size of harvest which equals the growth rate of the fish population. MSY gives the maximum sustainable yield Cm. It is the fish stock/population which yields maximum growth and, hence, maximum sustainable harvest, Cm. A larger fish stock than MSY would give a reduced yield because of pressure on food supplies. Again harvesting of fish higher than Cm would lead to reduced population sizes. If the fish population was reduced to a level smaller than Xmin then extinction of the species would follow. Xmin represents the minimum viable population because below this level of fish stock, the fish cannot find each other with sufficient frequency to reproduce themselves.

After determination of the maximum sustainable yield, it is very essential to find out the optimum rate of harvest (optimum use of renewable resources) which may not correspond to the maximum sustainable yield. To find out the optimum rate of harvest we need to introduce the concept of rate harvest and the costs and revenue relating to harvest of the resource.

In general, we would expect that for a given population size, the higher the level of effort, the larger will be the harvest or catch; and given the level of effort, the larger the population size, the larger will be the harvest. To show these relationships among the levels of harvest, effort and population size more systematically, we can use the following equation-

$$E = \frac{H}{X}$$

Where, E= level of effort put in the harvesting or catch

H= rate of harvest

X= growth of stock of the resource

Rewriting the above equation we have-

$H = EX$

Now, the rate of harvest is shown in Fig. 2.4, which shows how the level of effort determines the stock level and the rate of harvest.

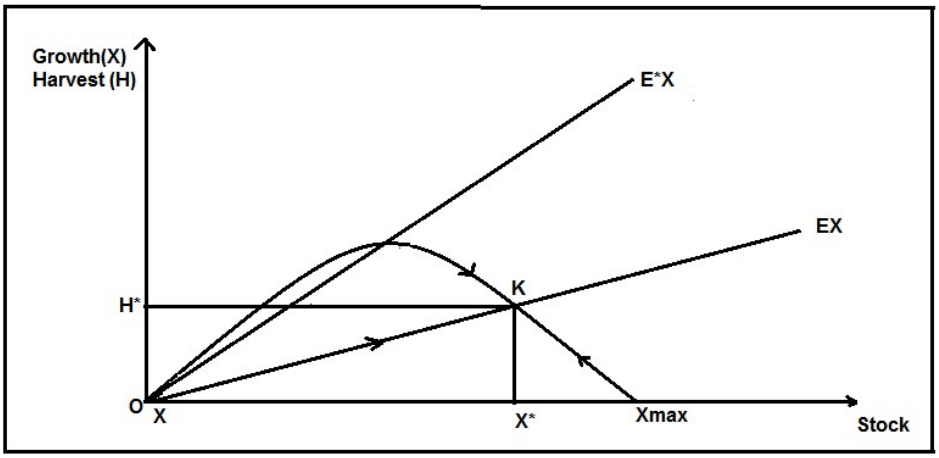


Figure-2.4: The relationships between harvest, population size and effort

In Fig. 2.4, the EX curve is equal to the rate of growth of resources at point K and it gives the harvest level H* and stock of resource X*. Any harvest level along the line EX to the right of X* will mean higher level of harvest than the sustainable yield and stock will reduce. On the other hand, any harvest along the line EX to the left of X* is less than the yield through natural regeneration and the stock will grow. Here, it is to be noted that, the harvest level H* is not the maximum sustainable yield but efforts can be adjusted to reach the maximum sustainable yield level as shown by E*X in Fig. 2.4.

After determining the relationship of harvest and stock level we have to determine the sustainable yield curve and for this we need to introduce costs and revenue in the analysis. The introduction of revenue and costs require establishment of relationship between harvest (yield) and the level of effort. Fig. 2.5 A shows the equilibrium level of harvest for different degrees of efforts put in the harvesting. Subsequently, the levels of efforts and the associated harvest levels are shown in Fig. 2.5 B. It is important to note that each level of effort is associated with an equilibrium population size that is unique to the effort in question. For example, in both Figures 2.5 A and 2.5 B, the effort level E1 is related not only to the sustainable harvest of H1 but also to the same equilibrium population. By joining the different

combinations of efforts and level of harvest we will obtain a curve similar to natural growth curve and it is called sustainable yield curve of renewable resource (Figure-2.5B). The sustainable yield curve is nothing more than the natural growth curve expressed in terms of effort. Each point along the sustainable yield curve assumes an equilibrium population size that corresponds to a given level of effort. However, the levels of effort and the equilibrium population size are inversely related which is seen from the figures 2.5 A and 2.5 B. That is, the larger the level of effort, the smaller the size of the equilibrium population and vice versa. This also suggests that excessive harvesting of a renewable resource could lead to its irrevocable destruction or extinction. Thus, in this sense, renewable resources are potentially destructible.

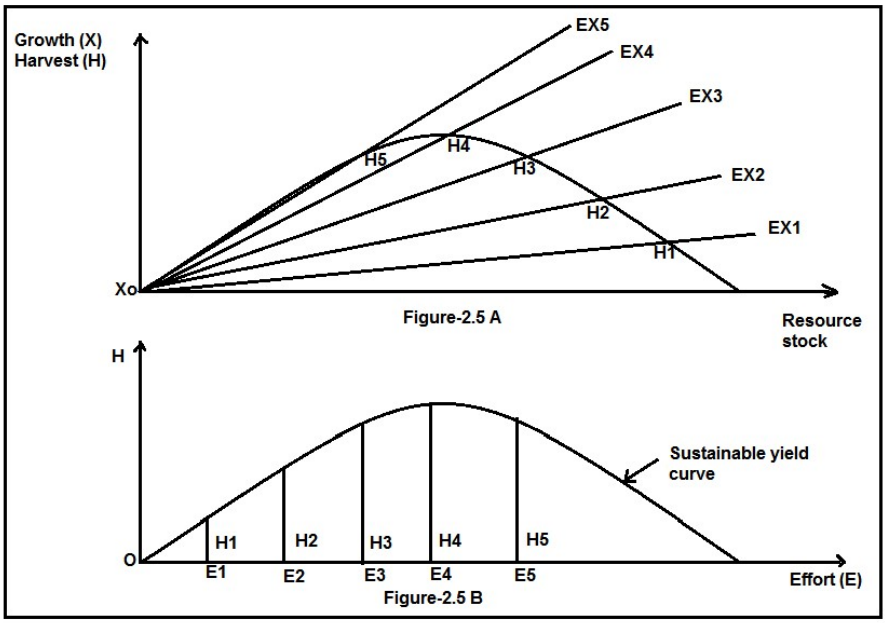


Figure-2.5 A

Figure-2.5 B

Now if we assume that effort is the only factor of production, then total cost will be equal to the level of efforts multiplied by the price of effort. The price of effort may be taken as the wage rate, W and thus total cost of harvest, TC = WE. Since firms in the fishery are assumed to be price-takers, the total cost curve will be a straight line with a constant slope equal to the market price of effort, W. Similarly, total revenue from the harvest can be obtained by multiplying quantity of harvest (H) with price of harvest per unit (P) that is, TR = PH. The total revenue curve will have the same

shape as the sustainable yield curve. In fact, it is nothing more than the monetised version of the sustainable yield curve.

Assuming wage rate (W) and price of harvest (P) to be constant, the total costs and total revenue curves are shown in Fig. 2.6.

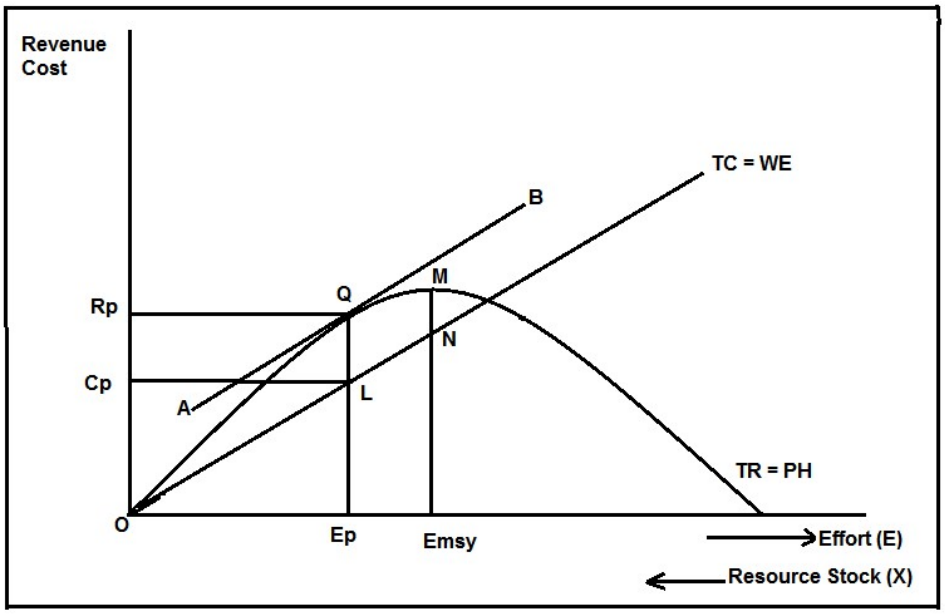
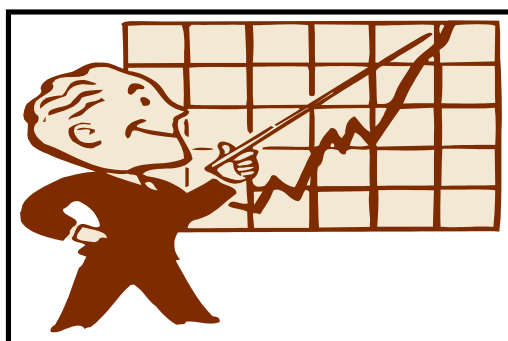


Figure-2.6: Determination of profit maximising or optimal level of harvest

In Fig. 2.6 fishing costs are introduced on the horizontal axis, increasing from left to right along with fishing effort. At high levels of fish stocks or low level of effort costs are lower. Costs increase as the size of the fish stock declines or level of efforts increase. Now to determine the profit maximising level of harvest we need to locate the point where the difference between total revenue and total costs is maximum or profit is maximum. This can be obtained by equating marginal revenue and marginal cost also. The slope of the marginal cost and total cost provide the marginal revenue and marginal cost curves. In Fig. 2.6, AB is the slope of the total revenue curve at point Q. At point Q the slopes of the total revenue and total costs curves become equal i.e. marginal cost equals marginal revenue which is the profit maximising condition. Thus, the profit maximising level of harvest (optimal level of resource use) is determined at Q. The profit is shown by the distance between the total revenue and the total cost curves and it is QL. On the other hand, the difference between total revenue and

total costs at the maximum sustainable yield is MN and in the Figure-2.6, QL > MN. Thus, profit at profit maximising effort (Ep) is higher than the profit at maximum sustainable yield (Emsy) level of effort. The profit maximising level of fishing effort Ep gives a larger size of fish population than the maximum sustainable yield, Emsy level of effort. If costs of harvest increases, then the profit maximising level of harvest will fall. On the other hand, if costs of harvest decreases then the profit maximising catch will come closer to the maximum sustainable yield. The profit maximising harvest would be equal to the maximum sustainable yield level of harvest only if there is no cost of harvest i.e. if fishing cost is zero.

The maximum sustainable yield is a biological concept which does not take into account costs of harvest. The optimum or profit maximising harvest clearly take into account of the costs and revenue and shows that if the renewable resource is owned by a profit maximising economic agent, then it will be managed in a sustainable way with harvest or exploitation less than the maximum sustainable yield.



CHECK YOUR PROGRESS

Q.6. What is meant by maximum sustainable yield?

Q.7. State the relationship between level of efforts in the harvesting of renewable resource and the rate of harvest and growth of stock of renewable resources.

Q.8. In what condition does the profit maximising level of harvest of renewable resource become equal to the maximum sustainable level of harvest?



2.6 LET US SUM UP

- Resource Economics studies the allocation of scarce resources. Resource Economics is mainly concerned with the flow of resources from nature to economic activities and provide an extensive idea about the availability, scarcity and potentiality of resource base of the nature.
- There is a very close relationship between the environment and economic activity of humankind. The relationship between environment and economy can be best explained with a model what is called the “Material Balance Model”. This approach visualises the total economic process as a physically balanced flow between inputs (resources) and outputs (waste/residuals).
- The Material Balance Model is based on the first and second law of Thermodynamics. According to the first law, matters and energy can neither be created nor destroyed. In the material balance model, it implies that in the long run the flow of materials and energy extracted from nature for production and consumption must be equivalent to the flow residuals into the environment from these activities. The second law of Thermodynamics known as Entropy law states that, nature’s capacity to convert matter and energy is not without bound. During the conversion process some of the energy becomes unusable in another process although it still exists. Thus, the transformation of materials and energy is an irreversible transformation of useful materials into waste.
- Natural resources are the natural assets (raw material) occurring in nature that can be used for economic production or consumption. It is anything derived from the nature that is directly used by human beings.
- There are numerous ways to classify natural resources they are- regeneration capacity, source of origin, stages of development etc.

- On the basis of regeneration capacity natural resources are classified into two major categories: renewable and non-renewable natural resources. On the basis of source of origin resources are classified into biotic resources and abiotic resources. On the basis of stages of development resources are classified into potential, actual, reserve and stock resources.
- Although, renewable resources are regenerative in nature, the ability to regenerate is not unlimited. The natural process of regeneration requires a time frame and it has certain limit. Such resources must be managed in a sustainable way so that only additions to stocks, or the 'sustainable yield' are harvested. Thus, optimal management of renewable resources is a crucial concern of resource economics i.e. to determine the optimum rate of use of renewable resources over time or over generations.
- The natural growth path of any biological resource is a function of time.
- The maximum sustainable yield (MSY) of a renewable resource is the amount of the resource which can be harvested without depleting the stock. A 'sustainable yield' would be a size of harvest which equals the growth rate of the stock of the resource.
- For a given population size of a renewable resource, the higher the level of effort, the larger will be the harvest or catch; and given the level of effort, the larger the population size, the larger will be the harvest.
- The optimal level of harvest of renewable resource is determined at the harvest yield level where the difference between total revenue and total cost is maximum.



2.7 FURTHER READING

Eugine, T. (2009). *"Environmental Economics",* Vrinda Publications (P) Limited, Delhi.

Hussen, A.M.(2000). *"Principles of Environmental Economics-Economics, Ecology and Public Policy"*, Routledge, London & New York.

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Kolstad, C.D. (2003). *"Environmental Economics"*, Oxford University Press, New York, Oxford.

Purkayastha, G. (2014). *"Environmental Economics-Theory, Problems and Solutions",* Kalyani Publishers, New Delhi.

Tietenberg, T. & L. Lewis (2012). *''Environmental and Natural Resource Economics",* 9th Edition, Pearson.



2.8. ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Allen Knees (1970) and R.V. Ayres (1969).

Ans to Q No 2: The material Balance Model is based on the first and second law of Thermodynamics. According to the first law, matters and energy can neither be created nor destroyed. The second law of Thermodynamics known as Entropy law states that, nature's capacity to convert matter and energy is not without bound.

Ans to Q No 3: The three important ways to classify natural resources are regeneration capacity, source of origin, stages of development.

Ans to Q No 4: The three main characteristics of natural resources are- utility, scarcity and potential for depletion.

Ans to Q No 5: Two examples of renewable resources are fisheries and forests. On the other hand, two examples of non-renewable resources are coal and iron.

Ans to Q No 6: The maximum sustainable yield (MSY) of a renewable resource is the amount of the resource which can be

harvested without depleting the stock. A 'sustainable yield' would be a size of harvest which equals the growth rate of the stock of the resource.

Ans to Q No 7: The relationship among the levels of harvest, effort and population size can be given by-

$$E = \frac{H}{X}$$

Where, E= level of effort put in the harvesting or catch
H= rate of harvest
X= growth of stock of the resource

Ans to Q No 8: The profit maximising harvest of renewable resource would be equal to the maximum sustainable yield level of harvest only if the cost of harvest is zero.



2.9 MODEL QUESTIONS

Short Questions: (Answer each question in about 150 words)

Q.1: Write a note on the Material Balance Model.

Q.2: Define natural resource. Discuss how resources are classified.

Q.3: Write a short note on maximum sustainable yield.

Long Questions: (Answer each question in about 300 to 500 words)

Q.1: Define renewable resources. Diagrammatically explain the concept of maximum sustainable yield of renewable natural resources.

Q.2: What are the different types of renewable resources? Explain the process of determination of optimal level of renewable resource use.

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UNIT 3 : ECONOMICS OF RESOURCES-II

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Non Renewable Resources: Concepts and Types

3.4 Difference between Renewable and Non-Renewable Resources

3.5 Optimal Management of Non-Renewable Resources

3.6 Backstop Resources: A Renewable Substitute

3.7 Optimal Extraction Path with Increasing Marginal Cost

3.8 Let Us Sum up

3.9 Further Reading

3.10 Answers to Check Your Progress

3.11 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- describe the nature of non-renewable resources
- distinguish between renewable and non-renewable resources
- identify the optimal extraction path of non-renewable resources.
- explain the relationship between opportunity cost and extraction of non-renewable resources
- discuss the backstop resources and their importance in non-renewable resource management.

3.2 INTRODUCTION

Conventionally, natural resources are classified as renewable resources and non-renewable resources based on their rate of regeneration. In this unit, we shall deal with economics behind the non-renewable resources. Here, we are going to discuss the different concepts relating to non-renewable resources and their significance; also how non-renewable resources are different from renewable resources and how to allocate non-

renewable resources among the generations, i.e., optimal management of these resources. Non-renewable resources are exhaustible due to its finite availability. Consequently, it involves the challenge for managing the stock of these declining resources among generations. Therefore, management of these resources has become an important issue in modern planning for development.

3.3 NON-RENEWABLE RESOURCES: CONCEPTS AND TYPES

Non-renewable resources are those which are available in finite quantities and for which the natural replenishment feedback loop can safely be ignored. The rate of replenishment for these resources is so low that it does not offer a potential for augmenting the stock in any reasonable time frame. As discussed in previous Chapter, three separate concepts are used to classify the stock of non-renewable resources: *current reserves*, *potential reserves* and *resource endowment*.

- *Current reserves* are defined as known resources that can profitably be extracted at current prices. The magnitude of these current reserves can be expressed as a number.
- *Potential reserves* are most accurately defined as a function rather than a number. The amount of reserves potentially available depends upon the price people are willing to pay for those resources—the higher the price, the larger the potential reserves. Higher prices enable not only more expensive measures to recover more of the resources from conventional sources, but also measures to extract resources from previously untapped unconventional sources.
- The *resource endowment* represents the natural occurrence of resources in the earth's crust. Since prices have nothing to do with the size of the resource endowment, it is a geological, rather than an economic concept. This concept is important because it represents a physical upper limit on the availability of terrestrial resources.

Distinction between the above three concepts are very much essential. Otherwise, failure to distinguish between the first two concepts can lead to massive underestimation of time until exhaustion. Another mistake is when it is assumed to avail entire resource endowment as potential reserves at a price people would be willing to pay. But it is possible only when the people are willing to pay an infinite price. But, we cannot wait for the arrival of an infinite price.

