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Introduction to Environmental Economics

SEMESTER - VI

ECONOMICS

BLOCK - 1

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COURSE INTRODUCTION

This is the second course of sixth semester of the BA (Major) programme in Economics. This course has been entitled 'Introduction to Environmental Economics.' This course contains a total of fifteen units and has been divided into two blocks. The first block contains 7 units while the second block contains the rest.

In the recent times, particularly with the emergence of global warming as a major global problem, environmental issues have taken the centre-stage of discussion in any developmental debate. As a result a separate branch in Economics has emerged, widely called as Environmental Economics or the Economics of Environment. Here, we shall discuss some of the very important concepts relating to the discipline of Environmental Economics.

BLOCK INTRODUCTION

This is the first block and it contains the first seven units of the course. The first unit has been entitled "Basics of Environmental Economics". In this unit, we have discussed the preliminary concepts like the subject matter of environmental economics, its nature and scope, the environmental-economy interaction and state of environmental degradation. The second has been titled "Externality and Market Failure". In this unit, we have discussed the meaning of market success and why do markets fail. Various cases of market failure, the concept of externalities and its different types, how externalities lead to market failure, and the various ways to correct externalities have been discussed. Apart from that, important concepts like public goods and how the presence of public goods lead to market failure, particularly the problems of free rider and tragedy of common have also been discussed. In the next unit, the concept of property rights and how it corrects market failure of environmental goods have been discussed. In that context, the Coase theorem has been discussed with special reference to the problem of the tragedy of commons have been described. The fourth unit has been entitled "Environment and Development". Here, the relationship between economic development and environmental degradation and the important concept of the Environmental Kuznets Curve (EKC) has been discussed. Further, the factors responsible for the relationship between economic development and environmental degradation has been explained. In the next unit, we have discussed environmental regulation and policies. Here, important concepts like pollution and its different types, control and management of pollution, different instruments used for management of environment as well as pollution taxes and marketable pollution permits have been discussed. The sixth unit has been entitled "Solid Waste Management". Here, the different categories of solid waste, the major causes and effects of urban and industrial waste, different sources of urban and industrial wastes as

well as their effects control measures have been discussed. The last unit of the block is on valuation of environmental goods and services. In this unit, the basic concepts in environmental goods and environmental valuation, the need of valuation of environmental resources, different techniques of environmental valuation have been discussed. The next block of the course starts with the discussion on Economics of Natural Resources.

While going through a unit, you will notice some along-side boxes, which have been included to help you know some of the difficult, unseen terms. Some "ACTIVITY' (s) have been included to help you apply your own thoughts. 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 1: BASICS OF ENVIRONMENTAL ECONOMICS

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 What is Environmental Economics?

1.4 Nature and Scope of Environmental Economics

1.5 The Environment-Economy Interaction

1.6 The State of Environmental Degradation

1.7 Let Us Sum Up

1.8 Further Reading

1.9 Answer to Check Your Progress

1.10 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- understand the subject matter of environmental economics
- learn about its nature and scope
- understand the environmental-economy interaction
- know about the state of environmental degradation.

1.2 INTRODUCTION

Economics is about the allocation of scarce resources amongst competing uses. The environment can be defined as the surroundings, which include all flora and fauna, aquatic ecosystems, energy and material resources, and the atmosphere. Unlike regular commodities, the state of the environment affects the well-being of mankind - locally and globally, in the short run and in the long run. It is therefore quite natural to integrate the environment into the economic system, to analyze the environment in the context of the economic allocation problems. The concept of environmental economics refers exactly to this situation. Thus, environmental economics is a branch of Economics that deals with various environmental issues.

Due to the strong relationship between economy and environment, humans are facing lots of environmental problems caused by economic development.

1.3 WHAT IS ENVIRONMENTAL ECONOMICS?

In broad terms, Environmental Economics looks at how economic activity and policy affect the environment in which we live. Some production generates pollution - for example, Power Station emissions can cause acid rain and also contribute to global warming. Household consumption decisions too affect the environment - for example, more consumption can mean more waste sent to polluting incinerators or garbage dumps.

Environmental economics takes into consideration issues such as the conservation and valuation of natural resources, pollution control, waste management and recycling, and efficient creation of emission standards. Economics is an important tool for making decisions about the use, conservation, and protection of natural resources because it provides information about choices people make, the costs and benefits of various proposed measures, and the likely outcome of environmental and other policies.

There are many examples of the way in which the economy and the environment interact and are interdependent. For example, agriculture and environment are also mutually interdependent. Society has become aware of the environmental impact of agriculture over the last few decades because of an increased understanding of the negative consequences of certain agricultural practices. At the same time it has become apparent that many of these practices have resulted from the policies introduced to encourage farmers to produce agricultural output. Examples of the negative consequences of agriculture include water pollution (both surface and groundwater), soil erosion and soil compaction, the loss of wetlands because of drainage, and the loss of biodiversity because of land clearance for more agriculture as well as the adoption of new technologies. These outcomes have resulted because many commodity-specific price and income support programs did not require farmers to take account of the environmental

consequences of their actions.

Thus, 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.



CHECK YOUR PROGRESS

Q 1: Define the term Environmental Economics? (Answer in about 20 words).

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.....