Non-renewable resource can also be classified as *recyclable resources* and *non-recyclable resources*. A *recyclable resource* is one that, although currently being used for some particular purpose, exists in a form allowing its mass to be recovered once that original purpose is no longer necessary or desirable. For example, copper wiring from an automobile can be recovered after the car has been shipped to the junkyard. The degree to which a recyclable resource is actually recycled is determined by economic conditions.

The current reserves of a non-renewable recyclable resource can be augmented by economic replenishment, as well as by recycling. Economic replenishment takes many forms, all sharing the characteristic that they turn previously unrecoverable resources into recoverable ones. One obvious stimulant for this replenishment is price. As price rises, producers find it profitable to explore more widely, dig more deeply and use lower-concentration ores.

However, the potential reserves of non-renewable recyclable resources can be exhausted. The depletion rate is affected by the demand for and the durability of the products built with the resource, and the ability to reuse the products. Except where demand is totally price inelastic (i.e., insensitive to price), higher prices tend to reduce the quantity demanded. Durable products last longer, reducing the need for newer ones. Reusable products (e.g., rechargeable batteries or products sold at flea markets) provide a substitute for new products.

But all non-renewable resources are not recyclable; there are certain non-renewable resources which are irreversibly transformed if they are in use, they are known as non-recoverable or non-recyclable resources. For

example, if energy resources (such as oil, coal etc.) are combusted and turned into heat energy, the heat dissipates into the atmosphere and becomes non-recoverable. Current use of non-renewable non-recyclable resources precludes future use; hence, the issue of how they should be shared among generations has gained significant importance.

3.4 DIFFERENCE BETWEEN RENEWABLE AND NON-RENEWABLE RESOURCES

Non-renewable resources can be distinguished from renewable resources primarily on the ground of rate of replenishment. Natural replenishment augments the flow of renewable resources at a significant rate. Solar energy, water and biological populations are all examples of renewable resources. For this class of resources, it is possible, though not inevitable, that a flow of these resources could be maintained perpetually. However, this cannot be held true for non-renewable resources. Replenishment rate of non-renewable resources is so low that it does not offer a potential for augmenting the stock in any reasonable time frame.

Continuations of volume of non-renewable resources are dependent on humans. How do humans use or extract these resources? Consumption by one generation can reduce its availability for subsequent generations due to its finite availability. For renewable resources, such as solar energy, the flow is independent of humans. The amount consumed by one generation does not reduce the amount that can be consumed by subsequent generations. However, there are some renewable resources; continuation of which crucially depends on humans. Excessive fishing reduces the stock of fish, which in turn reduces the rate of natural increase of the fish population.

Storage of renewable resources usually provides a different service than storage of non-renewable resources. Storing non-renewable resources prolongs their economic life; storing renewable resources, on the other hand, can serve as a means of smoothing out the cyclical imbalances of supply and demand. Surpluses can be stored for use during periods when deficits occur.

Managing renewable resources presents a different challenge from managing non-renewable resources, although an equally significant one. The challenge for non-renewable resources involves allocating declining stocks among generations while meeting the ultimate transition to renewable resources. In contrast, the challenge for managing renewable resources involves the maintenance of an efficient, sustainable flow.



CHECK YOUR PROGRESS

Q 1: Define non renewable resources. (Answer in about 30 words)

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Q 2: Is it possible to make available the entire resource endowment? If so how? (Answer in about 20 words)

_ _

Q 3: Mention the significant distinction between the different concepts of non-renewable resources. (Answer in about 60 words)

_ _

3.5 OPTIMAL MANAGEMENT OF NON-RENEWABLE RESOURCES

It is known that non-renewable resources are limited in quantity and are not reproducible. Extraction and consumption of a unit today of these resources involves an *opportunity cost,* i.e., the value that might have been obtained at some future date. This opportunity cost is also termed as *user cost*. The concept of user cost is the central issue of management of non-renewable resources. Non-renewable resources have a user cost as consumption or extraction of these resources at present reduces its availability in the future, as non-renewable resources are not reproducible

like renewable resources. Therefore, the user cost must be taken into account while determining how to allocate the resource over time. As a result, instead of the usual efficiency condition,

Price = marginal cost

We have,

Price = marginal cost + user cost *(1)*

This is the first condition of optimal depletion. As shown in Fig. 1, it implies that less of the resource will be extracted today than if it were producible. Given the demand $P = P(y)$, where p is price and y is quantity, only y^* units will be extracted by a planner or resource manager seeking to allocate extraction efficiently over time, leaving a positive difference '*AB'* between the price and the marginal cost of production or extraction.

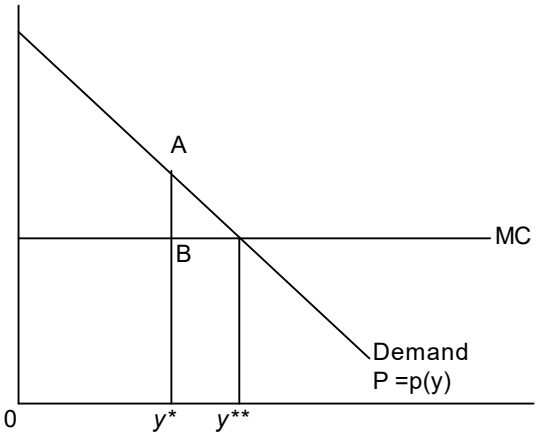


Figure 1: Relationship between marginal cost and price for an exhaustible resource

The second condition of optimal depletion describes the behavior of the user cost over time. To know the behavior of user cost over time, let us assume, for simplicity, a two period model. The owner of the resource can extract and sell the resource today, or it can leave the resources in the ground until the next period. Suppose a non renewable resource, say oil, is in fixed quantity, q and also the marginal cost of extraction remains constant, c. The demand in period t (t = 0,1) is given by the equation $p_t = (q - y_t)$, where p_t is price at time 't' and y_t is output that can be extracted at time 't', and the rate of discount is 'r'. Here, rate of discount 'r' is the rate at which present value of a stream of output levels extracted over a period of time 't'

is computed, so that allocation over the period 't' can be made possible. Now the question is what allocation of output between the two periods will yield the greatest net benefit? For efficient or optimal extraction of non renewable resources, it is important to determine what quantities to be extracted today and how much to leave it in the ground for future usages.

Net benefit in a single period is measured as the difference between consumers' willingness to pay for a good and costs associate with the production of it. In Fig. 1, net benefit is the area between *p(y)* and marginal cost (*mc)* from y = 0 *to y = y*.* The net benefit can then be written as

$$\int_0^{y_0} (q - y')dy' - \int_0^{y_0} c dy'$$

$$= \int_0^{y_0} [(q - y') - c]dy' \qquad \text{in the first period;}$$

and $$\int_0^{y_1} [(q - y') - c]dy' \qquad \text{in the second period;}$$

Where, y_0 and y_x represent actual first-period and second-period outputs and *y '* is a variable of integration.

Now our objective is to choose a level of output in each period in such a way as to maximize the sum of net benefits over both periods, taking care to multiply the second period's benefit by the discount factor 1/(1 + r) to obtain a present value. In symbols, the problem is:

$$\text{Maximize } \int_o^{y_0} [(q - y') - c]dy' + \frac{\int_o^{y_1} [(q - y') - c]dy'}{1+r}$$

Subject to

$$y_0 + y_1 = q$$

For maximization, the Lagrangian function will be

$$L = \int_0^{y_0} [(q - y') - c]dy' + \frac{\int_0^{y_1} [(q - y') - c]dy}{1+r} + \lambda(q - y_0 - y_1)$$

Where, λ is a Lagrange multiplier, differentiating with respect to y_0, y_1 and λ, and setting the results equal to zero, we get

$$(q - y_0) - c - \lambda = 0 \qquad \text{.....(2)}$$

$$\frac{(q - y_1) - c}{1/(1-r)} - \lambda = 0 \text{ (3)} \qquad \text{.....(3)}$$

$$q - y_0 - y_1 = 0 \qquad \text{.....(4)}$$

Solving for y_0, y_1, λ and substituting the values for y_0 and y_1 into the demand equation, we get the prices for the two periods, p_0 and p_1.

Now from equation (2) and (3), we can say that the present value of the user cost is the same for both periods as $y_{1=} y_0 (1+r)$. So the second condition for optimal management of non renewable resource is that the present value of the user cost must be the same in all periods or, equivalently, the undiscounted user cost must rise at the rate of interest, but the condition that costs should not rise with cumulative extraction.

We can also generalise these conditions for any number of periods within which the resource is allocated, simply by retaining the assumption of constant marginal cost of extraction. We have proved that the user cost rises at the rate of interest. This can be stated as

$$P_1 - MC = (P_0 - MC)(1 + r)$$

Then the equation for the time path of price is

$$P_1 = MC + (P_0 - MC)(1 + r) \quad (5)$$

Now, we can easily expand the above time path of price for any number of periods. That is,

$$P_t = MC + (P_0 - MC)(1 + r)^t \quad (6)$$

Here, price draws away from marginal extraction cost, rising at a rate that approaches the rate of interest as the user cost component of price comes to dominate the extraction cost component. This is shown in Figure 2

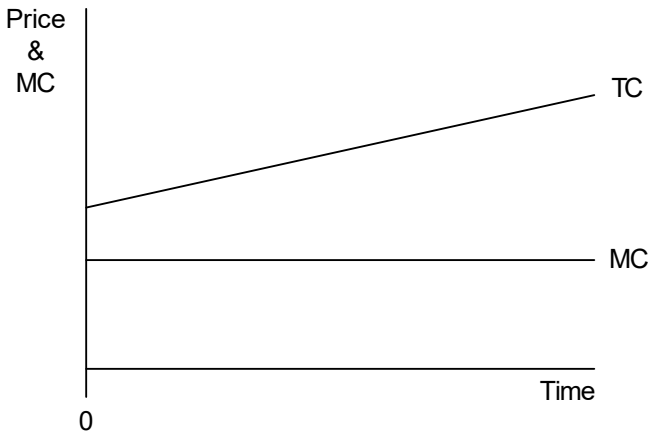


Figure 2: Time path of price and its relationship to resource costs (marginal cost of extraction and user cost)

Fig. 2 shows the behavior of marginal cost of extraction and user cost. The terms 'TC' which means total cost is the sum of marginal cost of extraction and user cost. The horizontal line MC is representing the marginal cost of extraction and the vertical distance between TC and MC is the marginal user cost which is increasing at a rate equal to rate of interest over the time periods. This increase in the marginal user cost depicts the rising scarcity of the resource and consequently, the opportunity cost of current consumption also increases due to declining stock of the resource.

In summary, our generalised model suggests that an efficient allocation over time of a non-renewable resource with a constant marginal cost of extraction involves rising marginal user cost and falling quantities consumed. This rise in the efficient marginal user cost reflects increasing scarcity and the resulting rise in the opportunity cost of current consumption as the remaining stock of the resource declines. The user cost will increase until the resource gets exhausted. So, even when the marginal cost of extraction is constant, an efficient allocation envisions a smooth transition to the exhaustion of a resource.

3.6 BACKSTOP RESOURCE: A RENEWABLE SUBSTITUTE

A backstop is a resource or a technology that can provide the same services as the non renewable resource, but at higher cost and without risking exhaustion in any meaningful time frame. The need for backstop resource arises with a question regarding the rising prices. The question is "does price rise infinitely?" And the answer is 'No'. Because, if a backstop resource is available, then it sets an upper limit for the price or cost of non-renewable resource by the price or cost of it. Otherwise, the non-renewable resource will be substituted by the backstop. Note that marginal cost of the backstop is also its price, because the backstop is available in unlimited quantity. Since the substitute is available in unlimited quantities, there is no user cost associate with it. Backstop resources are useful as the cost of it determines the initial price by determining the initial royalty to be added to the marginal cost of extraction.

Suppose, the non-renewable resource is substituted by a backstop resource at time *'T',* the price is given by

$$P_T = MC + (P_0 - MC)\ (1 + r)^T$$

But, as we know, in terms of backstop resources, price is equal to its marginal costs (MC_b) only, i.e.,

$$P_t = MC_b$$

Now, we have

$$MC_b = MC + (P_0 - MC)\ (1 + r)^T$$

Or,

$$(P_0 - MC) = \frac{MC_b - MC}{(1+r)^T} \quad (7)$$

The equation (7) shows that the user cost of the non-renewable resource at time t =0 is determined by the difference between the cost of the backstop and the cost of that resource, discounted back from the time of substitution. Now, putting equation (7) into equation (1), we get the equation for the price of the non-renewable resource in terms of the cost of the backstop at any time t < T:

$$P_t = MC + \frac{MC_b - MC}{(1+r)^{T-t}} \quad (8)$$

The above analysis reveals that the backstop resources are important aspect for the management of non-renewable resources. It plays two important roles in this respect; firstly, it sets an upper limit on the price of the non-renewable resource; and secondly, it determines the initial price by determining the initial user cost to be added to the marginal cost of extraction.



CHECK YOUR PROGRESS

Q 4: What are the two conditions for optimal extraction path of non-renewable resources? (Answer in about 60 words)

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Q 5: How does opportunity costs behave with response to resource availability? (Answer in about 50 words)

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__ ___ ___ ___ ___ ___ ___ ___ ___ ____

3.7 OPTIMAL EXTRACTION PATH WITH INCREASING MARGINAL COST

So far we have expanded our initial model into a more realistic one by incorporating longer period of time and also by availing a backstop resource which is a perfect substitute for the non-renewable resource. But, the approach will more realistic when we consider a model with increasing marginal cost of extraction for additional units of the resource extracting. The justification for this supposition can be traced out in the works of David Ricardo and J.S. Mill. Ricardo suggested that it is plausible that the higher-quality deposits will be extracted first, and then followed by those of lower-quality, just like the case of agricultural lands in Ricardian theory of Rent. Later, J.S. Mill has pointed out that increasing costs can set in even as the deeper and thinner portions of the deposit of the resource are extracted.

Analytically, the present situation can also be handled in a similar manner as that are followed earlier. But, only departure is that marginal cost of extraction increases with the additional units extracted. The optimum extraction path of the resource is once again found by maximising the present value of the net benefits, but in this case using the modified extraction cost function. The results of this maximisation are illustrated using the following figures:

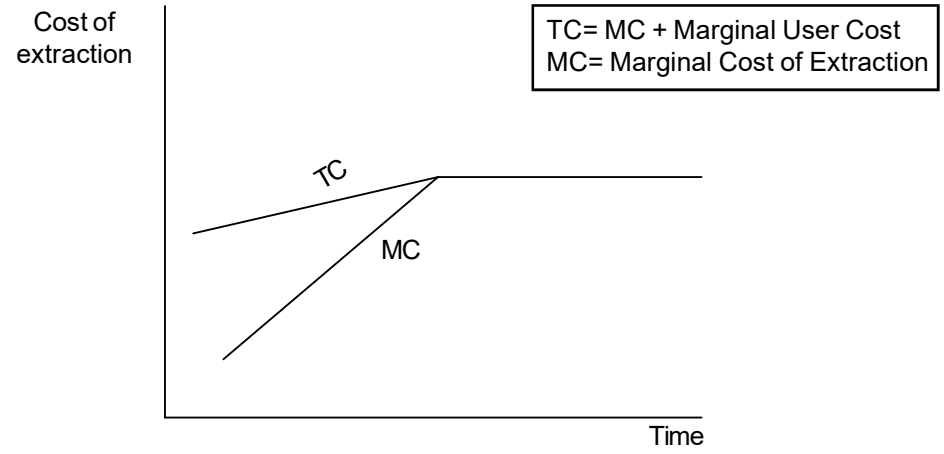


Figure 3: Increasing Marginal Extraction Cost with Substitute Resource

By comparing Figures 2 and 3, we have found a significant distinction between the two situations in terms of the behaviour of marginal user cost. In case of constant marginal cost of extraction, user cost was rising at a rate *'r'* over time. However, in case of increasing marginal cost of extraction, marginal user cost is decreasing over time with additional units extracted. Finally, it becomes zero at the time of transition to a renewable resource (i.e., backstop resource). The reason behind this is that marginal user cost is an opportunity cost reflecting forgone future marginal net benefits. In contrast to the case of constant marginal cost, in the increasing marginal cost case every unit extracted now raises the cost of future extraction. Therefore, as the current marginal cost rises over time, the sacrifice made by future generations diminishes as an additional unit is consumed earlier; the net benefit that would be received by a future generation, if a unit of the resource were saved for them, gets smaller and smaller as the marginal extraction cost of that resource gets larger and larger. By the last period, the marginal extraction cost is so high that earlier consumption of one more unit imposes no sacrifice at all. At the switch point, the opportunity cost of current extraction (as reflected in the marginal user cost) drops to zero, and total marginal cost equals the marginal extraction cost.

The two cases are also different in terms of depletion of the non-renewable resource. In the constant-cost case, the resource ultimately gets

exhausted. However, in case of increasing cost, the resource does not deplete completely; something will be left in the ground because it is more expensive than the backstop.



CHECK YOUR PROGRESS

Q 6: Diffentiate between the cases of constant-cost and increasing-cost of extraction of non-renewable resources. (Answer in about 60 words)

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3.8 LET US SUM UP

- Three separate concepts are used to classify the stock of non-renewable resources: *current reserves*, *potential reserves* and *resource endowment.*
- Non-renewable resources can be classified as *recyclable resources* and *non-recyclable resources.*
- Non-renewable resources can be distinguished from renewable resources primarily on the ground of rate of replenishment, availability and storage services.
- There are basically two conditions for optimal management of non renewable resources. First, price should incorporate both marginal cost of extraction and user cost. Second, the present value of the user cost must be the same in all periods or, i.e., the undiscounted user cost must rise at the rate of interest.
- Opportunity cost increases with increasing scarcity of non renewable resources.
- Backstop resources not only to set an upper limit on the price of non-renewable resources but also determines the initial price by determining the initial user cost to be added to the marginal cost of extraction.

- The behavior of user cost is completely contradictory in the case of increasing cost of extraction to the case of constant-cost.



3.9 FURTHER READING

- Bhattacharya, R.N. (2001) *Environmental Economics- An Indian Perspective,* New Delhi: Oxford University Press.
- Fisher, A.C. (2008) *Resource and Environmental Economics,* New York: Cambridge University Press.
- Tietenberg, T. and Lewis, L. (2018) *Environmental and Natural Resource Economics,* New York: Routledge.



3.10 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Non-renewable resources are those resources which are available in finite quantities and also its rate of replenishment is so low that it does not offer a potential for augmenting the stock in any reasonable time frame.

Ans to Q No 2: It is possible to make available the entire resource endowment only when people are willing to pay an infinite price.

Ans to Q No 3: It is very much essential to distinguish the various concepts of non-renewable resources to avoid two mistakes. First, if we fail to distinguish between current reserves and potential reserves then it can lead to massive underestimation of time until exhaustion. Second, when we assume to avail entire resource endowment as potential reserves at a price people would be willing to pay. But it is possible only when the people are willing to pay an infinite price. But, we cannot wait for the arrival of an infinite price.

Ans to Q No 4: The two conditions for optimal extraction path of non renewable resources are:

i. First, price should incorporate both marginal cost of extraction and user cost.

ii. Second, the present value of the user cost must be the same in all periods or, i.e., the undiscounted user cost must rise at the rate of interest, given that marginal cost of extraction remains constant.