1.4 NATURE AND SCOPE OF ENVIRONMENTAL ECONOMICS

Nature: The environmental economics is regarded as both positive and normative Science. It also covers both micro and macro aspects of environmental problems.

Positive and Normative Aspects:Environmental economics is based onscientific theories, e.g., laws of thermodynamics. When we study the cause and effect relationship, it encompasses the positive aspect. On the other hand, it is also based on the principles of welfare economics to incorporate environment into economic analysis as an economic variable. Thus, when it relates to policy measures, it is considered as normative aspect.

Micro and Macro Aspects: Economists such as Pigou, Hoteling and Nordhaus have formulated their models in relation to individual firms and natural resources. Therefore it covers the micro and macro aspects of the environmental problems. For example, in metropolitan cities like Delhi, people do not get fresh air to breathe. Its solution comes under the micro level planning. Besides this when the problem of pollution affects the economy

as a whole, like increase in temperature, then if falls under the category of macro aspects.

Besides these primary aspects, nature of environmental economics can also be extended as a study of static and dynamics and as a social science.

Study of Static and Dynamic:Classical and neoclassical economists have applied both static and dynamic approaches in relation to environment. They have applied economic welfare approach to environment which is static in nature, whereas under dynamic approach, they focus on forests, minerals, fossil fuels and water resources.

As a Social Science: Environmental economics deals with economic and managerial aspects of pollution and natural resources. It interacts between human beings and their physical surroundings. It studies the impact of pollution on human beings and suggestsrational utilization of resources in a proper way so that there may be an increase in social welfare or minimization of social costs.

Scope: Environmental economics revolves around three broad questions.

- What are the economic and institutional causes of environmental problems?
- How can we assess the economic importance of environmental degradation?
- How can we design economic policies to slow environmental degradation?

The first question leads to an analysis of market failure and government failure. For example, one of the principal reasons for market failure is that there are incomplete markets for environmental resources. By incomplete we mean there are many cases where no market exists for the efficient allocation of an environmental resource and hence cannot be priced in the market. For example, clean air, beautiful views, unpolluted beaches, tropical rainforests, a quiet environment etc. The second question requires us to be able to place economic values on environmental degradation. As we have already noted, many environmental resources and

goods are not priced in markets, thus, environmental economics has developed a set of methods to add values on these types of goods. Lastly, to address the third question we will use economic toolsto critically evaluate environmental policies and whether they are likely to achieve the aims of reducing or halting environmental degradation.



CHECK YOUR PROGRESS

Q 2: Explain the difference between positive and normative aspects of Environmental Economics. (Answer in around 20 words)

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Q 3: Explain the scope of Environmental Economics. (Answer in around 70 words)

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1.5 THE ENVIRONMENT-ECONOMY INTERACTION

Environmental economics is concerned with efficient allocation of environmental resources. The environmental provides both a direct value as well as raw material intended for economic activity, thus making the environment and the economy interdependent. For this reason, the way in which the economy is managed has an impact on the environment which in turn, affects both welfare and the performance of the economy.

By 'Economy', we refer to the population of economic agent, the institutions they form (which includes firm and government) and the inter connections between agents and institutions, such as markets. By 'Environment', we mean the biosphere, the 'thin skin on the earth's surface on which life exists', to quote from Nisbet (1991), the atmosphere, the geosphere and all flora and fauna. Our definition of environment thus includes

life forms, energy and material resources, the stratosphere and troposphere. These constituent part of the environment interact with each other :- an example is the effect of changes in biosphere composition on the composition of the atmosphere.

Environment is made up of different components :-

E1= Energy and materials.

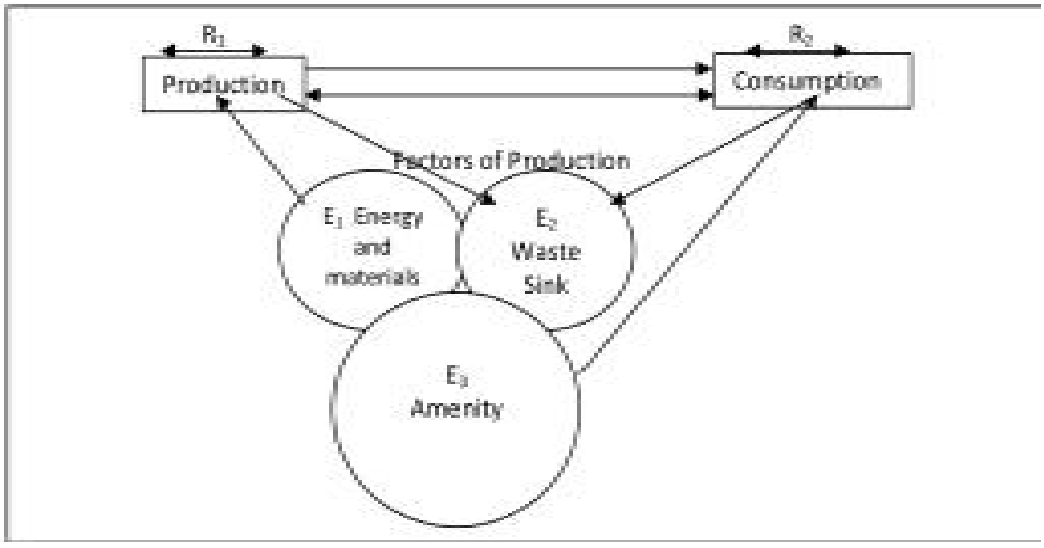
E2 = Waste Sink

E3 = Amenity

E4 = Global life Support Services

On the other hand, economy is made up of production and consumption activities. The inter-connection between the economy and the environment are summarized in Figure 1.1.