Ans to Q No 5: Behavior of opportunity cost with regards to the availability of non renewable resources can be traced out as a negative relation. When there is relatively higher level of resources are available, marginal opportunity is also relatively higher. But as resource get depleted, marginal opportunity cost increases at a rate equal to the interest rate.

Ans to Q No 6: There are basically two differences between the cases of constant-cost and increasing cost of extraction of non-renewable resources: firstly, user cost increases with time in case of constant cost. However, in case of increasing cost, it decreases over time with cumulative amount of extraction. Secondly, in constant-cost case, the resource ultimately gets exhausted entirely. But it does not get exhausted entirely when marginal cost of extraction is increasing.



3.11 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: Distinguish between renewable resources and non-renewable resources.

Q 2: In a two period model framework, find out the price for each period and also the net social benefit, when the demand function is

$P_t = (10 – Y_t)$, marginal cost of extraction is \$2 *and* quantity of the resource that can be extracted is fixed at 10 units.

Long Questions (Answer each question in about 300-500 words)

Q 1: Briefly discuss the nature of non-renewable resources.

Q 2: Illustrate the optimal extract path of non-renewable resources.

Q 3: Describe the importance of backstop resources in the management of non-renewable resources.

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UNIT 4: PROPERTY RIGHTS AND ENVIRONMENTAL RESOURCES

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Various Types of Property Rights

- 4.3.1 Private Property Regime
- 4.3.2 State Property Regime
- 4.3.3 Common Property Regime
- 4.3.4 Open Access Regime

4.4 Property Rights and Their Environmental Implications

4.5 Common Property Resources (CPRs) and Tragedy of Commons

4.6 Tragedy of the Commons: A Game Theoretic Approach

4.7 Let Us Sum Up

4.8 Further Reading

4.9 Answers to Check Your Progress

4.10 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- know about the concept of property rights and their characteristics.
- distinguish between the various types of property rights and their environmental implications.
- describe the association between common property resources and the tragedy of the commons.

4.2 INTRODUCTION

Property rights represent a bundle of entitlements that define the owner's privileges and obligations for use of a resource or an asset. By examining such entitlements and how they affect human behavior, we can better understand how environmental problems arise from government and

market allocations. Property rights can be vested either with individuals, groups or with the state.

Well-defined property rights are very much essential for a market to operate efficiently. Otherwise, market cannot rely upon for efficient management of natural resources. A well-defined property right has the following general characteristics:

- *Comprehensively assigned:* All assets or resources must be either privately or collectively owned, and all entitlements must be known and enforced effectively.
- *Exclusive:* All benefits and costs from use of a resource should accrue to the owner, and only to the owner, either directly or by sale to others. This applies to resources that are owned in common as well as to resources for which private property rights have been assigned.
- *Transferable:* All property rights must be transferable from one owner to another in a voluntary exchange. Transferability provides the owner with an incentive to conserve the resource beyond the time he or she expects to make use of it.
- *Secure:* Property rights to natural resources should be secure from involuntary seizure or encroachment by other individuals, firms or the government. The owner has an incentive to improve and preserve a resource while it is in his or her control rather than exploit the assets.

An owner of a resource with a well-defined property right (one exhibiting above four characteristics) has a powerful incentive to use that resource efficiently because a decline in the value of that resource represents a personal loss. For instance, farmers who own the land have an incentive to use fertilizer and irrigate it because the resulting increase in production raises income of the farmers. Similarly, they also have an incentive to rotate crops when that raises the productivity of their land.

In a market economy, when well-defined property rights are exchanged, this exchange facilitates efficiency. For example, when there is a well-defined system of property rights, sellers have the right to prevent

the consumer from consuming the product in the absence of payment, the consumer must pay to receive the product. Given a market price, the consumer decides how much to purchase by choosing the amount that maximizes his or her individual consumer surplus. However, most market failures with natural resources, take place due to inability of the institutions to establish well-defined property rights. Because when a person has a property right over a piece of land, he can take action when any damage has done to it. However, we generally do not have any property rights over the river and the air, through which significant amounts of pollution travel. Therefore, market fails to manage the natural resources efficiently.



CHECK YOUR PROGRESS

Q 1: Define property rights. (Answer in about 20 words)

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Q 2: How market failure occurs in a system without well-defined property rights? (Answer in about 60 words)

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4.3 VARIOUS TYPES OF PROPERTY RIGHTS

Let us discuss the various types of property rights and how they influence the interaction between human and the natural environment. There are mainly four types of property rights and we call them as "property right regimes", namely private property, state property, common property and open access.

4.3.1 Private Property Regime

Under *private property* regime, an individual or corporation has the right to exclude others and to regulate the use of the resources. This regime provides the institutional arrangement for a successful exclusion because this type of property is more effective

in making the government enforce their rights. Private property regimes appear to be stable and adaptive because they have the social and legal sanction to exclude others and effectively to resist unwanted intrusions (through power of the state). Examples are privately owned land, privately owned machines, livestock ownership, etc.

4.3.2 State Property Regime

In *state property* regime, entitlements to the resources are completely held by the state, enabling it to control, access and regulate use of the resource. Examples of state property rights regimes include forests, parks, etc. States attempt to protect the resources in two ways:

- By nationalising a large amount of resources to protect the natural reserves; and
- By passing laws designed to protect the natural environment.

Problems can arise in state-property regimes in terms of both efficiency and sustainability when the incentives of bureaucrats who implement and/or make the rules for resource use diverge from collective interests.

4.3.3 Common Property Regime

Under *common property* regime, a group of users who can exclude others and regulate the use of it manages the resources. Entitlements to use resources may be formal, protected by specific legal rules, or they may be informal, protected by tradition or custom. Common-property regimes exhibit varying degrees of efficiency and sustainability, depending on the rules that emerge from collective decision-making.

4.3.4 Open Access Regime

In *open access* regime, no one owns or exercises control over the resources. Use of the resources is free and open to all. Resources can be exploited on a first-come, first-served basis

because no individual or group has the legal power to restrict accessibility. An open access regime can be efficient only if the 'shadow price' of the resource is zero. That means if there is no social cost of extracting or using a marginal unit of the resource, it is beneficial for the society not to assign specific property rights over it. This regime is also known as *Res nullius* property right regime. This regime has also given rise to what has become popularly known as the "tragedy of the commons", which will be discussed in the later section.

4.4 PROPERTY RIGHTS AND THEIR ENVIRONMENTAL IMPLICATIONS

Initially, property rights have not defined for the use of the environment. Under such conditions, market fails to allocate resources efficiently, and the resulting structure of production is distorted. For instance, the environment has been used as a receptacle of waste that can be interpreted as common property resource. This leads to the over exploitation of the environment. Therefore, the property rights for using the environment should be more clearly defined. The environment should no longer be used as a free good for receiving waste; rather, a scarcity price should be charged. One way of introducing a price and redefining property rights is to introduce an emission tax. Another way would be to auction pollution licenses. Finally, the government could specify maximum emissions per firm (permits) which would implicitly set a price on pollutants. In all these cases, the environment, as a receptacle of waste, would be transformed into a private resource with a positive price by defining a new set of rules.

Another implication of property rights for environmental resources is in the conversion of public goods (like environmental quality) into private property. However, this conversion may result in serious consequences, as the new owner of the resources (who follows the rules of the market) may fail to internalise the negative external effects of their activities. Therefore, the public goods approach to environmental problems requires government intervention since the market does not provide public goods.

The property rights maintain that in many cases involving public goods, private property rights can define through government intervention.

However, under certain circumstances private property right is also not desirable, as it can lead to over-exploitation or destruction of the natural resources. First, when the growth rate of the resource value is less than the financial interest rate, the owner of the resource might prefer to use the resource rapidly in order to maximize profits. Second, uncertainty about availability of the resources in the future, can lead to over-exploitation. Third, the current precarious economic situation of many owners will force them to overuse the resources in the short run, without considering strategies to maintain the resources in the long run. One such possible case may arise when private property rights in a wilderness area would allow the owner to develop it for agriculture or extractive resource use, thus reducing the amenity services flow from the area, or to preserve the wilderness. State property rights become necessary for such kind of natural resources.



CHECK YOUR PROGRESS

Q 3: State the differences between Common Property Regime and Open Access Regime. (Answer in about 50 words)

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Q 4: In what circumstances is Private Property Right undesirable for allocation of environmental resources? (Answer in about 60 words)

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4.5 COMMON PROPERTY RESOURCES AND TRAGEDY OF THE COMMONS

If we look deeply into the Common Property Resources (CPRs), we get to know that CPRs can be governed through shared private ownership

regimes or government ownership regimes with community participation in its management. A resource is likely to be commonly owned or managed when its territorial division is either not feasible (such as the fish in the ocean) or very costly to enforce. There are two basic characteristics that all the CPRs have:

- A well-defined group has to have exclusive right over the resources;
- Presence of reciprocal externalities;

Due to the first characteristic, CPRs get its nature of being *non-excludable* within the members of the group, but the group has right to exclude other groups or individuals from its use. The second characteristic makes CPRs *divisible* in nature. Because the actions of each member affect the well-being of all other member of the group as, for instance, the grazing of one member's cattle on the common pasture affects the other cattle owners. Whenever any one of these characteristics is violated, CPR assumes the nature of 'open access resource'.

A most commonly referred problem with CPRs is the 'Tragedy of the Commons'. Whenever any of the set of rules and regulations characterised for CPRs is violated, individual choice may prevail over the social choice. Then it is rationale for an individual to over extract or overuse the CPR, and yet, individually not become responsible for the damage. In such a situation, CPR assumes the nature of open access resource.

The 'Tragedy of the Commons' is a metaphor that illustrates how individuals act in collectivity. CPR can deplete or degrade due to over extraction or overuse beyond its sustainability limit. Garret Hardin called this problem of CPR as the 'Tragedy of the Commons'. He explains the problem as follows: There is a pasture "open to all" where it is expected that each herdsman will try to keep as many cattle as possible in order to maximise his utility. All the herdsmen have the same behavior, which leads to a point where their aggregate activities begin to exceed the sustainable yield of the pasture. However, each herdsman is still motivated to add more and more cattle, because in doing so he acquires all the benefits of selling additional animals and shares the costs of overgrazing. Therefore, each man locks into a system that motivates him to increase his herd without

limit. This may lead to over grazing of the pasture beyond the limit of sustainable yield and consequently, complete depletion or degradation of the resource. This result holds for all types of natural resources.



CHECK YOUR PROGRESS

Q 5: What are the two basic characteristics of Common Property Resources? (Answer in about 40 words)

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4.6 TRAGEDY OF THE COMMONS: A GAME THEORETIC APPROACH

This postulate can also be illustrated in the framework of a 'prisoner's dilemma' game. The 'prisoner's dilemma' game is a classic example of non-cooperative game where two rationale players (individuals or groups) fail to cooperate and come up with a sub-optimal solution for the game. Suppose, there are two herdsmen (Meggi and Jimi) who let their herd to be pastured on a field (the CPR that belong to both). Now they have to choose one among the following two strategies: either they can co-operate with each other by sending only one animal each or they can act non-cooperatively by sending out three animals each to be pastured on the field.

		Jimi	
		Co-Operative	Non-Cooperative
Meggi	Co-Operative	60,60	20,80
	Non Co-Operative	80,20	30,30

As shown in the figure, if they co-operate and send out only one animal to pasture, they can each earn net profit of 60. But if Meggi sends out three animals while Jimi only sends out one, Meggi can increase her net profits to 80 by capturing a disproportionate share of the profit. Jimi

would only earn net profits of 20. Since a net profit of 80 exceeds 60, Meggi has an incentive to cheat and send out three animals to the field. Jimi has the same incentive: if Meggi co-operates and Jimi does not, Jimi can earn net profits of 80 while Meggi only earns 20. If both fall for this incentive to act non-cooperatively by sending out three animals, they overgraze the field and their net profit fall to 30 each. The end result is that both Meggi and Jimi earn only total net profits of 60 (30 + 30), while the social optimum is total net profits of 120 (60 + 60) when both co-operate.

Technically, the choice of non-cooperation is the dominant strategy for each player. A dominant strategy gives a player a greater pay-off regardless of the other player's actions. In our example, the non-co-operative strategy dominates the co-operative one since 80 > 60 and 30> 20. This outcome is called Nash equilibrium, obtained when each player choose to send three animals for grazing on the field. Here, the tragedy is that even though the strategy of co-operation would be better for both the herdsmen, but due to their individual rationale, they opt for the strategy of non-co-operation. This may benefit them individually but society will not benefit from it. Maximization of individual output will lead to complete destruction of the resource, i.e., the grazing land.

However, Hardin has failed to differentiate between situations of open access and situations of common property. The tragedy of the commons fits better in open access situations. As the possibility of co-operation for protection and efficient use of the resources are higher in case of Common Property Resources.



4.7 LET US SUM UP

- Property rights represent a bundle of entitlements that define the owner's privileges and obligations for use of a resource or an asset. Property rights are very much essential for a market to operate efficiently. Otherwise, without property rights, market cannot rely upon for efficient management of natural resources.

- Property right regimes can be classified as: private property regime, state property regime, common property regime and open access regime.
- None of the property right regimes is regarded as best for conservation of environmental resources. Although private property right has some efficiency over the other regimes, sometimes it can also lead to depletion/destruction of the resource.
- Common property resources can lead to the problem of the 'tragedy of the commons' due to its unique characteristics.
- In game theory, the 'tragedy of the commons' is a situation where participants choose a sub-optimal strategy even if there is optimal strategy available to them.



4.8 FURTHER READING

- Bhattacharya, R.N. (2001) *Environmental Economics- An Indian Perspective,* New Delhi: Oxford University Press.
- Hanley, N.; Shogren, J.F. and White, B. (1997) *Environmental Economics in Theory and Practice,* London: Macmillan Press Ltd.
- Perman, R.; Ma, Y.; McGilvray, J. and Common, M. (2003) *Natural resource and environmental economics,* England: Pearson Education Limited.
- Tietenberg, T. and Lewis, L. (2018) *Environmental and Natural Resource Economics,* New York: Routledge.



4.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Property rights are a bundle of entitlements that define the owner's privileges and obligations for use of a resource or an asset.

Ans to Q No 2: When well defined property rights are not available in system, it becomes difficult to enable people to reveal

their willingness to pay for the good or service it provides. Everyone will try getting it free of cost, which may result in free rider problem. In such a case, it is not possible for the market to operate efficiently, even if possible; market allocation can never be efficient.

Ans to Q No 3: The difference between common property resources and open access resources is that a group of people have exclusive right over resources in term of common property resources. But, in open access resources, no one has exclusive right over the resource. These resources are used by everyone.

Ans to Q No 4: When non-use value of a resource is higher than its use value, then it is not desirable to assign private property rights. Because, non-use value is different for different people. If the owner of the resource finds it more profitable to destroy it, then private property will give him that power. Under such circumstances, it is not likely to assign private property rights.

Ans to Q No 5: The basic characteristics of common property resources are:

- *Excludability*: people who have exclusive right over the resources can exclude other from using it.
- *Divisible in nature*: one person's consumption of these resources can reduce its availability for others.



4.10 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: What are the basic characteristics of a well-defined property right system?

Q 2: Illustrate the problem "The Tragedy of the Commons" in terms of Common Property Resources.

Long Questions (Answer each question in about 300-500 words)

Q 1: Give a brief note on various property right regimes and their environmental implications.

Q 2: Is the problem "The Tragedy of the Commons" a game of prisoner's dilemma? Give justification for your answer.

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UNIT 5: ENVIRONMENT AND ECONOMIC DEVELOPMENT

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Trade-off between Environment and Economic Development – Kuznets' Analysis

5.4 Population and Environment

5.5 Poverty and Environment

5.6 Exogenous and Endogenous Poverty

5.7 Let Us Sum Up

5.8 Further Reading

5.9 Answers to Check Your Progress

5.10 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- define and explain the trade-off between environment and economic development
- discuss various consequences of growth of population on the environment
- derive the relationship between poverty and environment
- discuss about exogenous poverty and endogenous poverty

5.2 INTRODUCTION

The primary objective of this chapter is to present the environment and economic development linkages on different grounds and more specifically the relation between population growth and environment and also the inter-linkages between poverty and environment.

In environmental economics, we study how economic activity and policy affect the environment and also how environment supports the

economic activities. Therefore, it is found to have great importance to discuss the interlinkage between economy and environment. The economy works in support of the environmental system and the economic activities affect the environment and the latter also affects the economy. The economy is a system consisting of producers, consumers and the market where interaction between the producers and consumers takes place. The main purpose of the economy is to produce goods and services to satisfy consumer's wants. For production of goods and services, the economy needs the support of environment, because, the production of goods and services needs both man-made as well as natural resources. Again, there are two types of natural resources: renewable and non-renewable. The renewable resources include forests and fisheries, whose quantity can be increased after depletion. On the other hand, the non-renewable resources are exhaustible in nature. Examples of non-renewable resources are coal, iron ore, crude oil etc.

The natural environment is viewed as having three distinctive functions. Environment is the source of basic raw materials for human use. It also functions as a repository and a decomposer of the waste materials releasing from the consumption and production sectors of the economy. The natural environment also provides the valuable amenities and ecological services to the human beings. Environmental resources are essential for sustaining production of goods and services. An economy cannot produce goods and services without using the natural resources. But, due to increase in the rates of extraction of environmental resources beyond their regeneration capacity, the problem of environmental degradation arises in many developing countries like India. Again, the scarcity of environmental resources is continually augmented through technological advances.

The natural environment plays important role in an economy. The natural environment acts as the provider of inputs for production of goods and services. Environmental resources such as minerals, fossil fuels etc. help in the production activities. Growing production activities directly contribute towards increase in the rate of economic growth. The environment

also acts as sequestering carbon, filtering air and soil formation. All these activities help in the functioning of economic activities.

The ecosystems that support the livelihood of people are being degraded continuously with the growing needs of people all around the world. The growth of population, growing urbanisation, industrialisation, consumerism in any nation leads to more and more exploitation of natural environment. Degradation of the ecosystem services are being disproportionately borne by the poor. Again, ecosystem degradation is one of the principal factors contributing to poverty. This also creates barrier to achieve the Millennium Development Goals set by the United Nations. Therefore, population growth and poverty are key drivers of degradation of the ecosystem services.

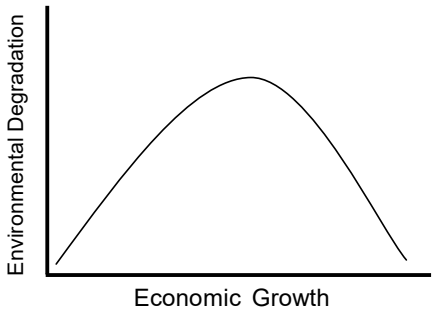
5.3 TRADE-OFF BETWEEN ENVIRONMENT AND ECONOMIC DEVELOPMENT – KUZNETS' ANALYSIS

Simon Smith Kuznets proposed the idea of Kuznets curve in his presidential address to the American Economic Association in 1954 and in his paper "Economic Growth and Income Inequality", which was published in 1955 in The Journal of Economic Perspective. The Kuznets curve is primarily used to show the relationship between economic growth and inequality. Simon Smith Kuznets states that in the early stage of economic growth, the inequality in the distribution of income is very high but in the later stages it improves. This observation is shown by an inverted- U shaped curve which is also called the Kuznets curve. The original Kuznets curve shows the trade-off between economic growth and inequality in the income distribution. The Kuznets curve is further used to show the trade-off between economic growth and environmental degradation. This is named as Environmental Kuznets Curve (EKC). The curve basically states the relation between changes in environmental quality due to economic growth (GDP per capita). According to this hypothesis, at the early stage of economic growth as GDP per capita increases the environmental quality goes on decreasing (environmental pollution increases). However, beyond a certain

point, increase in economic growth that is GDP per capita leads to reductions in environmental damage. The Environmental Kuznets Curve can be explained more specifically by the following points:

- In the early stage of economic growth, income level remains low. With low income, pollution abatement is undesirable as individuals are better off using their limited income to meet their basic consumption needs. Therefore, in this stage environmental quality degrades at a high rate. This stage is reflected by the positively sloping portion of the Environmental Kuznets Curve (EKC).
- After reaching a certain level of economic growth, individuals begin to realise the trade-off between environmental quality and consumption. Here, environmental damages start to increase at a lower rate.
- The turning point occurs in the latter stages of economic growth. In the latter stages, at higher levels of income, people start to demand for better environmental quality. Again, spending on abatement dominates as individuals prefer improvements in environmental quality over further consumption, and environmental quality begins to improve alongside of economic growth. The negatively sloped portion of the Environmental Kuznets Curve (EKC) reflects these stages of economic growth.

Figure: 5.1 The Environmental Kuznets Curve



The Environmental Kuznets Curve (EKC) is an inverted U shaped curve because of the inverse relationship between economic growth and economic degradation. At the early stage of economic growth that is in the developing stage, an economy does not take care of the environment.

Therefore, the environment continuously degrades. The highest point on the curve is called the turning point. After reaching a certain level of economic growth, the economy starts taking the environmental consequences under consideration. Therefore, the economy develops various technologies to clean up the environment and environmental degradation starts declining. The downward sloping portion of the curve reflects where economic growth leads to fall in enviromental degradation.



CHECK YOUR PROGRESS

Q.1: What are the functions of the environment in supporting economic activity?

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Q.2: What do you mean by Environmental Kuznets Curve?

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Q.3: What is sustainable development?

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5.4 POPULATION AND ENVIRONMENT

Population becomes an environmental issue if it increases to a level whose requirement cannot be met by the earth's available resources. Rapidly growing population creates the problem of land, water and fire wood shortages in rural as well as urban areas. Increasing population density is a problem for many developing and under-developed countries which contributes to the severe and accelerating degradation of natural resources. The effects of population on the environment can be discussed more specifically by the following points:

- **Problems from overuse of natural resources-**

Over population leads to over use of the natural resources such as forests, water, fisheries and mineral resources etc. If use of these resources

surpasses the capacity to regenerate, it leads to environmental degradation. Continuous growth of population also accelerates the environmental degradation and that would severely compromise the ability of both the present as well as future generation to meet their needs.

- **Problem from over use of land resource-**

  The burden of population pressure affects the land resources in terms of decline in the size of farmer's household and the sustainability of cultivated land. Increasing population leads to increasing demand for cultivable land which is one of the responsible factors of deforestation. The increasing need of cultivable land forces the people to cut the forest plants.

- **Problem from over use of chemicals on land-**

  The increasing population results in increasing demand for food. To meet the need of the population, farmers adopt intensive farming and excessive use of chemical fertilizers and pesticides. Excessive use of chemical fertilizers and pesticides on the soil results in degradation of the soil quality. This deteriorates the protective cover of the soil.

- **Problem from exploitation of forest resources-**

  Deforestation is not only resulted from clearing forest resources to get cultivable land but also from the collection of fuel wood from the forest, construction of roads, hydropower projects.

- **Problem from exploitation of mineral resources-**

  With the growth of population, demand for mineral resources increases which leads to more and more extraction of minerals from the earth's crust. Extraction of minerals results in many environmental pollutions such as air, water, soil and noise pollution. It also harms the biodiversity due to destruction of forest around the mining fields.

- **Problem from the generation of waste-**

  Increasing consumption increases waste generation. Man dumps waste in the environment. If it crosses the absorption capacity of

the environment, it results in environmental degradation in the form of air and water pollution.

One of the important factors for environmental degradation is population growth. To meet the objectives of growth, environmental degradation must be reduced and productivity of the existing resources to sustain. (If growth of Gross National Income (GNI) and production of food are slower compared to the population growth, the standard of living of people will be poor and difficulty in achieving food self-sufficiency will arise.)

5.5 POVERTY AND ENVIRONMENT

Poverty is defined as a social condition of chronic insecurity resulting from malfunctioning of economic, ecological, cultural and social systems. This causes group of people to lose the capacity to live beyond minimal levels of satisfaction of their needs and aspirations. There are many dimensions of poverty. The complex reality of poverty varies from country to country, community to community and individual to individual. Some distinct aspects of poverty are inequality, ill health, illiteracy, environmental degradation, gender bias etc.

There are strong linkages between poverty and environment which is also called as poverty-environment nexus. Poverty in developing countries is considered as a factor responsible for environmental degradation. Environmental degradation affects the society as a whole but mostly affect the poor. The struggle of the poor to survive is a core cause of problems such as deforestation, desertification and unsanitary water. The poor relies on natural resources more than the rich. The rural poor are forced to extract forest resources for survival. They cut forest woods for fuel which is one of the responsible factors of deforestation. Besides that most of the rural poor depends on livestock farming for their livelihood. They graze cattle on pasture lands more than the carrying capacity of the grass lands. Overgrazing is a factor causing destruction of soil quality and thus soil degradation and soil erosion. *The UNDP Human Development Reports* therefore describes poverty as the greatest polluter.

Environmental scarcities of arable land and water result in loss of livelihoods. These are some of the key factors causing poverty. The loss of agricultural land due to drought, flood and land degradation affect the poor. The poor often live on steeply sloped hilly areas, where they are at higher risk of landslides and resulting loss of life during storms and floods.

Environmental degradation also affects the health of population. Poorly designed irrigation and water systems, inadequate housing, poor waste disposal and water storage are responsible factors for the most common vector-borne diseases including malaria, dengue etc. Diseases primarily generating from a poor water supply include cholera, conjunctivitis, typhoid etc. These diseases mostly affect the poor because of their greater exposure and low nutritional intake.

Thus, environment degradation not only affects the livelihood of poor but also their health and causes further poverty.

On the one hand, poverty is considered as the greatest polluter. The poor people are forced to degrade the environment for sustaining their livelihood. On the other hand, the destruction of natural resources seriously affects the lives of the poor. Environmental degradation hurts the poor most, because, shortage of drinking water or fuel wood affects the poor more than the rich. The poor suffers mostly from frequent and severe storms, floods, droughts, health impacts of toxic pollution, insecurity of access to productive resources such as arable land, fresh water and sustainable energy. Thus, destruction of environmental resources makes the poor highly impoverished.

5.6 EXOGENOUS AND ENDOGENOUS POVERTY

As discussed above, there is an inter-linkage between poverty and environmental degradation. On the basis of this linkage, poverty can also be categorised into exogenous and endogenous poverty. Exogenous poverty among the population is initially caused by external factors rather than environmental factors. But, endogenous poverty among the population is often induced by exogenous poverty. Excessive pressure on agricultural

land, soil and forest by population leads to further environmental degradation. This ultimately gives a boost on the vicious circle of poverty.

When poverty is caused by external factors other than environmental degradation is called exogenous poverty. Exogenous poverty is caused by factors like inequality in distribution of income or wealth but exogenous poverty causes environmental degradation. The policies to eradicate this type of poverty, should address the root causes of generating exogenous poverty. If exogenous poverty can be eradicated then it also can help to mitigate the adverse impact of poverty on environmental degradation.

Poverty is called 'endogenous poverty' when it is caused by environmental degradation. This is resulted by market failure, institutional failure, failure to have proper property right etc. In such case, environmental degradation put the poor into a situation where they have no other option but to fall back upon the environment which further degrades the environment. In such situation, the poverty eradication programmes to be adopted and also to be combined with policies to address the market failure and institutional failures.

Therefore, to deal with the poverty-environment nexus, policies required to be adopted. But while framing these policies, government need to identify the type of poverty whether it is exogenous or endogenous poverty.



CHECK YOUR PROGRESS

Q.4: How does population growth create problem to the environment? Explain briefly.

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Q.5: What do you mean by poverty-environment nexus?

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Q.6: What is the main difference between exogenous and endogenous poverty?

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5.7 LET US SUM UP

- The EKC explains that at the initial stage of development, economic growth leads to environment degradation and thereafter, environmental degradation goes on increasing at this stage but after reaching a particular level of economic development that is the turning point, the economy starts taking care of the environmental consequences that are resulted by development activities by taking various measures to clean up the environment along with sustaining the economic development.
- Continuous increase in population leads to over extraction of environmental resources and thus degrades the environment.
- The poverty is considered as the greatest polluter of the environment. On the other hand, environmental damages hurt mostly the poor.
- The two important types of poverty are exogenous poverty and endogenous poverty. When poverty is caused by factors other than environmental degradation, called exogenous poverty. If poverty is caused by environmental degradation, it is called endogenous poverty. The distinction between these two types of poverty becomes important while framing government policies to eradicate poverty.



5.8 FURTHER READING

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5) Everett, T.,Ishwaran, M., Ansaloni, G.P. and Rubin, A. (2010) Economic Growth and the Environment, Department for Environment Food and Rural Affairs (DEFRA), Evidence and Analysis Series.



5.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: The environment supports economic activities mainly by the following ways:

- It provides life support.
- Supplies natural resources for production and consumption purposes.
- Absorbs waste products.
- Supplies amenity services.

Ans to Q No 2: The Environmental Kuznets Curve (EKC) is an inverted U shaped curve. It shows the inverse relationship between economic growth and economic degradation.

Ans to Q No 3: The sustainable development is defined by the Bruntland Report of UNDP as the development which meets the need of present generation without compromising the ability of the future generation to meet their needs.

Ans to Q No 4: Rapidly growing population leads to land, water and fire wood shortages in rural areas and in the urban areas, problems like lack of sanitation and clean water are resulted. Increasing population density is a problem for many developing and under developed countries which contributes to the severe and accelerating degradation of natural resources.

Ans to Q No 5: The linkages between poverty and environment which is also called as poverty-environment nexus. Poverty is considered as a factor responsible for environmental degradation. Again, environmental degradation affects the

society as a whole but mostly affect the poor because the struggle of the poor to survive is a core cause of problems such as deforestation, desertification and unsanitary water.

Ans to Q No 6: When poverty is caused by factors other than environmental degradation such as inequality in distribution of income or wealth is called exogenous poverty. But poverty is called 'endogenous poverty' when it is caused by environmental degradation. This is resulted by market failure, institutional failure, failure to have proper property right etc.



5.10 MODEL QUESTIONS

Short Questions: (Answer each question in around 150 words)

Q 1: Write a short note on the trade off between population and environment.

Q 2: "Over extraction of natural resources lead to environmental degradation" Explain.

Long Questions: (Answer each question in around 300-500 words)

Q 1: Explain the Environmental Kuznets Curve.

Q 2: How does population growth create problem to the environment?

Q 3: Does incidence of poverty lead to degradation of environment? Explain.

Q 4: Make a critical analysis of exogenous and endogenous poverty.

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UNIT 6: INTERNATIONAL TRADE AND ENVIRONMENT

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Impact of International Trade on Environment

6.2.1 Positive and Negative Impacts

6.3 Environment as a Source of Comparative Advantage

6.4 Pollution Haven Hypothesis

6.5 Empirical Evidence of Industrial Concentration among North (Developed countries) and 'South' (Developing Countries)

6.6 Latest Development

6.7 Let Us Sum Up

6.8 Further Reading

6.9 Answers to Check Your Progress

6.10 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- learn about the impacts of international trade on environment
- know how environment acts as a source of comparative advantage
- understand about pollution haven hypothesis
- know about how the industrial concentration takes place in North (Developed) and South (Developing) Countries
- know about latest development about this Issue

6.2 INTRODUCTION

Trade and environment is one of the most debated topic in the studies of economics over the years because of the increasing concerns on how international trade affects environment and vice versa. The debate is not new, it emerged in the early 1970s with concerns such as environmental protection, environmental policies on trade and the impact of trade on

environment. Most of the developed economies expressed interests on environmental degradation linked with the globalization process, for instance, industrial pollution. In the 1980s, environmental concerns increased as more complex environmental issues were raised such as the climate change and the depletion of the ozone layer. Later in the 1990s, the sustainable development concept was introduced as trade liberalization and the globalization process accelerated.

Effective environmental policies and institutional frameworks are needed at the local, regional, national, and international levels. The impact of trade liberalization on a country's welfare depends on whether appropriate environmental policies are in place within the country in question (e.g. correctly pricing exhaustible environmental resources). Stringent environmental policies are compatible with an open trade regime as they create markets for environmental goods that can subsequently be exported to countries that follow suit on environmental standards – the so-called first-mover advantage. This is especially true for complex technologies such as renewable energies.

6.2.1 Positive and Negative Impacts

Negative Impacts:

Economic growth resulting from trade expansion can have an obvious impact on the environment by increasing pollution or degrading natural resources. In addition, trade liberalization may lead to specialization in pollution intensive activities in some countries if environmental policy stringency differs across countries – the so called pollution haven hypothesis.

Moreover, trade is related to numerous environmental problems. The Handbook on Trade and Environment emphasizes that trade acts as facilitator of the "international movement of goods that, from an environmental perspective, would best never be traded. With hazardous wastes and toxic materials, the environmental risks increase the further the goods are transported, since spillage is always possible. Equally, such 'goods' may end up being dumped

in countries without the technical or administrative capacity to properly dispose of them, or even assess whether they should be accepted. Trade also makes possible the over-exploitation of species to the point of extinction—there is rarely enough domestic demand to create such pressure." Examples include the threats to species such as elephants, due to trade in ivory, the deterioration of air quality in parts of China attributed to export-led growth, and unsustainable harvest rates in tropical rainforests due to trade in timber.

A major concern is that the increasing competition between companies induced by further trade liberalizations causes a "race to the bottom" in environmental standards, because, countries might weaken their environmental policy in order to shelter their industry from international competition or to attract foreign firms due to low costs of environmental protection as a similar incentive as low labour costs.

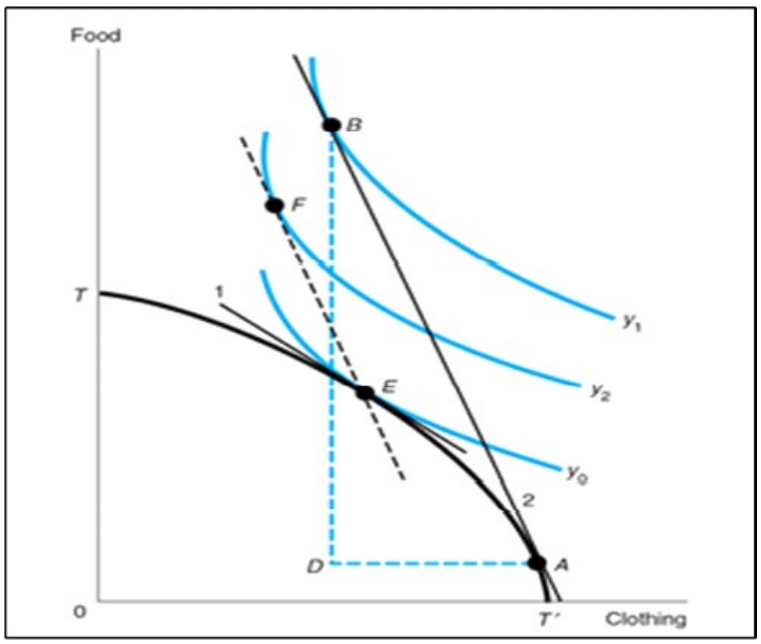
Positive Impacts:

However, increased trade can in turn, by supporting economic growth, development and social welfare, contribute to a greater capacity to manage the environment more effectively. More importantly open markets can improve access to new technologies that make local production process more efficient by diminishing the use of inputs such as energy, water and other environmentally harmful substances.

Similarly, trade and investment liberalization can provide firms with incentives to adopt more stringent environmental standards. As a country becomes more integrated within the world economy, its export sector becomes more stringent environment standards. As a country becomes more integrated within the world economy, its export sector becomes more exposed to environmental requirements imposed by the leading importers. Changes needed to meet these requirements, in turn, flow backwards along the supply chain, stimulating the use of cleaner production processes and technologies.

The positive effects of trade on environment can be gauged through the increase of national wealth. Countries trade to take advantage of their differences; therefore, trade between identical countries would have been useless. This is one of the reasons why trade allows countries to specialise in the production of the goods in which they have a comparative advantage, increasing the amount of output by using the same endowment and avoiding wastage; this is what we call Allocative Efficiency (see Figure 1). A country in autarky can be consuming x amount of clothing and food at point E and be very efficient at producing clothing. However, when the country opens its economy to trade, it can start allocating all its resources in the production of Clothing, therefore, producing an amount at point A and import food with the trading partner. In addition to that, we can see that trade restriction tend to decrease the efficiency in the allocation of resources. In the North-South context, some developed countries like the USA produce sugar or rice while its import from other developing countries would have been cheaper and the resources used in the production could have been more efficiently used in the production of other products.

Figure 1



Moreover, trade generates wealth by forcing domestic firms to be exposed to foreign competition, triggering efficiency in the domestic economy. Furthermore, the openness of a country to foreign investment and technology can bring more efficient methods of production.

Efficiency can therefore be good for the environment, as wastage can be reduced in the process of production and fewer inputs can be used. Also, wealthier people may want a better environmental quality, enabling the poor to escape the cycle of environmental destruction and impoverishment. The increase of national wealth and economic activity may also lead trade to increase environmental damage, depending on the strength of existing environmental laws, or the wastage of wealthier populations. The three mains means by which trade can be harmful to the environment are:

- **The Scale factor:** Trade can amplify some existing problems such as weak environmental policy in some countries.
- **The income effect:** The quantity of greenhouse gases and toxin produced by countries with high GDP per capita is extremely high compared to households in developing countries.
- **Pollution haven effect:** It arises from the competitive aspect of trade. Polluting industries tend to implement themselves in countries with relatively low environmental regulation in order to avoid the cost of good environmental regulations in countries with higher standards.