Figure 1.1: Interaction between Economic Activities and Environment



E_4 = Global life Support Services

Here we simplify the economy into two sectors, production and consumption. Exchanges of goods and services and factors of production take place between these two sectors. The environment is shown in the figure in two ways, as the three interlinked circles E_1 , E_2 and E_3 , and the all-encompassing boundary labeled E_4. The production sector extracts energy resources (such as oil) and material resources (such as iron ore) from the environment. These are transformed into outputs, some useful and some are waste products, such as SO_2. There is some recycling of resources

within the production sector shown by the loop R_1 and within the consumption sector, as shown by the loop R_2.

The environment's first role, then is a 'supplier of resources'. The second role is as a sink, or receptor for waste products. These wastes may result directly from production or from consumption. In some cases, wastes are biologically or chemically processed by the environment. The environment acts as a waste sink, as a partial recycling factory for human waste from production or consumption and as a source of energy and material resources. The next role of the environment is marked by E_3. The environment acts as a supplier of amenity, educational and spiritual values to society. The boundary marked E_4 represents the global life support services provided by the environment. These include:

- Maintenance of an atmospheric composition suitable for life.
- Maintenance of temperature and climate.
- Recycling of water and nutrients.

Using the environment for one purpose (as a supplier of material resources) can reduce its ability to supply us with other services, such as the ability to breathe clean air. That is why in the figure, the three circle E_1, E_2 and E_3 are shown as overlapping: there are conflicts in resource use. These conflicts would include the following:

- Using a mountain region as a source of mineral means its amenity value is reduced.
- Using a river as a waste disposal unit means its amenity value is reduced and that we can no longer extract so many material resources (fish to eat) from it.
- Felling a forest for its timber reduces the electricity generating capacity of a dam, owing to soil erosion and reduces amenity values since the forests inhabitants (animal and human) are displaced or destroyed.
- Preserving a wetland for its aesthetic qualities forgoes use of the drained land for agriculture.

The environment thus a scarcer source, with many conflicting demands placed on it. The scarcity resulting from these conflicting demands is termed as relative scarcity resulting from these conflicting demands is

termed as relative scarcity, which in principle a correct set of (shadow) prices could solve. This is distinguished from absolute scarcity, whereby all demands on environmental services are simultaneously increasing. The major cause of absolute is economic growth. This implies an increasing demand for materials and energy, an increase in waste outputs and increased demands for environmental quality as an input to recreational, educational and scientific activities. If the amount of environmental resources is fixed, then absolute scarcity will increase as world economic growth occurs.



CHECK YOUR PROGRESS

Q 4: How are the environment and the economy interlinked? (Answer in around 20 words)

.....

.....

Q 5: What are the main components of environment? (Answer in around 20 words)

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1.6 THE STATE OF ENVIRONMENTAL DEGRADATION

One of the greatest challenges facing humanity is environmental degradation, including deforestation, desertification, Pollution and climate change - an issue of increasing concern for the international community. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable. Environmental degradation can lead to a scarcity of resources. Moreover, extreme weather events, such as severe flooding, increase the spread of waterborne diseases, such as malaria and diarrhea.

The main sources of environmental degradation are:

- Air Pollution: Air pollution is an essentially urban and industrial phenomenon. Some air pollution may be found in rural areas due to smoke from combustion of firewood for domestic cooking and heating (in the hill areas) as well as smoke from chimneys of rural industries such as brick and rice mills. In the major cities, the main source of air pollution is vehicular pollution or emission from the exhaust of automobiles.
- Water Pollution: while 70 percent of the surface of the earth is covered by water, the water in the oceans and the seas is saline and therefore not fit for drinking, agricultural or industrial purposes. The main storehouses of fresh water are found in the downhill phase of the hydrological cycle and are in the form of lakes, ponds, reservoirs, rivers, streams and aquifers. It is from these sources that humans draw water for drinking, domestic purposes, irrigation and industrial activities. It is in these water bodies that bulk of fishing takes place and yield considerable environmental and aesthetic benefits and is crucial to the preservation of biodiversity in fish and bird species.

These water bodies of the world are in danger of being rendered unusable due to severe water pollution. There are three major sources of water pollution in India. These are-industrial wastes, urban sewage and solid waste and agricultural pollutants.

- Deforestation: Forests are a major natural resource of India. Approximately one-fifth of our land mass is under forests. Deforestation stems from two main sources that are intertwined. First, the commercial demand for timber drives the feeling of trees. Second, the land under forest may be needed for alternative economic purposes, most notably for mining or agriculture.
- Noise Pollution: This form of pollution is unique in the sense that it is not material related but activity related. It is essentially an urban industrial phenomenon arising out of congested living. The effect of this on human health is relative but it can cause nervous disorders and deafness. The major sources are industrial and processes, surface and air transport,

construction and other community activity.