CHECK YOUR PROGRESS

Q 1: Point out the positive impacts of international trade on environment. (Answer in about 40 words)

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Q 2:	Point out the negative impacts of international trade on environment. (Answer in about 30 words) ___ ___ ___ ___ ___ ___ ___ ___ ___ _ __ ___ ___ ___ ___ ___ ___ ___ ___ __

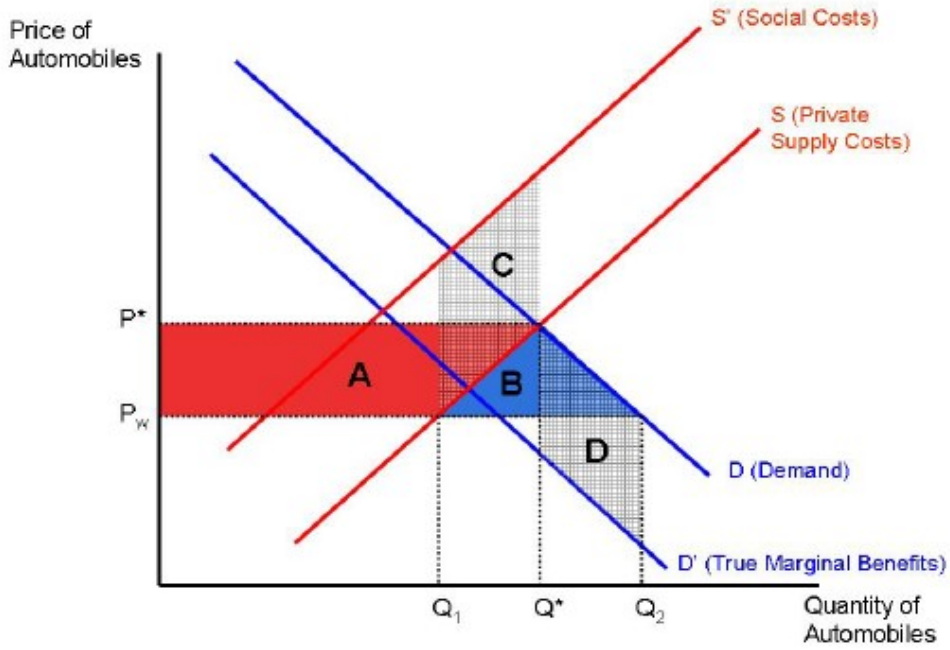
6.3 ENVIRONMENT AS A SOURCE OF COMPARATIVE ADVANTAGE

Over the course of the last half-century the costs associated to environmental degradation have become increasingly apparent. The depletion of natural resources, the detrimental effects of pollution on human health and the uncertain prospects brought about by global climate change have become first-order issues for policy-makers and academics.

In an attempt to address these concerns many countries have adopted stricter environmental regulations. However, the stringency of regulation varies across countries, suggesting the possibility that environmental regulation affects the location of polluting industries. In particular, if stricter environmental regulation increases the relative cost of production for polluting industries, one would expect these to relocate to countries with laxer regulation. In other words, lax environmental regulation is a potential source of comparative advantage for polluting industries.

The expansion of the world trading system has raised issues on the relationship between trade and environment. Answering the question of trade being good or damaging for the environment is not an obvious thing. However, we can use economic theory to gauged the gains and losses caused by environmental externalities on trade. It is obvious that some environmental externalities work at the advantages of countries by the presence of natural resources (gold, diamond, oil…) and climates favoring agriculture in some places of the world. However it can also have negative impact on the trading system.

Figure 2



The Ricardian Model of trade uses the concept of comparative advantage and tells us that two countries trading together gain from trade by specialising in the goods for which they have the lowest opportunity cost. However, the model does not consider the environmental factor associated with the production and consumption. Figure 1 represents the welfare effects of imported goods (here, automobiles), which is generally the case for developing countries. The supply curve S consider private costs while the curve S' also encloses social costs including both private costs and externalities. P* and Q* are respectively the domestic price and the domestic production in autarky. When the country opens its economy to world trade, Pw is the world price, which will eventually be the domestic price under a condition of free trade agreement, while Q1 is produced domestically and (Q2 - Q1) is imported, for a total domestic consumption of Q2. The traditional interpretation of the graph is the following:

- Domestic producers of auto lose the area A as the prices have decreased
- Domestic consumers gain areas A+B as their welfare has increased
- The net gain from trade is therefore (A+B) - A = B.

However, if we take into account environmental externalities, we can have a different situation. If the production of automobiles causes environmental damage, then by lowering production the country gains cross-hatched area C in reduced environmental costs—costs which are shifted to countries producing automobiles for export. On the other hand, if environmental damage is associated with the consumption and use of automobiles, lowering the true marginal benefits from consumption, then trade increases the environmental costs of consumption by the shaded area D. This observation put into question the concept of overall gains from trade as externalities put how the conditions of the nature and size of the environmental damages.



CHECK YOUR PROGRESS

Q 3: How environment can become a comparative advantage in case of international trade? (Answer in about 40 words)

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6.4 POLLUTION HAVEN HYPOTHESIS

The pollution haven hypothesis states that, when industrialized developed nations seek to set up their factories abroad, they will often go with the cheapest option available to them in terms of resources and factors of production that they require. And this often happens at the cost of environmentally unsound practices. In general, developing countries with cheap resources and labours tend to have weak environmental regulations, and conversely countries with stricter environmental regulations become more expensive for companies because the costs of maintaining the associated standards are comparatively high. Therefore, the companies that cause a lot of environmental pollution generally prefer to set up their factories and other facilities in developing countries that have lax environmental regulations – 'pollution havens'. Apart from lax environmental

regulations, people and policymakers in developing countries also attach a lower value to the need for clean environment.

Pollution haven hypothesis (1)

- For given level of environmental policy, liberalizing trade or foreign investment rules causes polluting industry (or firms/ production facilities) to relocate to countries with weaker environment policy

Pollution haven hypothesis (2)

- Tightening pollution policy in one country causes production of polluting industry (or firms / production facilities) to relocate to other countries with weaker environmental policy

Globalization causes polluting activities to concentrate in (poor) countries with weak environmental regulations.



CHECK YOUR PROGRESS

Q. 4: What is pollution haven hypothesis? (Answer in about 50 words)

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6.5 EMPIRICAL EVIDENCE OF INDUSTRIAL CONCENTRATION AMONG NORTH (DEVELOPED COUNTRIES) AND 'SOUTH' (DEVELOPING COUNTRIES)

There are low levels of living and deprivations in human development in the Global South countries. In addition, the Global South country's levels of labour productivity (output per worker) are extremely low compared with those in the Global North. Low productivity leads to low income, which can leads to low capacity and to low productivity.

The Global South is dependent on and vulnerable to the Global North. There is an unequal strength between the Global North and the Global South. The Global North being stronger than the Global South, the unequal strength between the two is manifested not only in the dominant power of the Global North to control the pattern of international trade and agreement regulating

it but also in their ability often to dictate the terms whereby technology, foreign aid, and private capital are transferred to Global South. This has acted as a factor in contributing to the persistence of low levels of living, rising unemployment, and growing income inequality in the Global South compared to the Global North.

One of the most interesting developments in trade policy in recent years has been the emergence of trade liberalization as an environmental issue. In addition to facing traditional protectionist pressures, recent initiatives such as the North American Free Trade Agreement and the Uruguay Round of GATT negotiations have been questioned on the grounds that they might increase pollution. This has led to much debate about the environmental consequences of free trade.

In reality, of course, trade is influenced by many conflicting factors. However, as a first step in understanding the interaction between trade and the environment, it is useful to isolate the impact of environmental standards on the pattern of trade. To make inferences about the actual pattern of trade, one would have to weigh the influences derived from environmental policy against other determinants of trade.

Pollution is one of the many environmental challenges facing the world today. Developed countries have the resources and technologies to combat pollution. As a result of the health risks and the potential impact of climate change, there have been efforts to reduce pollution. However, while this may be easy for developed countries, halting environmental pollution may undermine economic growth and competitiveness of developing countries whose economies depends on natural resources. Developed countries have achieved substantial economic growth and development and can afford to focus on environmental goals because basic living necessities have been achieved.

At every point and in every level of development, countries need to make choices between often conflicting goals. Developing countries desire to ensure energy for all at a competitive price to achieve and sustain economic growth and poverty reduction. The energy poverty experienced in these regions has been linked with the high level of income and non-

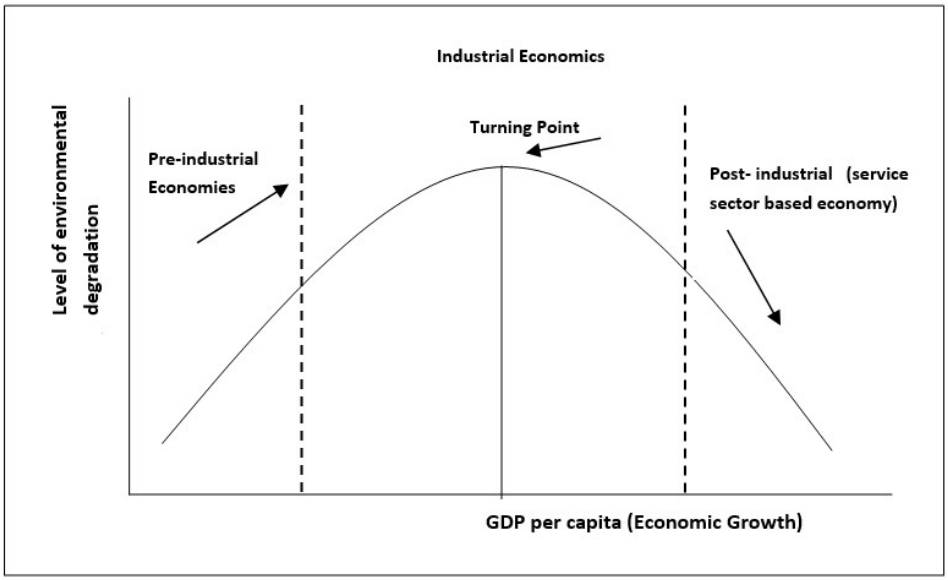
income poverty in the regions. In their desire to develop and improve the standards of living of their citizens, these countries will opt for the goals of economic growth and cheap energy for all. This may lead to environmental pollution and degradation. More so, energy access, and at a lower price, is necessary to make the industries in developing countries competitive and contribute to economic growth, job creation and development. Ensuring energy access to the population and enhancing the competitiveness of local industries may require providing energy at lower prices through energy subsidies. This will encourage energy over-consumption, waste and inefficiency and also fuel environmental pollution.

Most developing countries, especially those in Sub-Saharan Africa, depend majorly on natural resources for revenue and foreign exchange. These economics are driven by funds generated from exploitation of natural resources such as coal, oil and gas, agricultural and forest resources, gold, copper, etc. The livelihood of the masses also depends on these resources. However, the exploitation and processing of some of these resources result in environmental pollution and degradation. For instance, the exploration of oil and the activities of multinational oil companies in the Niger Delta region of Nigeria has caused substantial land, water and air pollution. However, for Nigeria to maintain its current economic growth path and sustain its drive for poverty reduction, oil exploration and production will continue to be a dominant economic activity. This is also the case with a number of other developing countries.

The inevitability of pollution in developing countries has been demonstrated by the Environmental Kuznet Curve (EKC).The Kuznets hypothesis was first proposed by Simon Kuznets. The EKC is a hypothesized relationship between indicators of environmental degradation and income per capita. The environmental Kuznets curve suggests that economic development initially leads to deterioration in the environment, but after a certain level of economic growth, a society begins to improve its relationship with the environment and levels of environmental degradation reduces.

However, critics argue there is no guarantee that economic growth will lead to an improved environment – in fact, the opposite is often the case. At the least, it requires a very targeted policy and attitudes to make sure that economic growth is compatible with an improving environment.

Figure 3



Causes of Environmental Kuznets Curve:

1. **Empirical evidence of declining pollution levels with economic growth:** Studies found that higher economic growth in the US led to increased use of cars, but at the same time – due to regulation, levels of air pollution in particular sulphur dioxide levels declined.
2. **Spare income with growth:** With higher rates of economic growth, people have more discretionary income after paying for basic necessities; therefore, they are more amenable to paying higher prices in return for better environmental standards.
3. **Focus on living standards as opposed to real GDP:** Traditional economic theory concentrates on increasing real GDP and rates of economic growth. But there is a growing awareness the link between economic growth and living standards can be weak. Focusing on living standards can become politically popular.
4. **Improved technology:** The primary driving force behind long-term economic growth is improved technology and higher productivity.

With higher productivity, we can see higher output, with less raw materials used. For example, since the 1950s, the technology of car use has significantly improved fuel efficiency. In the 1950s, many cars had very low miles per gallon. In recent years, car manufacturers have made strides in reducing fuel consumption and have started to develop hybrid technology.

5. **Solar and renewable energy:** A good example of how improved technology has reduced potential for environmental damage is the progress in solar technology. In recent years, the cost of solar energy has significantly fallen – raising the prospect of clean technology.
6. **De-industrialisation.** Initially, economic development leads to shifting from farming to manufacturing. This leads to greater environmental degradation. However, increased productivity and rising real incomes see a third shift from industrial to the service sector. An economy like the UK has seen industrialisation shrink as a share of the economy. The service sector usually has a lower environmental impact than manufacturing.

This is based on the fact that developing countries desire industrialization and economic growth and tend to consume more cheap energy. There is also need for developing countries to build roads and rail tracks and develop massive infrastructure to promote economic growth. Such activities that are required at the take-off stage of economic development are substantially energy-intensive.

The important role of industrialization in the development process of developing countries cannot be overemphasized. There is need for structural transformation from small-scale agriculture to industrialization in order for developing countries to experience inclusive and pro-poor growth. However, industrialization requires massive use of energy resources which could lead to pollution and environmental degradation. China would not have achieved the impressive economic growth and development it has recorded in recent years if they had cared about pollution at the initial stage of development. Other developed economies like the OECD are also focusing on environmental sustainability after achieving considerable growth and

improvement in the living standard of their citizens. The Chinese economic model is energy intensive, with strong focus on investment and industrialization, and is being adopted by a number of developing countries. In conclusion, developing countries in their quest for economic development and poverty reduction are expected to put economic growth, energy for all and industrialization at the fore front of their goals before giving consideration to environmental issues. Therefore, compelling developing countries like those in Sub-Saharan Africa and South Asia to pursue environmental goals, particularly reduction in CO2 emissions, will require substantial economic, technological and financial support from developed countries and the international community to compensate for the economic losses associated with reducing pollution.



CHECK YOUR PROGRESS

Q5: What does Environmental Kuznet Curve implies? (Answer in about 30 words)

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Q 6: Write two causes of Environmental Kuznet Curve? (Answer in about 100 words)

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6.6 LATEST DEVELOPMENT

Sustainable development and protection and preservation of the environment are fundamental goals of the WTO. They are enshrined in the Marrakesh Agreement (1994), which established the WTO, and complement the WTO's objective to reduce trade barriers and eliminate discriminatory treatment in international trade relations. While there is no specific agreement dealing with the environment, under WTO rules members can adopt trade-related measures aimed at protecting the environment provided a number of conditions to avoid the misuse of such measures for protectionist ends are fulfilled.

The WTO contributes to the protection and preservation of the environment through its objective of ensuring sustainable development and avoiding protectionism, through its rules and enforcement mechanism, and through work in different WTO bodies.

Countries have undertaken a number of environment-related efforts under the World Trade Organization (WTO) framework including negotiating tariff reductions in environmental goods and services, seeking more clarity on the relationship between existing WTO rules and specific trade obligations in multilateral environmental agreements, and seeking disciplines on fisheries subsidies. In this way, the WTO is building a multilateral framework for international trade that also discourages any misguided temptation to engage in a "race to the bottom".

The inclusion of environmental provisions in bilateral and regional trade agreements has also helped harmonize environmental regulations between developed and developing countries. More advanced economies can provide resources and institutions for capacity building, and can encourage less-developed partners to strengthen environmental regulations. The OECD has addressed many issues on trade and environment such as environment and regional trade agreements (RTAs) *the drivers of environmental provisions in RTAs*, as well as the stringency of environmental policies as a driver for trade in environmental goods and services. The world organizations are also currently developing set of policy indicators on trade and environment to help monitor progress towards more policy coherence, and to identify policy priorities at the intersection of trade and environment.



6.7 LETS US SUM UP

- International trade has both positive and negative impacts on environment. Positive impact implies that international trade leads to increase in economic welfare of the country. Negative impacts imply international trade affects the environment quality of a country due to higher industrial activities.

- If stricter environmental regulation increases the relative cost of production for polluting industries, one would expect these to relocate to countries with laxer regulation. This means, lax environmental regulation is a potential source of comparative advantage in polluting industries.
- The companies that cause a lot of environmental pollution generally prefer to set up their factories and other facilities in developing countries that have lax environmental regulations – 'pollution havens'.
- There is an unequal strength between the Global North and the Global South. In addition, the Global South country's levels of labour productivity (output per worker) are extremely low compared with those in the Global North. Low productivity leads to low income, which may lead to low capacity and low productivity.
- The WTO contributes to the protection and preservation of the environment through its objectives of ensuring sustainable development and avoiding protectionism, through its rules and enforcement mechanism, and through work in different WTO bodies.



6.8 FURTHER READING

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6.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Increased trade, by supporting economic growth, development and social welfare, contribute to a greater

capacity to manage the environment more effectively. More importantly open markets can improve access to new technologies that make local production process more efficient by diminishing the use of inputs such as energy, water and other environmentally harmful substances.

Ans to Q No 2: Economic growth resulting from trade expansion can have an obvious impact on the environment by increasing pollution or degrading natural resources. In addition, trade liberalization may lead to specialization in pollution intensive activities.

Ans to Q No 3: If stricter environmental regulation increases the relative cost of production for polluting industries, one would expect these to relocate to countries with laxer regulation. That means, lax environmental regulation is a potential source of comparative advantage for polluting industries.

Ans to Q No 4: The pollution haven hypothesis states that, when industrialized developed nations seek to set up their factories abroad, they will often go with the cheapest option available to them in terms of resources and factors of production that they require. And this often happens at the cost of environmentally unsound practices.

Ans to Q No 5: The environmental Kuznets curve suggests that economic development initially leads to deterioration in the environment, but after a certain level of economic growth, a society begins to improve its relationship with the environment and the level of environmental degradation reduces.

Ans to Q No 6: Causes of Environmental Kuznets curve:

1. **Empirical evidence of declining pollution levels with economic growth:** Studies found that higher economic growth in the US led to increased use of cars, but at the same time – due to regulation, levels

of air pollution in particular sulphur dioxide levels declined.

2. **Spare income with growth:** With higher rates of economic growth, people have more discretionary income after paying for basic necessities; therefore, they are more amenable to paying higher prices in return for better environmental standards.



6.9 MODEL QUESTIONS

Long Questions (Answer in about 300-500 words)

Q 1: Explain the impact of international trade on environment.

Q 2: Explain environment as a source of comparative advantage with a suitable example.

Q 3: Why polluting countries mostly prefer developing countries. Explain.

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UNIT 7: MARKET FAILURE AND EXTERNALITIES

UNIT STRUCTURE

7.1 Learning objectives

7.2 Introduction

7.3 Market Failure

7.4 Environment and Market Failure

7.5 Concept of Externalities

7.6 Types of Externalities

7.7 Relationship between Environment and Externalities

7.8 Internalisation the Externalities- Solution by Pigou and Coase

7.9 Let Us Sum up

7.10 Further reading

7.11 Answer to check your progress

7.12 Model questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- understand the concept of market failure and externalities.
- understand the roles of environment in relation with market failure.
- elaborate the concept of externalities and its different types.
- analyzing the relationship between environment and externalities with different examples.
- examined internalisation of externalities and the solution given by Pigou and Coase.

7.2 INTRODUCTION

Market failure occurs when individuals acting in rational self-interest produce a less than optimal or economically inefficient outcome. Market failure can occur in explicit markets where goods and services are bought and sold outright, which we think of as typical markets. Market failure can also occur in implicit markets as favours and special treatment are

exchanged, such as elections or the legislative process. On the other hand, an externality stems from the production or consumption of a good or service, resulting in a cost or benefit to an unrelated third party. Externalities lead to market failure because a product or service's price equilibrium does not accurately reflect the true costs and benefits of that product or service. Equilibrium is the ideal balance between buyers' benefits and producers' costs, while market failure is the inefficient distribution of goods and services in the market.

7.3 MARKET FAILURE

A market is an institution, especially deals in exchange, that serves society by organising economic activity. The power of a perfectly functioning market rests in its decentralised process of decision making and exchange and for the resources to be allocated properly there is no requirement of central planning. Markets usually use prices to communicate the wants and limits of a diverse society so as to bring about the co-ordinated as well as co-operative economic decisions in the most efficient manner.

However, markets can fail if prices do not communicate the diverse society's desires. Market failures occur when private decision based on these prices, or lack of them, do not generate an efficient allocation of resources. Market failure is the economic situation defined by an inefficient distribution of goods and services in the free market. Inefficiency implies that resources could not reallocate to make at least one person better off without making anyone else worse off also known as Pareto efficiency. In market failure, the individual incentives for rational behaviour do not lead to rational outcomes for the group. In case of market failure what is usually observed is the difference between what individuals want privately and what society wants in a collective manner. In other words, each individual makes the correct decision for him or herself, but those prove to be the wrong decisions for the group. The economic outcomes under market failure deviate from what economists usually consider optimal and are usually not economically efficient. In traditional microeconomics, this can

sometimes be shown as a steady-state disequilibrium in which the quantity supplied does not equal the quantity demanded.

Furthermore, there can be market failures in government activity, too. One noteworthy example is rent-seeking by special interest groups. Special interest groups can gain a large benefit by lobbying for small costs on everyone else, such as through a tariff. When each small group imposes its costs, the whole group is worse off than if no lobbying had taken place.

The main sources of market failures include externalities, monopoly, information asymmetries, and factor immobility. One easy way to illustrate market failure is the public goods problem. A pure public good is one that provides non-excludable and non-rival benefits to all people in a given society. *Nonexcludability* means it is technically impossible or extremely costly to exclude any individual from the benefits of a good. *Nonrivalry* means that there is no rivalry among the consumers because the enjoyment of the good by any one person does not reduce its availability for others. For example, National defence is one such public good because each citizen receives similar benefits regardless of how much they pay. It is very difficult to privately produce the optimal amount of national defence. Since governments cannot use a competitive price system to determine the correct level of national defence, they also face major difficulty in producing the optimal amount. This may be an example of a market failure with no pure solution.

7.4 ENVIRONMENT AND MARKET FAILURE

Usually, the threat to biodiversity exists because many of the services provided by non-excludable and non-rival in character. As a result of these characteristics, biodiversity in and of itself has no value reflected by market prices. In contrast, the commodity resources of the habitat (for example, chemicals, minerals, timber, game) are valued on the market, and the supply and demand reflect the relative scarcity of these goods. Therefore, there is pressure to harvest the commodity goods at the expense of biodiversity. This lack of a complete market implies that the unintended

effects of private economic decisions can create biodiversity loss, to a socially inefficient level.

As an example of market failure, let us consider the case of Madagascar, one of the ecologically richest, but economically poorer, countries in the world regarding habitat destruction and the threat to biodiversity. As resource managers and policy makers became more aware of the importance of managers and policy makers became more aware of the importance of biodiversity to support and maintain human life locally and globally, international agencies dubbed Madagascar as a prime spot to conserve biodiversity – the totality of genes, species, populations and ecosystems. Biologists estimate that 150000 of the 200000 species on the island are unique to Madagascar, the fourth largest island in the world: 98 per cent of the palm species, 93 per cent of primates, 80 percent of flowering plants, 95 percent of reptiles, 99 per cent of frogs, 97 per cent of tenrec and 89 per cent of carnivores (USAID, 1992).

There are also over 12 million human inhabitants on Madagascar (50 per cent under 15 years of age), with a population density of 17.5 and a growth rate of 3 per cent per year. Agriculture employs over 85 per cent of the population, with over 70 per cent of farmers engaged in production on two – third of the cultivated land. As the locals try to increase or maintain their per capita income of about US$200 a year, habitat destruction through deforestation has increased rapidly over the last few decades. Deforestation is occurring at an estimated rate of 200000ha/yr, with nearly 80 percent of the original forest cover already gone. The economic cost of environmental degradation has been estimated at US$100-290 million (5- 15 % of GDP to 75%) derived from deforestation.

The factors leading to habitat destruction and the loss of biodiversity originate in several sources of market failure. First, habitat destruction arises from public ownership of large areas of land with open access property right regimes and limited government capacity to manage the land. These economic incentives encourage the overexploitation of wildlife, timber, grazing lands and crop lands. Second, land tenure is often insecure since the locals in remote rural areas have little or no influence over the national

laws, policies, social changes and economic forces. Lack of secure land tenure provides little incentive to maintain the habitat necessary for biodiversity conservation. The local residents have little incentive to conserve if they are unsure their kin will have access to the same land. This is because of the lack of well defined property rights.



CHECK YOUR PROGRESS

Q.1. State whether the following statements are True or False:

(a) Markets can fail if prices do not communicate the diverse society's desires [True]

(b) There can never be market failures in government activity [False]

Q.2. Explain the concept of market failure.

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Q.3. How public goods create market failure?

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Q.4. Discuss briefly how market failure is related with environment.

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7.5 CONCEPT OF EXTERNALITIES

The concept of externalities is as relevant to the field of economics as when Arthur Pigou first postulated the idea in 'The Economics of Welfare' (1924). An *externality* is a cost or benefit that *stems* from the production or consumption of a good or service. An externality exists when the consumption and production choices of one person or firm enter the utility or production function of another entity without that entity's permission or compensation. Say, if an individual wants to play his stereo loudly, his neighbours must listen as well. This causes a divergence between the

internal or private and social marginal costs or benefits of the good in question. Again for more examples, pollution caused by factories, power houses, railways, transport vehicles etc. is a cost to the society but not to the individual undertakings. Similarly, beneficial externalities of social overheads like roads etc. cause a divergence between private and social marginal benefits.

Let us understand the concept of externality by means of an example, laundry shop and a steel mill. Suppose an individual's utility function is given by u (x, y) where x and y are quantities of two goods (laundry service & steel) consumed. The individual chooses how much of x is to be consumed but has no control over consumption of y. How much of y will be consumed is chosen by other. This is known as externality.

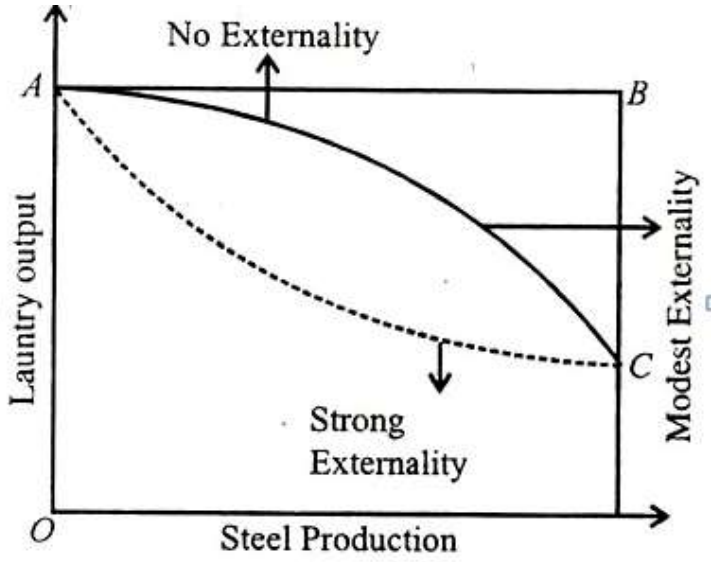


Fig. 1.

The above figure 1 illustrates production externality. This shows production possibilities for steel and laundry the maximum amount of the two that can be produced. Note that with no externality both can produce maximum amount and with a modest externality involved (say, smoke), increased steel production diminished laundry's output.

7.6 TYPES OF EXTERNALITIES

Externalities can be both positive and negative. They exist when the actions of one person or entity affect the existence and well-being of another.

In economics, there are four different types of externalities—positive externalities and negative externalities. As implied by their names, positive externalities generally have a positive effect, while negative ones have the opposite impact.

7.6.1 Negative Externalities

When negative externalities are present, it means the producer does not bear all costs, which results in excess production. For example, a factory that produces widgets, it pollutes the environment during the production process. The cost of the pollution is not borne by the factory, but instead shared by society. If the negative externality is taken into account, then the cost of the widget would be higher. This would result in decreased production and a more efficient equilibrium. In this case, the market failure would be too much production and a price that didn't match the true cost of production, as well as high levels of pollution.

7.6.2 Positive Externalities

Now let's take a look at the relationship between positive externalities like education and market failure. Obviously, the person being educated benefits and pays for this cost. However, there are positive externalities beyond the person being educated, such as a more intelligent and knowledgeable citizenry, increased tax revenues from better-paying jobs, less crime, and more stability. All of these factors positively correlate with education levels. These benefits to society are not accounted for when the consumer considers the benefits of education. Therefore, production of education services would be less than socially optimal if these external benefits are not taken into account. Clearly, public policymakers should look to subsidize markets with positive externalities and punish those with negative externalities.

Externalities, which can be either positive or negative, can affect an individual or single entity, or it can affect society as a whole.

The *benefactor* of the externality—usually a third party—has no control over and never chooses to incur the cost or benefit.

7.7 RELATIONSHIP BETWEEN ENVIRONMENT AND EXTERNALITIES

In order to address the different manifestations of the environment, regarding environment crisis or environmental issue, such as, climate change, pollution, natural and technological risks, toxic waste, species extinction, exhaustion of natural resources etc. as a public problem, economists resort to analyse all these perspectives mostly under the preview of negative externalities.

Starting in the 1960s, in a climate of growing political and social awareness of the environmental crisis, *economics* has been abruptly confronted with the necessity of taking the environment into account, the issue of the exhaustion of natural resources and the issue of the environmental damage caused by industrial pollution. It is on these premises that a specific branch of economics addressing environmental problems, known as “environmental economics”, has developed. The key analytical concept around which this field of investigation is structured is that of *externalities*. The concept of externality is not specific to environmental issues: it is used to define situations where the activities of one (or more than one) economic agent(s) have consequences on the economic well-being of other agents, without any kind of exchange or transaction occurring between them. When these indirect consequences increase well-being, externalities are qualified as “positive”; otherwise, they are qualified as “negative”. Pollution is the classic example of a negative externality, while public health policies produce positive externalities. Since there is no reward (or gain) for those producing positive external effects or sanctions for those causing negative external effects, externalities cause the market to fail to achieve an efficient allocation of resources. In fact, when externalities are present, private and social costs diverge, so that profit maximizing decisions are socially inefficient because prices do not carry all the relevant information.

Let us take the example of a factory that produces the good X, maximizing its profit. In order to decide the optimum level of production, the cost of production has to be taken into account in the economic calculus. If the factory can dispose freely of its waste in the environment, without paying for it, the cost of pollution is not taken into account when deciding the optimum level of production. As a result, the volume of production maximizing the producer's private profit is higher than that guaranteeing the social optimum. Different instruments have been proposed in order to achieve this goal: giving a price to free environmental resources, taxing the polluter, introducing regulation, attributing property rights over environmental resources. These instruments are applied in order to correct price signals, so that individual optimizing decisions are aligned with the socially optimum resources allocation. This frame of analysis is the major contribution of economic theory to the field of environmental policies. To summarize, pollution causes damage but de-pollution implies costs. Resources are scarce, so those resources to be invested in the protection or restoration of the environment cannot be used for the production of other socially valuable goods. The internalization of environmental negative externalities results in solving a problem of cost-benefit analysis applied to pollution and de-pollution.

Moreover, the valuation of environmental costs and benefits has become one of the main topics of research in environmental economics. Valuing environmental goods is considered necessary in order to decide among conflicting objectives. For example, when managing a forest, conflicts can arise between objectives of biodiversity preservation, of wood production, of recognition of cultural values attached to the forest. In the neoclassical approach the way to solve the conflict is through comparing costs and benefits of different forest management measures. This implies putting a price not only on biodiversity but also on people's attachment to forests as part of their identity. This implies *not considering* that in real life not all objectives are tradable and that social relations exist (including relations to the environment) that are constituted by refusing to put a price on them. Economists define the social value of a good according to the

intensity of consumers' preference as expressed by people's willingness to pay. However, when markets are absent, as is the case of environmental goods, preferences cannot be observed through consumers' actual choices.

Let us consider the epistemic uncertainty surrounding environmental processes which account for environmental degradation. An epistemic uncertainty refers to the insufficiency in taking care of environment due to lack of knowledge or information. We cannot always identify the specific causes of incidences of environmental damage, because we are confronted with complex systems which involve complex social and ecological interdependencies. Moreover, we must acknowledge that there are different ways to value the environment, some of them quantifiable, others not so. In such cases, the concept of negative externalities can be a useful heuristic in discussing environmental damage. In this situation the externality can be discussed from the view point of epistemic uncertainty and moral uncertainty. Uncertainty (epistemic), because of the wide variety of natural and social processes that have to be explored, researched and taken into account as relevant in the public decision concerning environmental issues. In particular, how these two kinds of uncertainty can be reduced so as to make collective decisions on environmental problems possible, while still achieving inclusiveness and valuing the environment.

Moreover, the relations existing between human beings and their environment are complex, and this complexity cannot be grasped through economic tools alone. These tools can deal only with a part of the relevant interactions accounting for environmental degradation, that is, those interactions that can fit a market frame. This implies that collective decisions on environmental issues call for a multidisciplinary approach. Externalities are in fact produced by a form of "cost shifting" (from economic activities of production to the environment) which is considered legitimate in our societies. In this sense, the definition of social and environmental rights, and, more generally, forms of political critique, in modifying or challenging the terms of legitimacy, can reduce the social acceptability of the cost shifting, helping to develop forms of internalization..



CHECK YOUR PROGRESS

Q.5. State whether the following statements are True or False:

(a) Pure public goods are not characterized by the existence of externalities [False]

(b) In negative externalities, the producer does not bear all costs [True]

Q.6. Define externalities.

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Q.7. Distinguish between positive and negative externalities.

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Q.8. Discuss how environment and externalities are related with each other?

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7.8 INTERNALISING THE EXTERNALITY

In economic terms, internalization of externalities is the effect of changing incentives to allow people to consider behaviour changes. Through internalizing the externalities people generally become aware about the external effects of their actions. Internalizing the externality means shifting the burden, or costs, from a negative externality, such as pollution or traffic congestion, from outside to inside (external to internal). This can be done through taxes, property rights, tolls, and government subsidies. An example in the case of pollution would be pollution rights. That means, if a company wants to pollute more, they would have to pay more money for more pollution rights. Instead of placing the burden (the costs of higher pollution) on people breathing air, a government would place a monetary tax on pollution. The tax would be in the form of pollution rights that companies would bid on and

purchase from the government. This shifts the burden (the costs of higher pollution) from outside the company to inside the company.

The purpose of internalizing an externality is to reduce the burden (or costs) of a negative externality by getting the people who are producing the externality to pay for the negative effects. The economic explanation of the internalization of externalities is that, in order to eliminate market failures caused by externalities, it is necessary to introduce external costs into the prices, so as to encourage buyers and sellers in the market to change their rational choices, produce or purchase quantities that are closer to the social optimum, and correct efficiency deviations of externalities.

7.8.1 Internalisation of the Externalities- Solution by Pigou and Coase

Externalities have significant effects on societal welfare. Take for ex-ample the positive externalities derived from education, which not only lead to increased future output but have also been shown to reduce crime. Moreover, it is essential that the negative externalities arising as a result of economic growth, the most fundamental way of improving living standards, are minimised.

The solutions to externalities put forward by the two schools of thought; that of Pigou advocated the public policy means of taxes and subsidies and Coase advocated the private resolution approach, (hereafter referred to as the Pigovian and Coasean ap-proaches respectively.

Pigou's thoughts on technological externalities are correct, while his proposition on pecuniary externalities was fundamentally wrong. If an in-dustry enjoys external economies, a subsidy should not be required. The im-plied gains in efficiency are adequately signalled by the input price, and profit-maximizing output levels by the firms are socially efficient. So unlike technological externalities, pecuniary externalities do not result in inefficiency, and thus do not warrant corrective action. In fact, it is the abil-ity of firms to inflict pecuniary losses that generates efficiency in competitive markets.

Efficiency merely requires that people have clearly defined property rights over the ownership of property but not over the market value of that property. We may even rule out pecuniary exter-nalities, as they ultimately arise from technological external economies from somewhere within the system.

Coase's powerful article 'The Problem of Social Cost' (1960) revolutionized the way the economics profession viewed externalities. In this groundbreak-ing article, he argued that the Pigovian approach would "lead to results which are not necessarily, or even usually, desirable". The alterna-tive that Coase proposed is perhaps best described using the real life example involving a doctor and a confectioner. The doctor's business was impeded by machinery used by the confectioner and the court forced the confectioner to compensate him.

Coase argued that the same optimum result could have been achieved through private bargaining between the two parties. The ruling dictated that the doc-tor had the legal right to prevent the confectioner from using his machinery. Intuitively, the doctor would have been willing to receive a payment from the confectioner for him to continue using his machinery, so long as this was greater than the cost to the doctor of moving premises, or building a wall etc. This relates to the fact that Pigou failed to take into account the concept of op-portunity cost. If the shoe was on the other foot i.e. the confectioner had the legal right to use his machinery, the outcome would be analogous. The doc-tor would simply have to pay the confectioner to stop using his machinery. If the doctor's income would have fallen more through continued use of this machinery than it added to the income of the confectioner, then there would clearly be room for bargaining.

Such rearrangement of legal rights through the market would take place whenever this led to an increase in the value of production. When we take transaction costs into account, this will only take

place if the increase in pro-duction is greater than the cost involved in bringing it about.

More precisely (despite Coase never explicitly mentioning it), the Coase the-orem states the following:

1. Externality problems are efficiently resolved by assignment of legal rights.
2. The efficient resolution of an externality is independent of who has legal rights.

Coase argued that the Pigovian approach is inherently wrong in assuming that building con-struction is necessarily “anti-social”. It may or may not be. It is necessary to weigh the harm against the good that will result. He claims “nothing could be more “anti-social” than to oppose any action which causes any harm to anyone” (Coase, 1960, 35). Put simply, this would erect barriers that would make any sort of construction work nigh on impossible. The reciprocal nature of externalities had also never been acknowledged beforehand. If the confec-tioner mentioned above had been using his machinery for years before the doctor set up his practice, then which party deserves compensation becomes more ambiguous. Coase also alluded to the idea of government failure. He purports that externalities that a government tries to solve are actually caused by gov-ernmental action itself (Coase, 1960). Prof. Wolf (1987) expands on this argument, labelling them as ‘derived externalities’. Derived externalities means unanticipated side-effects, often in an area remote from that in which public policy was intended to operate. On the other side of the debate, Prof. Grand (1991) argues that government organizations should not necessarily be sin-gled out as being subject to the ‘derived externality’ problem. Any activity, whether undertaken in the public or private sector, has the potential to cause unintended side effects. The effects of certain actions cannot always be ad-equately predicted, a fact of life to which private organizations are as subject as public.