Disposal of Reactive waste and the dangers of Radiation: The world was first made aware of the dangers of nuclear radiation when the two atomic bombs were dropped on Japan in August 1945. Apart from military uses, nuclear material such as uranium and plutonium are mainly used in nuclear power plants to generate electricity. The advantages of nuclear power plants over conventional ones are - cheap, clean and compact. The problem lies in the disposal of the waste nuclear fuel.

- Climate Change: Climate change is a global problem and has occupied the attention of international policy planners since early 1990s. Human industrial activity, mainly the combustion of fossil fuels, has resulted in large scale production of certain gases such as carbon monoxide and carbon dioxide and oxides of nitrogen that have heat trapping properties. This form a shield in the upper atmosphere. Earth receives heat from the Sun, absorbs part of it and reflects a part back to space. These gases effectively reduce the amount that would normally be reflected back. This is called the Greenhouse Effect. As a result, there is an increase in the average global temperature. It is estimated that the global temperature has raised about 1.5 degrees celsius in the last two hundred years.
- Depletion of the Ozone layer: A layer of a mixture of oxygen O2 and Ozone O3, known as the ozone layer in the upper atmosphere is responsible for reflecting back most of the ultraviolet rays arriving from the Sun. Without this layer life-form on earth would be exposed to high levels of ultraviolet rays that cause Cancer. Certain chemicals produced in manufacturing such as chlorofluorocarbons (CFCs) used in aerosol propellants and emissions from high flying jet aircraft break down the Ozone.
- Acid Rain: Combustion of fossil fuels like coal and the exhaust of automobiles are major contributors to the generation of an air pollutant called sulphurdioxid. This gaseous compound reacts with water vapor to form diluted sulphuric acid. This acid then falls to earth in droplets known as acid rain. Where soils and water lack pH buffers that neutralize

acids, the increase in the acidity can cause great harm to vegetation and fish.

- Desertification: This is a direct consequence of deforestation continuous degradation of forests will result in the spread of deserts. The barren land will produce less trees and vegetation. This will further erode the top soil. Wind and tide will remain unchecked. Deserts will spread further. The problem will become self-aggravating.
- Decline of Biodiversity: Biodiversity refers to the variety of plant and animal life on the planet. Species of animals, plants and other creatures are dependent on each other in myriad ways. Not only do they depend on each other for food up and down the food chain but different species perform for each other a series of life sustaining takes that preserve a balance in nature. Besides, the number of species in existence presents a veritable gene bank that guides and governs evolution in ways that are yet to be fully understood. Biodiversity loss occurs when an entire species is wiped out of existence, thereby breaking some delicate link in a chain that may be vital to others.
- There is a general agreement that the state of environmental degradation as it is today must not be allowed to continue and something should be done about it. At the same time, there are considerable debates about the appropriate management strategy that should be adopted to address the problem. The so called abatement theorists insist that the continuous development of pollution reducing and abating technology will be adequate to bring degradation levels to acceptable standards while the subscribers of sustainable development feels that the problem must be addressed through planned reduction of output and consumption levels.



CHECK YOUR PROGRESS

Q6: What is environmental degradation? (Answer in around 20 words)

.....

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Q 7: What are the main sources of Environmental degradation? (Answer in around 70 words)

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.....



1.7 LET US SUM UP

- Environmental Economics looks at how economic activity and policy affect the environment in which we live.
- 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.
- The nature of environmental economics is regarded as both positive and normative science and it also covers both micro and macro aspects of environmental problems.
- Environmental Economics has wide scope. It tries to answer the causes of environmental problems, how to assess the environmental degradation and what are the possible economic policies to reduce environmental degradation.
- Environmental economics is concerned with efficient allocation of environmental resources. The environment provides both a direct value as well as raw material intended for economic activity, thus making the environment and the economy interdependent.
- The environment is a scarce resource with many conflicting demands placed on it.
- The main sources of environmental problem are air pollution, water pollution, deforestation, noise pollution, disposal of reactive waste and the dangers of radiation, climate change, depletion of ozone layer, acid rain, desertification and decline of biodiversity.



1.8 FURTHER READING

(1) Bhattacharya, R. N. (2013). *Environmental Economics.* New Delhi: Oxford University Press.

(2) Hanely, N, Shogren, J. and White, B. (2013). *Environmental Economics.* New Delhi: Oxford University Press.

(3) Kolstad, C. D. (2010). *Environmental Economics.* New Delhi: Oxford University Press.

(4) Perman, R., Ma, Y., Common, M., Maddison, D. & McGilvray, J. (2003). *Natural Resource and Environmental Economics.* US: Pearson Addison Wesley.

(5) Shankar, U. (2001). *Environmental Economics.* New Delhi: Oxford University Press.

1.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: 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 economics and other social goals.

Ans to Q No 2: Environmental economics is based on scientific theories, e.g., laws of thermodynamics. When we study the cause and effect relationship, it encompasses the positive aspect. On the other hand, it is also based on the principles of welfare economics to incorporate environment into economic analysis as an economic variable. Thus, when it relates to policy measures, it is considered as normative aspect

Ans to Q No 3: Environmental economics has a wide scope. It tries to answer the causes of environmental problems, how to assess environmental degradation and what are the possible economic policies to reduce environmental degradation.