Thus, Pigou's propositions, concluded that his failure to distinguish between 'pecuniary' and

techno-logical externalities somewhat limited his belief that all externalities require government intervention. The solutions to externalities explore the Coasean approach and emphasize its prevailing relevance. We concede that the Pigovian approach is desirable in certain circumstances, however, particularly when a market for Coasean trading is simply non-exis-tent.



CHECK YOUR PROGRESS

Q.9. What do you mean by internalising the externalities?

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Q.10. Explain briefly the Pigou's and Coase's approach in internalising the externalities.

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7.9 LET US SUM UP

- Market failure occurs when individuals acting in rational self-interest produce a less than optimal or economically inefficient outcome.
- Market failure can occurs both in explicit market and implicit market.
- The common types of market failures include *externalities, monopoly,* information asymmetries, and factor immobility.
- The economic outcomes under market failure deviate from what economists usually consider optimal and are usually not *economically efficient*.
- The factors leading to habitat destruction and the loss of biodiversity originate in several sources of market failure.

- As an example of market failure, we can cite the case of Madagascar, one of the ecologically richest, but economically poorer, countries in the world regarding habitat destruction and the threat to biodiversity.
- Pure public goods are characterized by the existence of externalities.
- An externality is a cost or benefit that stems from the production or consumption of a good or service.
- Externalities can be both positive and negative.
- The concept of externality is not specific to environmental issues: it is used to define situations where the activities of one (or more than one) economic agent(s) have consequences on the economic well-being of other agents, without any kind of exchange or transaction occurring between them.
- Internalization of externalities is the effect of changing incentives to allow people to consider behaviour changes through which people generally became aware about the external effects of their actions.
- The solutions to externalities put forward by the two schools of thought; that of Pigou advocated the public policy means of taxes and subsidies and Coase advocated the private resolution approach.



7.10FURTHER READING

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7.11 ANSWER TO CHECK YOUR PROGRESS

Ans to Q No 1: **(a)** True, **(b)** False

Ans to Q No 2: Market failure occurs when individuals acting in rational self-interest produce a less than optimal or economically inefficient outcome. Market failure can occur in explicit markets where goods and services are bought and sold outright, which we think of as typical markets. Market failure can also occur in implicit markets as favours and special treatment are exchanged, such as elections or the legislative process. Market failures can be solved using private market solutions, government-imposed solutions, or voluntary collective actions.

Ans to Q No 3: Public goods create market failures if some consumers decide not to pay but use the good anyway. Public goods are goods or services which, if produced, the producer cannot limit its consumption to paying customers and for which the consumption by one individual does not limit consumption by others. For example, National defence is one such public good because each citizen receives similar benefits regardless of how much they pay. It is very difficult to privately produce the optimal amount of national defence. Since governments cannot use a competitive price system to determine the correct level of national defence, they also face major difficulty producing the optimal amount. This may be an example of a market failure with no pure solution.

Ans to Q No 4: Biodiversity in and of itself has no value reflected by market prices. In contrast, the commodity resources of the habitat (for example, chemicals, minerals, timber, game) are valued on the market, and the supply and demand reflect the relative scarcity of these goods. The

factors leading to habitat destruction and the loss of biodiversity originate in several sources of market failure. For example, Madagascar is one of the ecologically richest, but economically poorer, countries in the world regarding habitat destruction and the threat to biodiversity.

Ans to Q No 5: (a) False, (b): True

Ans to Q No 6: An externality stems from the production or consumption of a good or service, resulting in a cost or benefit to an unrelated third party. Externalities lead to market failure because a product or service's price equilibrium does not accurately reflect the true costs and benefits of that product or service.

Ans to Q No 7: When negative externalities are present, it means the producer does not bear all costs, which results in excess production. With positive externalities, the buyer does not get all the benefits of the good, resulting in decreased production. A factory that pollutes the environment during the production process is an example of negative externality. On the other hand, positive externality like education brings more stability to the environment.

Ans to Q No 8: In order to address the different manifestations of the environment, regarding environment crisis or environmental issue, such as, climate change, pollution, natural and technological risks, toxic waste, species extinction, exhaustion of natural resources etc. as a public problem, economists resort to analysis all these perspectives mostly under the preview of negative externalities. There are different ways to value the environment, some of them quantifiable, others not so. In such cases, the concept of negative externalities can be a useful heuristic in discussing environmental damage. In this situation the externality can be discussed from the view point of epistemic uncertainty and moral uncertainty.

Ans to Q No 9: In economic terms, internalization of externalities is the effect of changing incentives to allow people to consider behaviour changes. Through internalizing the externalities people generally became aware about the external effects of their actions. Internalizing the externality means shifting the burden, or costs, from a negative externality, such as pollution or traffic congestion, from outside to inside (external to internal). This can be done through taxes, property rights, tolls, and government subsidies. An example in the case of pollution would be pollution rights. That means, if a company wants pollute more, they would have to pay more money for more pollution rights.

Ans to Q No 10: The solutions to externalities put forward by the two schools of thought; that of Pigou advocated the public policy means of taxes and subsidies and Coase advocated the private resolution approach, (hereafter referred to as the Pigovian and Coasean ap-proaches respectively).

Pigou's thoughts on technological externalities are correct, while his proposition on pecuniary externalities was fundamentally wrong. On the other hand, Coase the-orem states that externality problems are efficiently resolved by assignment of legal rights and the efficient resolution of an externality is independent of who has legal rights.



7.12 MODEL QUESTIONS

A) Short Questions (Answer each question in about 150 words)

Q 1: Explain how market failure occurs in government activity?

Q 2: Discuss the concept of externalities with examples and a diagram.

B) Long Questions (Answer each question in about 300-500 words)

Q 1: Explain how habitat destruction and the loss of biodiversity originate as a source of market failure.

Q 2: Discuss how externalities are related with environment.

Q 3: Make a comparative analysis of Pigovian and Coase Approach in solving internalisation of externalities.

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UNIT 8: VALUATION OF ENVIRONMENT

UNIT STRUCTURE

8.1 Learning objectives

8.2 Introduction

8.3 Types of Values of Environmental Goods

8.3.1 Use Value and Non-use Value of Environment

8.4 Methods of Valuation

8.4.1 Direct Method

8.4.2 Indirect Methods

8.5 Contingent Valuation Method

8.5.1 Willingness-to-Pay (WTP) and Willingness-to-Accept-Compensation (WTAC)

8.6 Hedonic Pricing

8.7 Travel Cost Method

8.7.1 Tourism Expenditure Approach

8.8 Measures of Non-use Values

8.9 Let Us Sum Up

8.10 Further Reading

8.11 Answer to Check Your Progress

8.12 Model Questions

8.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- understand how the valuation of environment is done.
- understand the methods of valuing environment.
- know about the different types of values of environmental goods.
- analyse the different methods in details regarding environmental valuation.
- examine the various issues, such as the problems, uses etc. associated with the different methods of valuation of environment.

8.2 INTRODUCTION

Environmental goods and services are the biogeochemical processes, attributes or the products thereof that relate to the self-maintenance of an ecosystem, provision of wildlife habitat, cycling of carbon, nitrogen, phosphorus, sulphur, water or the trapping of nutrients, etc. and make the basis of sustenance as well as prosperity to the human society. Only some environmental goods and services have markets, and therefore, prices of only a few of them are available as data. These prices too, are only the indicators of the minimal payments at which the consumers and the producers have agreed to enter into transactions. At these prices, there may be substantial consumer and/or producer surpluses that may go unaccounted. The worth of environmental goods and services include these unaccounted surpluses, but their prices do not generally reflect their worth. However, a greater part of environmental goods and services have no markets and, therefore, no prices at which they are available to the consumers. Valuation of such goods and services is much more relevant.

Environmental goods and services are often public goods, which to some extent, may be harnessed by many without adversely affecting each other's interest. However, these goods and services have a limit to their bearing capacity, beyond which they cannot sustain their use. Crowding on their use can decrease users' utility. Public goods often suffer from free-riders' problem. Although each user values them, none has an incentive to pay to maintain them. These goods and services may also be affected by externalities, or uncompensated side effects of human actions. Market mechanism cannot often regulate their consumption, production and allocation. That necessitates a collective action for their upkeep, which incurs considerable public cost. Hence, the valuation such goods and services may help the resource managers to deal with the effects of market failures, by measuring it in a proper way.

The objective of the present chapter is to discuss various methods that are suggested or applied to find a pecuniary measure of the worth of environmental goods and services and evaluate them from the viewpoint of

institutionalism. In this regards the direct and indirect methods of valuations are disused in this chapter. Moreover, the methods that we are going to discuss suffer from some flaws too. However, we must be aware of these biases in the back of our mind while discussing what follows for a better environmental valuation.

8.3 TYPES OF VALUES OF ENVIRONMENTAL GOODS

Understanding the value of environmental goods requires understanding of the notion of "values" of environmental goods. There are two types of values – Use Value and Non-use Value. The value of an environmental good can be divided into two groups: use value and existence value.

8.3.1 Use Value and Non-Use Value of Environment

The use value corresponds to the value that people gain from the direct use of the product, for example, walking in a national park or swimming in a clean lake. Therefore, the use value refers to the satisfaction or utility that consumers obtain by directly consuming the goods.

The Non-Use value or existence value corresponds to the value that an individual may assign to an environmental good, despite that he/she is not directly using the good; for example, how much would someone be willing to pay for the giant panda to continue to exist in the wild, despite the fact that the person does not expect to ever see a giant panda in the wild? Therefore, the non-use value is the gain in person's utility without the person actually using the good directly. It refers to the increase in productivity, well being etc. The non-use value can be categorised into: existence value, option value, bequest value and existence value.

8.4 METHODS FOR VALUING THE ENVIRONMENT

As we all know economic value is a measure of the benefits provided by a good or services to an economic agent. Most often what we observed

is that in a free market economy a consumer is willing to pay for an item and in case of a socialist economy an individual will sacrifice an amount of time to obtain a goods or services. Again, environmental valuation refers to assignment of money values to non-marketed assets, goods and services, where the money values have a particular and precise meaning. If a good or service contributes positively to human wellbeing, it has economic value. But, environmental values are measured in money terms through the concept of individuals, willingness to pay and willingness to accept.

There are numerous methods for assigning a value to environmental goods and services, and these can be divided mainly into the following categories:

8.4.1 Direct Method

Direct Valuation Method is a value for an environmental good proposed by asking individuals about how much they are willing to pay to obtain a certain quality of environment or to avoid a particular change in the environment and also the willingness to accept compensation for some degradation of environmental quality. The suitability of these methods depends mostly on the environmental good in question and the applicable economic limitations.

The direct method is stated preference, i.e., it basically involves asking people how much an environmental good is worth. These information are collected through opinion polls or surveys. The most commonly used direct method is the Contingent Valuation Method (CVM).

8.4.2 Indirect Methods

Indirect Valuation Methods examine the value of an environmental good based on the existing relationship between the quality of the environment and market-priced goods (for example, rich fishing water and the price of licenses for fishing. The indirect methods are revealed preferences, i.e., in such cases real choices of people are observed in some market and information are inferred on the trade-

offs between money and the environmental goods. The most commonly used indirect methods are Hedonic Pricing (HP) Method and Travel Cost Method (TCM).



CHECK YOUR PROGRESS

Q.1. State whether the following statements are True or False:

(a) **The use value of environment** corresponds to the value that people gain from the direct use of the product [True]

(b) Indirect methods of valuations are not revealed preferences [False]

Q.2. Why environmental goods should have value? Justify.

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Q.3. Define use vale and non-use value of environment.

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Q.4. Distinguished between direct and indirect methods of valuation.

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8.5 CONTINGENT VALUATION METHOD (CVM)

The CVM may be a modern name for the survey method. Only difference being is that the CVM elicits, thorough appropriately worded questions, how people would respond to hypothetical changes in some environmental service. These questions may be in the form of referendum (yes or no) or a payment card, apart from the direct questioning of the exact amount an individual / household is willing to pay. However, the direct questioning has been criticised as a difficult proposition to elicit the requisite information. The referendum approach includes dichotomous-choice, closed-ended, or take-it or leave-it question formats while the payment card format specifies a range of values he or she would be willing to pay. Another

way of eliciting information is through a bidding game procedure, which is somewhat similar to the payment card approach, where the respondent is offered different hypothetical bids until range is generated. In this, the true willingness to pay is expected to lie between positive and negative responses rather than on a single point. All these approaches are tested for their validity. In this regard, while conducting CVM different steps are followed. The most commonly used hypothetical questions simply ask people what value they place on a specified change in an environmental amenity, or the maximum amount they would be willing to pay to have it occur. The responses, if truthful, are direct expressions of value and would be interpreted as measures of compensating surplus (CS). The term Contingent Valuation Method (CVM) is conventionally used to refer to approaches based on this form of question.

Second major types of hypothetical questions ask for a yes or no answer to the question. 'Would you be willing to pay Rs X..? Each individual's response reveals only an upper bound (for a No) or a lower bound (for a Yes) on the relevant welfare measure. Questions of this sort are often referred to as referendum questions because of the analogy with voting on such things as bond issues. Discrete choice methods can be used to estimate willingness to pay functions or indirect utility functions for data on responses, and on the characteristics of the people surveyed.

The third and fourth major types of hypothetical questions do not reveal monetary measures directly. Rather, they require some form of an analytical model to derive welfare measures from responses to questions. The third approach to questioning is known as Contingent ranking. Respondents are given sets of cards and hypothetical alternatives, each depicting a different situation with respect to some environmental amenity and other characteristics that are presumed to be arguments in the respondent's preference function. Respondents are asked to rank the alternatives in order of preference by placing the cards in that order. These rankings can then be analysed to determine, in effect, the marginal rate of substitution between any other characteristics and the level of environmental amenity. If one of the other characteristics has a monetary price, then it is

possible to compute the respondent's willingness to pay for the good on the basis of the ranking of alternatives.

In the fourth type of hypothetical questions- Known as Contingent Activity Questions- individuals can be asked how they would change the level of some activity in response to a change in an environmental amenity. If the capacity can be interpreted in the context of some behavioural model, such an averting behaviour model or a recreation travel cost demand model, the appropriate indirect valuation method can be used to obtain a measure of willingness-to-pay (WTP).

The general criticism of CVM is regarding the validity of the insights derived from people's responses to hypothetical situations. How far would the estimates be reliable or accurate? The awareness of the respondent with regard to the suggested environmental amenities, which are often esoteric (for example, polar bear, acid rain and rain forests in arid zones), is crucial for getting reliable estimates from CVM. Lack of knowledge regarding the 'good' or 'bad' in question may result in hypothetical answer as well. Also, contingent valuation is inconsistent with the predominant national accounts application of market prices, since it includes consumer surplus which is appropriate for welfare measurement, but incorrect in recording national accounts transactions. Other methods such as estimating the cost of increased travel, or estimating the change in property values due to environmental deteriorations may be more consistent with market values but face problems of distinguishing environmental effects from other effects.

In short, CVM is vulnerable to several biases, which are classified into the following five categories: strategic, design, information, hypothetical and operational bias. Strategic bias refers to the problem involved in motivating respondents to reveal their true preference in situations when by not telling the truth they could still obtain benefits. The design bias comprises two components: starting point bias and payment vehicle (mode) bias. The information bias refers to the problem arising from the amount and quality of information supplied to the respondents. The *hypothetical bias* arises from the fact that the payments, as revealed through WTP, are

usually hypothetical. The *operational bias* may occur if the respondent is not familiar with the good or service to be valued. Some of these biases are specific to CVM whereas others are endemic to all survey methods.

In addition to the five types of biases, CVM suffers from one more problem, that is, how to estimate aggregate values based on the individual values expressed through WTP. To go from individual values to aggregate values requires the identification of the relevant population. The ideal population is the one that will benefit from the proposed environmental service or amenity and will pay for it.

In assessing the hypothetical costs of keeping environmental assets intact, maintenance costing focuses on the direct impacts of production. In contrast, contingent and related valuations of the demand / benefit side of environmental services attempt to measure the losses of services, in other words, environmental damage. Therefore, through CVMs, we attempt to account for the costs borne by economic agents due to environmental degradations. A serious drawback of these methods in the context of national level environmental accounting is the aggregation bias, that is, the problem of applying these valuations accumulate at the national level and distort the estimates of values. In view of this, such valuations do not seem to be applicable in recurrent national accounting. However, they might be useful in experimental studies that focus on selected environmental concerns or regions.

8.5.1 Willingness-to-Pay (WTP) and Willingness-to-Accept-Compensation (WTAC)

Many CVM researchers found that WTP measures were much less than WTAC measures for the same change in environmental quality. Initially, it was thought that this problem was unique to CVM, possible owing to the hypothetical nature of the exercise. However, an increasing body of evidence from the experimental economics literature also showed considerable divergences between the two measures. Moreover, this difference seemed to exist independently of income effects, transactions costs

or how often the good was traded. This evidence suggests that people systematically value losses more highly than equivalent gains, and reductions in losses more highly than forgone gains.

Two, possibly competing, arguments have been put forward to explain this disparity. The first, associated with Knetsch and co-authors, and Kahneman and Tversky (1979) is loss aversion. This states that individuals judge all gains and losses from a reference point, which is either existing entitlement to resources. Any decrease in the resource below this level cause a greater loss in welfare than the increase in welfare caused by an equivalent increase in the good. The implication is that we should expect WTAC to exceed WTP; and that, where a loss in welfare below the reference point is concerned, this should always be evaluated using a WTAC measure sine WTP would understate the loss. Similarly, WTP measures should be used for environmental gains.



CHECK YOUR PROGRESS

Q.5. State whether the following statements are True or False:

(a) CVM is also the modern name of survey method. [True]

(b) CVM suffers from the problem of how to estimate aggregate values [True]

Q.6. Explain briefly the concept of CVM.

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Q.7. What are the main biases involved with the concept of CVM?

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Q.8. Distinguished between WTP and WTAC?