The study of causes of environmental problems leads to an analysis of market failure and government failure. Moreover, assessment of environmental degradation requires estimating economic values on environmental degradation. Further, designing of economic policies use economic tools to critically evaluate environmental policies and whether they are likely to achieve the aims of reducing or halting environmental degradation.

Ans to Q No 4: Environmental economics is concerned with efficient allocation of environmental resources. The environment provides both a direct value as well as raw material intended for economic activity, thus making the environment and economy interdependent. For this reason, the way in which the economy is managed has an impact on the environment, which in turn affects both welfare and the performance of the economy.

Ans to Q No 5: Main components of environment are:

E_1 = Energy and materials

E_2 = Waste sink

E_3 = Amenity

E_4 = Global life support system.

Ans to Q No 6: Environmental degradation is defined as any change or disturbance to the environment perceived to be deleterious or undesirable.

Ans to Q No 7: Main sources of environmental pollution are: air pollution, water pollution, noise pollution, deforestation, desertification, decline of biodiversity andclimate change.



1.10 MODEL QUESTIONS

Short Questions (Answer each question in around 75 words)

Q 1: What is environmental economics?

Q 2: Explain the nature and scope of environmental Economics.

Q 3: What is environmental degradation? What are the main sources of environmental degradation?

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

Q 1: How is the environment and the economy interlinked? Explain

Q 2: "The environment is a scarce resource with many conflicting demands" Explain.

*** ***** ***

UNIT 2: EXTERNALITY AND MARKET FAILURE

UNIT STRUCTURE

1.1 Learning Objectives

2.2 Introduction

2.3 Market Successes and Market Failures

- 2.3.1 The Meaning of 'Market Success'
- 2.3.2 The Meaning of 'Market Failure'
- 2.3.3 Cases of Market Failure

2.4. Positive and Negative Externalities in Production and Consumption

- 2.4.1 Negative Externality in Production
- 2.4.2 Positive Externality in Production
- 2.4.3 Negative Externality in Consumption
- 2.4.4 Positive Externality in Consumption

2.5 Measures to Correct Externalities

- 2.5.1 Use of Prices to Correct Externalities
- 2.5.2 The Coase Theorem

2.6 Public Goods

- 2.6.1 The Optimal Level of Public Goods
- 2.6.2 The Free Rider Problem
- 2.6.3 The Tragedy of the Commons

2.7 Let Us Sum Up

2.8 Further Reading

2.9 Answers to Check Your Progress

2.10 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- know the meaning of market success and why do markets fail
- discuss the various cases of market failure
- discuss the concept of externalities and its different types
- explain how externalities lead to market failure

- describe the various ways to correct externalities
- discuss what is public goods and how the presence of public goods lead to market failure
- explain the free rider and tragedy of common problems in relation to public goods.

2.2 INTRODUCTION

In the first Unit, we have studied what environmental economics is all about and its nature and scope. Here in this chapter, we will study about the market situation of the environmental goods. From the perspective of neoclassical economics, the market system is considered to be the preferred institution for allocating scarce resources. Under certain assumed conditions the market system guided by the free expression of individual consumer and producer choices would lead to the maximization of the well-being of the society as a whole - the so-called invisible hand theorem. The market system accomplishes this wonderful feat using prices as a means of gauging resource scarcity. But for environmental goods complete markets do not exist at all. "Why are environmental goods and services not able to have a proper market? Why do markets fail for environmental goods?" The chapter deals with these questions.

This unit discusses in details about markets, how market operates and why do markets fail for environmental resources. It also citesvarious cases of market failure. The chapter focuses mainly on two cases of market failure broadly, i.e.,externalities and public goods.



LET US KNOW

The invisible hand is a term used by Adam Smith to describe the unintended social benefits of individual self-interested actions. The phrase was employed by Smith with respect to income distribution (1759) and production (1776). The Invisible Hand theorem holds true when market

has to satisfy the following conditions in order to be regarded as an efficient institutional mechanism for allocating resources: freedom of choice based on self-interest, perfect information, competition, mobility of resources, ownership rights.

2.3 MARKET SUCCESSES AND MARKET FAILURES

Ordinarily, the term "market" refers to a particular place where goods are purchased and sold.In economics, the term "market" does not mean a particular place but refers in an abstract way to purchase and sale transactions of a product and the formation of its price.

2.3.1 The Meaning of 'Market Successes'

Market for a commodity or service exists or functions when the demand (from buyers) and supply (from sellers) of that commodity or service exists. In economics,markets are commonly regarded as institutions that mediate between informed and consenting economic agents, i.e. buyers and sellers, who buy and sell at mutually agreed quantities and prices so as to bring about coordinated economic decisions in the most efficient manner in the society. Markets can successfully allocate resources at equilibrium point. Equilibrium is when the demand equals the supply, and buyers and sellers enjoy maximum combined utility and profit. The power of perfectly functioning market rests in its decentralized process of decision making and exchange where efficient allocation of recourses takes place in the society. Efficiency is defined as Pareto optimality when it is impossible to reallocate resources to make one person better off without making anyone else worse off.

Pareto efficiency or Pareto optimality is a state of allocation of resources from which it is impossible to reallocate so as to make any one individual or preference criterion better off without making at least one individual or preference criterion worse off. The concept is named after Vilfredo Pareto (1848-1923), Italian engineer and

economist, who used the concept in his studies of economic efficiency and income distribution.

2.3.2 The Meaning of 'Market Failure'

Market failure is a lack of equilibrium, during which consumers experience suboptimal utility and/or suppliers experience suboptimal profits.Market failure occurs when a market is unable to manage its resources efficiently due to the breakdown of price mechanism. For environmental assets, markets can fail if prices do not communicate society's desires and constraints accurately. Prices often understate the full range of services provided by an asset, or simply do not exist to send a signal to the market about the value of the asset. Market failure occurs when private decisions based on these prices or lack of them, does not generate an efficient allocation of resources. Inefficiency implies that resources could be reallocated to make atleast one person better off without making any one else worse off. A wedge is driven between what individuals want privately and what society wants as a collective.

To elaborate the concept let us discuss the theorem of welfare economics.The theorems of welfare economics says about the major benefits of markets on social welfare. The first theorem says that 1) a complete set of markets with well-defined property rights exist such that buyers and sellers can exchange assets freely for all potential transactions and contingencies; this theorem has the base for market failure. Other theorems are :2) consumers and producers behave competitively by maximizing benefits and minimizing costs; 3) market prices are known by all consumers and firms and 4) transaction costs are zero so that charging prices does not consume resources; then the allocation of resources will be a Pareto optimum. A market is said to be 'market success' when the conclusions of this theorem holds and allocation of resources is efficient.

To have 'market success' markets must be complete (first

theorem of welfare economics); meaning enough markets exist to cover each and every possible transaction so that resources can move to their highest valued use. Markets will be complete when traders can create a well-defined property rights system in a costless manner such that a market exists to cover any exchange necessary. The well-defined property rights system represents a set of entitlement that defined the owner's privileges and obligations for use of a resource or asset. The system has the following characteristics:

- Comprehensively assigned: All the assets or resources must be either privately or collectively owned and all entitlements must be known and enforced effectively.
- Exclusiveness: All costs and benefits from the use of a resource should accrue to the owner either directly or by sale to others.
- Transferability: 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 she expects to make use of it.
- Security: Property rights to natural resources should be secure from involuntary seizure or encroachment by other individuals, firms or the government. The owner has incentive to conserve and improve resources rather to exploit the resource.

Most market failures with environmental assets can be linked to incomplete markets. Markets are incomplete because of the failure or inability of institutions to establish well defined property rights.

2.3.3 Cases of Market Failure

For environmental goods and services, some cases of market failures occur. These are: (a) incomplete markets, (b) externalities, (c) public goods, (d) non-convexities, and (e) asymmetric information.

In this unit, we will discuss only about Externalities and Public goods.

2.4 POSITIVE AND NEGATIVE EXTERNALITIES IN PRODUCTION AND CONSUMPTION

The conditions for efficiency in consumption and production and overall economic efficiency were derived from the assumption that production costs are borne only by the producers of the product and the utility derived from the consumption is enjoyed only by the purchasers. This is always not true. Some products have external effects or externalities (also known as spillover effects or neighbourhood effects). Externalities are defined as the positive or negative consequences of economic activities on unrelated third parties. If the consumption and production activities of one individual or firm affect another person's utility and firm's production function so that the conditions of a Pareto optimal resource allocation are violated then it can be said that externality exists. Since the causers are not directly affected by those externalities, they will not take them into account. As a result, the social cost (or benefit) of these activities is different from their individual cost (or benefit), which results in a market failure. Most often it is because markets tend to be difficult and expensive to organize and enforce. This is more so when rights to property are difficult to define and costly to enforce and maintain, when a large number of parties are not significantly affected by the externalities individually, however large the aggregate damage or benefit might be.

Externality is of two types; negative and positive. Externalities can arise on the production oron the consumption side.

- Negative externality: Negative externalities are defined as economic activities that have negative effects on unrelated third parties.

  Example: Air pollution from coal-fired power plants
- Positive externality: Economic activities that have positive effects on unrelated third parties are considered positive externalities.

  Example: A beekeeper's bees not only produce honey but can help neighboring farmers by pollinating crops.

The famous book by the British economist A.C. Pigou, titled *Wealth and Welfare* (1912) was the first to deal with externalities in a systematic

way. Pigou argued that in the presence of externalities, even if we have perfect competition we do not achieve a Pareto optimum. The social benefit or cost is a combination of private and external benefits or costs.

Let us use the following notations:

MPC = marginal private cost

MEC = marginal external cost

MSC = marginal social cost and, by definition,

MSC = MPC + MEC

Also,

MPB = marginal private benefit

MEB = marginal external benefit

MSB = marginal social benefit and, by definition,

MSB = MPB + MEB

Now, overall economic efficiency requires MSC = MSB for each product. For, as long as MSB > MSC, production should be expanded, because additional benefit exceeds additional cost; on the other hand, if MSB < MSC, then production should be decreased in order to avoid the marginal inefficiencies.

Consequently, we should have, for each pair of products, equality between the **marginal social rate of product transformation (MSRPT)** and the **marginal social rate of substitution (MSRS)** between the goods. In the presence of externalities, if only the marginal private costs are considered, the economy will not reach economic efficiency.