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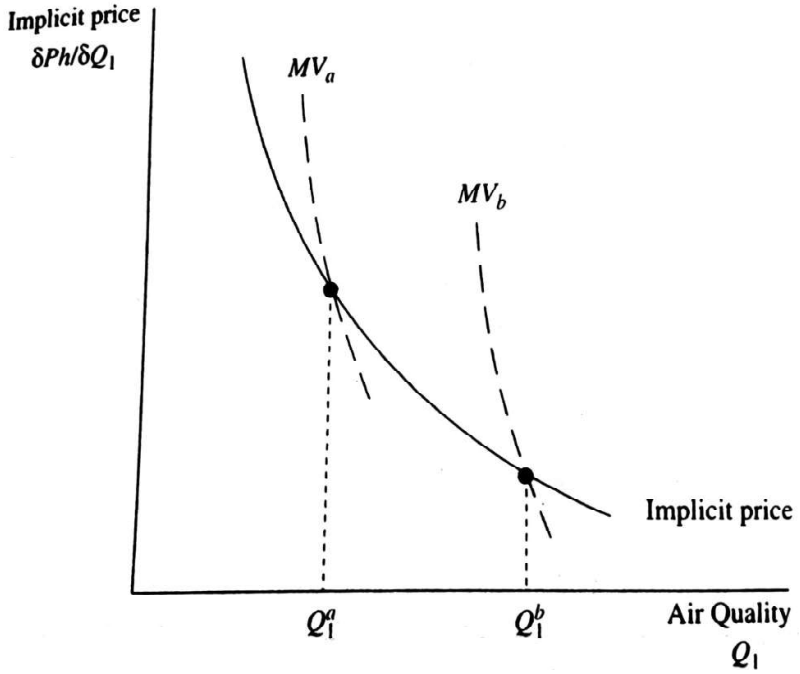
8.6 HEDONIC PRICING (HP)

The hedonic pricing approach derives from the characteristics theory of value first proposed by Lancaster (1966) and Rosen (1974). This seeks to explain the value of a commodity as a bundle of valuable characteristics. One or more of these characteristics may be environmental. For example, the value of a particular house may depend on the number of rooms, whether it has a garden, and how close it is to the shops, but also on the noise level in the neighbourhood and/or air quality levels. Other possible environmental variables include pleasant views, distance from toxic waste dumps, or offensive smells from factories or farms. The hedonic pricing (HP) approach was first applied to environmental valuation by Ridker and Henning (1967) and proceeds through three stages, First, a hedonic price function is estimated; second, implicit prices are calculated for the environmental variable of interest; third, a demand curve for this variable may be estimated. The HP approach utilises the same weak complementarity assumption as does the travel cost method, and can thus only measure use (as opposed to non-use) values.

In order to estimate a hedonic price function, it is necessary to gather data on house sale prices and all characteristics of those houses thought relevant to their value. For example, the analyst might estimate:

$$Ph = f [Si....Sm; Ni.....Nn, Qi....Qp]$$

Where, Si.....Sm are site characteristics (such as number of rooms, presence/absence of central heating), Ni.....Nn are neighbourhood characteristics (crime rate, distance from city centre, quality of local schools) and Qi.....Qp are environmental characteristics, such as air quality and noise levels. Partially differentiating with respect to any characteristics gives its implicit price. Unless the given function is linear, then these implicit prices will vary with the level of the characteristics. In the following diagram we show the hedonic price measure of value –



In the diagram, two individuals, a and b, purchase the air quality levels, say, Q1a and Q_1^b respectively. We show the implicit price (the marginal cost) of environmental characteristics $Q_{1,}$ which might be air quality, falling as Q_1 rises (although since the implicit price is everywhere positive, house prices are an increasing function of air quality levels). If individuals are not in equilibrium in this sense (because, for example, they are poorly informed about how the level of air quality varies across a city), then implicit prices (marginal cost) cannot be interpreted as marginal benefits.

The hedonic price technique is a method for estimating the implicit prices of the attributes that differentiate closely related products in a product category. Generally speaking, if the product class contains enough models with different combinations of attributes, it should be possible to estimate an implicit price relationship that gives the price of any model as a function of the quantities of its various attributes. This relationship is called the hedonic price function. The partial derivative of the hedonic price function with respect to any attribute gives its marginal implicit price. For example, prices of land in a residential area may include premiums for location in a clean and safe area and discounts for dirty and unsafe areas. If they do, it is then possible to estimate the demand for such environmental amenities as clean air from the price differentials revealed in private markets. Where

environmental changes affect producers of market goods, values can also be observed indirectly through examination of changes in product and factor prices and in producers' quasi-rents. Indirect Observed Methods involve a kind of detective work, in which clues about the values individuals place on environmental services are pieced together from the evidence that people leave behind as they respond to prices and other economic signals.

8.7 TRAVEL COST METHOD (TCM)

This is one of the oldest approaches to environmental valuation, proposed in a letter from Harold Hotelling to the US Forest Service in the 1930s, first used by Wood and Trice in 1958, and popularised by Clawson and Knetsch (1966). The method involves using travel cost as a proxy for the price of visiting outdoor recreational sites. A statistical relationship between observed visits and the cost of visiting is derived and used as a surrogate demand curve from which consumer's surplus per visit-day can be measured (by integrating under this curve). The method has been widely used in both the USA and the UK for valuing the non-market benefits of outdoor recreation, especially recreation associated with national parks and public forests. Recent developments of the techniques allow the welfare effects of changing the characteristics of a site to be analysed.

The Travel Cost Method (TCM) assumes weak complementarities between the environmental asset and consumption expenditure. This implies that, when consumption expenditure is zero, the marginal utility of the public good is also zero. So if travelling to a forest becomes so expensive that no one goes any more, the marginal social cost of a decrease in the quality of that forest is also zero. The TCM cannot therefore estimate non-user values. An implicit assumption made in most travel cost studies is that the representative visitor's utility function is 'separable' in the recreation activity being modelled. This means that , if the activity of interest is fishing, then the utility function is such that demand for fishing trips can be estimated independently of demand, say, for cinema trips (alternative leisure activities) or for heating oil (alternatives marketed non-leisure goods).

The simplest version of the TCM involves collecting data on visits to a site (V) from different parts of the surrounding country (zones, i) and explaining the visit rate per capita (Vi / Pi) as a function of travel costs, Ci. These costs are assumed to be some function of both distance and time spent travelling (travelling time is usually allocated a positive value to reflect the scarcity of leisure time) and of socio-economic variables Si. Therefore,

$$Vi/Pi = f(Ci, Si)$$

The travel cost method is often used in research to assess recreational or ecotourism values of a recreation site such as a national park or a hill station. The method could also be used for valuation of water supply and fuelwood. It is based on the recognition that the cost of travelling to a site is a major component of the full cost of a visit. It is also assumed that the amount of money people are prepared to spend to travel to a site, and the opportunity cost (value) of the time involved, can serve as a proxy for their willingness-to-pay (WTP) for the visit.

The travel cost method involves estimating the consumer's surplus from a demand curve derived from travel cost and socio-economic data. The usual economic assumption is that as the price of a good goes up, less of it is demanded. Therefore, the number of visits should be inversely related to the travel cost. Information on visitors' travel cost can be used to draw up a demand curve for the resource. The area under the demand curve (the consumer surplus) is used to estimate the WTP for the amenity.

It is necessary to estimate the time and money spent on travel to a particular recreation site. In some cases, the site in question may be the only tourist attraction in the area. In other cases, however, the site in question may be one of many in a popular tourist area, and the travel cost value has to be divided across all these sites. A similar problem arises if the journey to one site is undertaken for multiple purposes. For example, a person travels from the capital city to attend a business meeting in a regional town and then adds on a tourist visit to the nearby attraction. The method has been extensively used in India and other countries. An example of the use of this method for valuation of ecotourism is the country Costa Rica.

Further problems exist with the model. These include, first, the value of travel/ leisure time. Some authors have argued that a distinction should be made between the commodity value times, times that generates utility and the opportunity costs of time, which may be in terms of forgone earnings or forgone recreational opportunities. They find the commodity value of time to be positive but small and call for this to be noted out from the opportunity cost of time in calculating consumer's surplus. A final problem with the simple travel cost model considered here is that of multi-purpose trips. Moreover, there are two methods of TCM, viz, the Zonal Travel Cost Method and Individual Travel Cost Method. The Zonal travel cost method is the simplest and least expensive approach. It will estimate a value for recreational services of the site as a whole. It cannot easily be used to value a change in quality of recreation for a site, and may not consider some of the factors that may be important determinants of value. The Zonal travel cost method is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits "purchased" at different "prices." This information is used to construct the *demand function* for the site, and estimate the *consumer surplus* , or economic benefits, for the recreational services of the site. Again, the Individual Travel Cost approach is similar to the Zonal approach, but uses survey data from individual visitors in the statistical analysis, rather than data from each zone. This method thus requires more data collection and slightly more complicated analysis, but will give more precise results.

For the hypothetical example of the recreational fishing site, rather than simply collecting information on number of visitors and their zip codes, the researcher would conduct a survey of visitors.

8.7.1 Tourism Expenditure Approach:

A simpler and less precise way of estimating tourism or recreational benefits is to use the tourism expenditure approach. This does not capture any WTP above the actual price paid and

hence the estimated value excludes the consumer's surplus. Neither does it establish a relationship between price and demand, nor can it be used to forecast demand at different entry prices. It is however relatively easy to calculate as it assumes that the value of an area for tourism, recreation or scientific tourism can be based on how much people spend to travel and stay in the location.

Calculation of average tourism expenditure requires data on accommodation, food and transport expenditure, as well as any gate and guide fees. This is only possible when there is some control and recording of visitor expenditure. In India, Forest Departments collect these data. A problem with the approach is multiple purpose trips. Journeys often involve visiting different places or combining work and leisure pursuits, in which case some judgement about how much of the cost should be allocated to a particular recreational or tourism benefit is needed.

8.8 MEASURE OF NON-USE VALUES

There are two types of non-use values, viz., Option Value (OV) and Existence Value (EV). Moreover, there is one another type of value known as 'bequest value'. However, we talk mostly on the first two values, i.e., Option Value and Existence Value. Strictly speaking, these two values are not non-use values in the sense that people impute values to them for their possible use by them or somebody else in future. But these values are independent of their present use values.

8.8. 1 Option Value (OV):

Weisbrod introduced the concept of option value in 1964. Weisbrod argued that an individual who was not sure as to whether he would visit a site such as National Park would be willing to pay a sum over and above his expected consumer's surplus (CS) to guarantee that the site or the National Park would be available should he wish to visit in future. He called this extra sum the option value of the site. If Option Price (OP) is defined as the maximum sum the

individual would be willing to pay to preserve an option for the future use before his own demand uncertainty is removed, then the excess of OP over the expected consumer surplus can be called OV. It was argued that OV should be measured, if possible, and added to the expected CS in order to obtain the full measure of the value of providing an environmental service or amenity. According to Freeman III, OV is the algebraic difference between the expected value of the consumer's surplus and the state- independent willingness-to-pay. Since these two points on the willingness-to-pay curve represents alternative ways of measuring the same welfare change, the difference between their expected values cannot be a separate component of value. Furthermore, OV cannot be measured separately, it can only be calculated if we have enough information about people's preferences to estimate both OP and CS. In view of this, Freeman III is of the view that OV should not be considered as possible benefit from environmental protection.

8.8 2Existence Value (EV):

Existence values arise from preventing the extinction of a species or preventing the complete destruction of a natural resource or an environmental amenity. John. F. Krutilla first introduced the concept of EV in mainstream economics literature in 1967. It would be pertinent to state here that although the source of existence of EV is related to someone's use, it is independent of any use made of the resource by the person holding the EV.

The existence of non-use values is based on the hypothesis that people impute economic values on natural resources and environmental amenities and services independent of their present use of those resources. Based on this hypothesis, we presume that people might be willing to pay for conservation of some environmental services / amenities such as the valley of flowers, endangered species and biodiversity. In the environmental economics literature, resource values that are independent of

people's present use of the resource are variously called 'existence', 'intrinsic', 'non-user', and 'non-use' values. These values may arise from various motives such as desire to bequeath certain natural resource to one's heirs, or future generations or a sense of stewardship, or altruism, or an ethical concern.



CHECK YOUR PROGRESS

Q.9. What does the Hedonic Pricing focuses on?

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Q.10. Explain briefly the Travel Cost Method.

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8.9 LET US SUM UP

- Environmental goods and services are often public goods, which to some extent, may be harnessed by many without adversely affecting each other's interest and although each user values them, none has an incentive to pay to maintain them.
- Hence, the valuation environmental goods and services may help the resource managers to deal with the effects of market failures, by measuring it in a proper way.
- The value of an environmental good can be divided into two groups: use value and existence value.
- The use value refers to the satisfaction or utility that consumers obtain by directly consuming the goods and the non-use value is the gain in person's utility without the person actually using the good directly. It refers to the increase in productivity, well being etc.
- There are also numerous methods for assigning a value to environmental goods and services, and these can be divided mainly into direct method and indirect method

- **Direct Valuation Methods** basically involves asking people how much an environmental good is worth. These information are collected through opinion polls or surveys. **Indirect Valuation Methods, on the other hand,** examine the value of an environmental good based on the existing relationship between the quality of the environment and market-priced goods.
- *Contingent Valuation Method (CVM)* is an example of direct method and *Hedonic Pricing (HP) Method* and *Travel Cost Method (TCM)* are the examples of indirect method.
- Contingent valuation frequently elicits information on willingness to pay or willingness to accept compensation for an increase or decrease in some usually non-marketed goods or services.
- The hedonic price technique is a method for estimating the implicit prices of the attributes that differentiate closely related products in a product category.
- The travel cost method involves estimating the consumer's surplus from a demand curve derived from travel cost and socio-economic data.
- There are two types of non-use values, viz., Option Value (OV) and Existence Value (EV).



8.10 FURTHER READING

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8.11 ANSWER TO CHECK YOUR PROGRESS

Ans to Q No 1: (a) True, (b) False

Ans to Q No 2: Environmental goods and services are the biogeochemical processes and only some environmental goods and services have markets but their prices do not generally reflect their worth. However, these goods and services have a limit to their bearing capacity, beyond which they cannot sustain their use. Crowding on their use can decrease users' utility. Public goods often suffer free-riders' problem. Although each user values them, none has an incentive to pay to maintain them. That necessitates a collective action for their upkeep, which incurs considerable public cost. Hence, the valuation such goods and services may help the resource managers to deal with the effects of market failures, by measuring it in a proper way.

Ans to Q No 3: The use value corresponds to the value that people gain from the direct use of the product, for example, walking in a national park or swimming in a clean lake. Tthe non-use value is the gain in person's utility without the person actually using the good directly. It refers to the increase in productivity, well being etc.

Ans to Q No 4: The direct method is basically involves asking people how much an environmental good is worth. These information are collected through opinion polls or surveys. The most commonly used direct method is the *Contingent Valuation Method (CVM).* The indirect methods are real choices of people that are observed in some market and information and are inferred on the trade-offs between money and

the environmental goods. The most commonly used indirect methods are *Hedonic Pricing (HP) Method* and *Travel Cost Method (TCM).*

Ans to Q No 5: (a) True, (b) True

Ans to Q No 6: The term Contingent Valuation Method (CVM) is conventionally used to refer to approaches based on this form of question. The CVM may be a modern name for the survey method. Only difference being is that the CVM elicits, thorough appropriately worded questions, how people would respond to hypothetical changes in some environmental service. These questions may be in the form of referendum (yes or no) or a payment card, apart from the direct questioning of the exact amount an individual / household is willing to pay.

Ans to Q No 7: CVM is vulnerable to several biases, which are classified into the following five categories: strategic, design, information, hypothetical and operational bias. *Strategic bias* refers to the problem involve in motivating respondents to reveal their true preference in situations when by not telling the truth they could still obtain benefits. The *design bias* comprises two components: starting point bias and payment vehicle (mode) bias. The *information bias* refers to the problem arising from the amount and quality of information supplied to the respondents. The *hypothetical bias* arises from the fact that the payments, as revealed through WTP, are usually hypothetical. The *operational bias* may occur if the respondent is not familiar with the good or service to be valued.

Ans to Q No 8: Many CVM researchers found that Willingness to Pay (WTP) measures were much less than Willingness to Accept Compensation (WTAC) measures for the same change in environmental quality. Individuals judge all gains and losses from a reference point, which is either existing

entitlement to resources. Any decrease in the resource below this level cause a greater loss in welfare than the increase in welfare caused by an equivalent increase in the good. The implication is that we should expect WTAC to exceed WTP; and that, where a loss in welfare below the reference point is concerned, this should always be evaluated using a WTAC measure sine WTP would understate the loss. Similarly, WTP measures should be used for environmental gains.

Ans to Q No 9: The hedonic price technique is a method for estimating the implicit prices of the attributes that differentiate closely related products in a product category. Generally speaking, if the product class contains enough models with different combinations of attributes, it should be possible to estimate an implicit price relationship that gives the price of any model as a function of the quantities of its various attributes. This relationship is called the hedonic price function. In order to estimate a hedonic price function, it is necessary to gather data on house sale prices and all characteristics of those houses thought relevant to their value. For example, the analyst might estimate:

Ph = f [Si....Sm; Ni.....Nn, Qi....Qp]

Where, Si.....Sm are site characteristics (such as number of rooms, presence/absence of central heating), Ni.....Nn are neighbourhood characteristics (crime rate, distance from city centre, quality of local schools) and Qi.....Qp are environmental characteristics, such as air quality and noise levels.

Ans to Q No 10: The travel cost method is often used in research to assess recreational or ecotourism values of a recreation site such as a national park or a hill station. The method could also be used for valuation of water supply and fuelwood. It is

based on the recognition that the cost of travelling to a site is a major component of the full cost of a visit. It is also assumed that the amount of money people are prepared to spend to travel to a site, and the opportunity cost (value) of the time involved, can serve as a proxy for their willingness-to-pay (WTP) for the visit. The simplest version of the TCM involves collecting data on visits to a site (V) from different parts of the surrounding country (zones, i) and explaining the visit rate per capita (Vi / Pi) as a function of travel costs, Ci. These costs are assumed to be some function of both distance and time spent travelling (travelling time is usually allocated a positive value to reflect the scarcity of leisure time) and of socio-economic variables Si. Therefore, Vi/Pi =f (Ci, Si)



8.12 MODEL QUESTIONS

A) Short Questions (Answer each question in about 150 words)

Q 1: Why the methods for environmental valuations get importance?

Q 2: Define Option Value and Existence Value.

B) Long Questions (Answer each question in about 300-500 words)

Q 1: Explain the different types of hypothetical questions involved in CVM.

Q 2: Discuss the problems and uses associated with CVM.

Q 3: Analyses the role of Hedonic Pricing and Travel Cost Method in valuing the environment.

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Name of the Paper: Course Code:

Centre for Internal Quality Assurance (CIQA)
Krishna Kanta Handiqui State Open University
City Office, Housefed Complex, Guwahati- 06

Learner's Feedback on Course

Dear Learner,

Regarding the course as mentioned above, we would like to know your opinions and comments so as to improve the quality of self learning materials in future. Please respond to the following statements by ticking the number you feel most reflect your opinion. After completion of the additional comments, please detach the page and send/mail the same to us at the address given below.

The Director, Centre for Internal Quality Assurance, KKHandiqui State Open University
Housefed Complex, Dispur, Guwahati- 781006
(E-mail id: ciqa@kkhsou.in)

1. Approximately how many hours did you spend for studying the units in the course? | | | |
2. Please give your opinions (by √ mark) to the following items based on your reading of the block:

Sl. No.	Statements	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I.	The SLMs of the course fulfil the learning objectives set out in the beginning of each unit					
II.	The units of the SLM could satisfy my academic needs and expectations					
III.	The Unit writers have excellent knowledge about the course contents					
IV.	Language and contents of the units were presented at a level which I could readily understand					
V.	Ample opportunity for participation in the activities provided in the units					
VI.	Used enough Illustrations (Diagrams, tables etc.) for conceptual clarity					
VII.	Quality of content is engaging, relevant, and up-to-date					
VIII.	The self check questions are very helpful					
IX.	The Possible/model questions and the answers to check my progress have benefited me a lot					

Additional Comments: *(Please feel free to provide your open comments)*

1. Which aspects of the SLM, according to you, worked well?

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2. What sort of changes/improvements do you feel KKHSOU could implement to improve the overall quality of the SLM?

Thank you for taking the time to complete this form.

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