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The marginal rate of transformation is tied to the production possibilities frontier (PPF), which displays the output potential for two goods using the same resources. To produce more of one good means producing less of the other because the resources are efficiently allocated. The marginal rate of transformation (MRT) can be defined as how many units

of good x have to stop being produced in order to produce an extra unit of good y, while keeping constant the use of production factors and the technology being used.

Marginal rate of substitution (MRS) is the rate at which a consumer can give up some amount of one good in exchange for another good while maintaining the same level of utility.

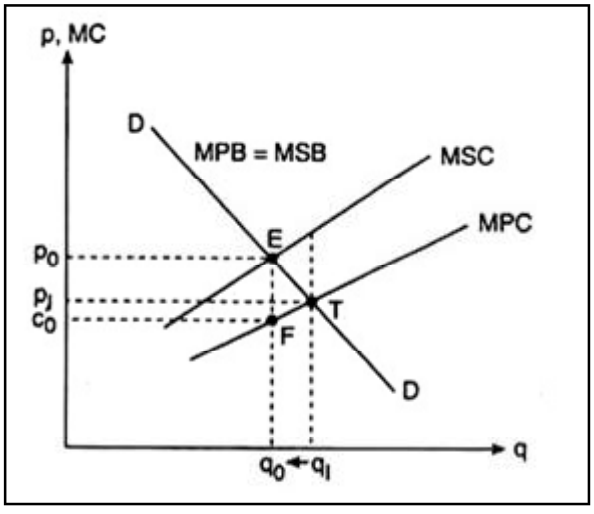
That is, for economic efficiency, consumers and producers must weigh the full social benefits and costs of consumption and production. One way to achieve this is to impose taxes and subsidies which bring private benefits or costs into line with social benefits or costs. We will now illustrate how these taxes and subsidies would work.

2.4.1 Negative Externality in Production

The case of a negative externality in production has been illustrated with the help of Fig. 2.1. Here we are assuming that there are no externalities in consumption. That is why the demand curve DD shows the marginal private and social benefits (MPB = MSB).

On the other hand, owing to the presence of externalities in production, the marginal social cost (MSC) curve is different from the marginal private cost (MPC) curve, the latter representing the competitive supply curve.

Figure 2.1: Negative Externality in Production



In the case of a negative externality, MSC would be greater than MPC, i.e., the MSC curve would lie above the MPC curve as has been shown in Figure 2.1. The optimal output here is q_0 with the price p_0. But the competitive market, if left alone, will produce q_1 at the price p_1. Thus, there would be a tendency to overproduce in the absence of any market intervention. At the optimal quantity q_0, the price would be p_0, but the MPC would be c_0. Thus, the government could levy a per unit tax of $(p_0 - c_0)$ on the firm, and thereby increase the MPC by $(p_0 - c_0)$, i.e., to the level of MSC. Consequently, the output of the firm would diminish to q_0 (from q_1). The consumers would pay the price p_0 = MSC.

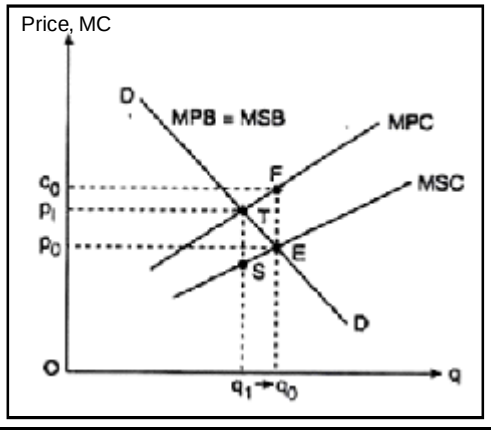
Now, the revenue from the tax could be used to pay for the external damage caused by the production of the commodity. Let us note, however, that the tax revenue could be more or less than the external damage.

The revenue would be equal to $(p_0 - c_0) \times q_0 = p_0EFc_0$ whereas the total external cost would be equal to the area between MSC and MPC curves up to $q = q_0$. Finally, the net gain to society from the tax is given by EFT which is the excess of MSC over MPC over the range of output from q_0 to q_1.

2.4.2 Positive Externality in Production

This case has been illustrated in Figure 2.2. In this case, since there

Figure 2.2: Positive Externality in Production and Effects of Government Intervention



are external benefits, the MSC would be less than MPC and the MSC curve would lie below the MPC curve. In the absence of any externality in consumption, the demand curve for the goods gives us the marginal social and private benefits (MSB = MPB).Therefore, the optimal output would be given by the point of intersection E between the demand curve DD and the MSC curve.

This optimal output is q_0 at the price p_0. At this output, we have MSB = MSC. However, if there is no market intervention, the competitive market will produce $q = q_1$ at the point of intersection T between the demand curve DD and the competitive supply curve MPC.

In this case of external benefits in production, the free market will produce less than the optimal output ($q_1 < q_0$). At the optimal level of output, the producers will receive a price $p = p_0$, but their marginal cost is MPC = c_0.

Since c_0 is greater than p_0, the producers would have to be paid a subsidy of ($c_0 - p_0$) if they are to increase the output level from q_1 to the optimal level q_0. In the earlier case of external cost a per-unit tax equal to the marginal external cost needed to be imposed to arrive at the optimal output level.

On the other hand, in the present case of external benefit, a per-unit subsidy equal to the marginal external benefit has to be given to the producers.

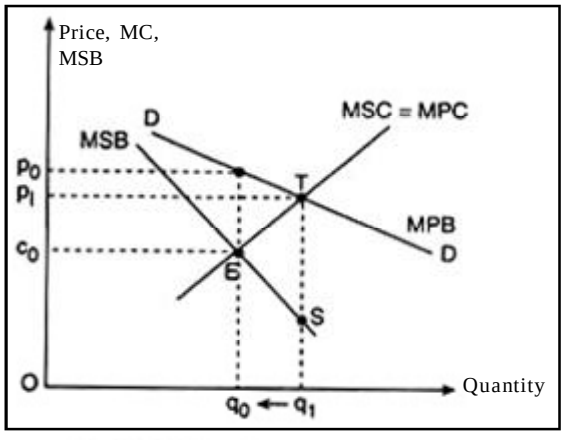
Now, the government may collect the money to be paid as subsidy from the people enjoying the external benefit. But here again, the expenditure on the subsidy [$- (c_0 - p_0) \times q_0 = P_0EFC_0$] may not be equal to total external benefit [= the area between the MPC and MSC curves up to $q = q_0$].

inally, the net benefit to society from the subsidy would be equal to STE which is the excess of social benefit over social cost over the range of output from q_1 to q_0.

2.4.3 Negative Externality in Consumption

This case has been illustrated in Figure 2.3. Since there are no externalities in production, MSC and MPC curves are identical .and either of them represents the competitive supply curve. However, on the demand side, the demand curve DD reflects only the marginal private benefit (MPB). In the presence of negative externality in consumption, the marginal social benefit (MSB) is less than the MPB. That is why the MSB curve lies below the MPB or the DD curve. The socially optimal quantity again is q_0 at the MSC = MSB point, E, and the price is p_0.

Figure 2.3: Negative externality in consumption and effects of government intervention



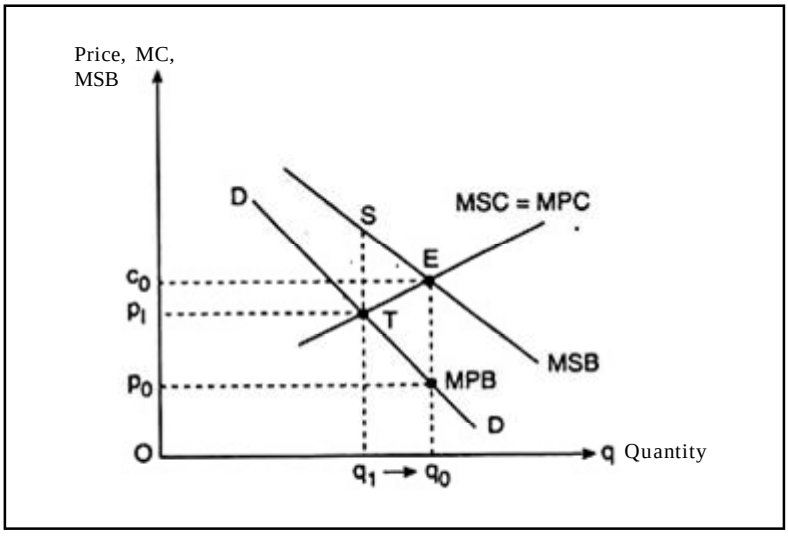
However, in the absence of any intervention, the quantity supplied and demanded is q1 at the point of intersection T of the DD (or MPB) curve and the MPC = MSC curve, and the price here is p_1. Thus, there is an overproduction of the commodity ($q_1 > q_0$) as compared to the socially optimal level.If the output is to be restricted to the optimal level, q0, the price has to be raised to p_0. But the supply price at $q = q_0$ is c_0. Hence, a tax equal to ($p_0 - c_0$) per unit needs to be levied. Then the consumer would pay the price p_0 including the tax which is equal to MPB, i.e., c_0, plus the cost of externality in consumption which is ($p_0 - c_0$).

Here the revenue generated from the tax may be used to compensate those who are harmed by the negative externality of the consumption of the product. Also, the area EST represents the net benefit of the tax to society. This area is equal to the excess of MSC over MSB over the range of output from q_1 to q_0.

2.4.4 Positive Externality in Consumption

This case is illustrated by means of Figure 2.4. In the absence of externality in production, the MSC and MPC curves are identical and either of them represents the competitive supply curve. But on the demand side, the demand curve DD represents only MPB. In the case of positive externality in consumption, we have MSB > MPB, i.e., the MSB curve would lie above the DD curve or the MPB curve.

Figure 2.4: Positive externality in consumption and effects of government intervention



Given all this, the socially optimal level of output in Figure 2.4 is obtained to be q_0 at the MSB = MSC point E, the price of the output being p_0. Without any intervention, the quantity produced would be q, at the MPB = MPC (= MSC here) point T.

Since q1 < q0, there would be underproduction of output (as compared to the socially optimal level) in this case of positive externality in consumption. At $q = q_0$, the market price would be p_0 but the marginal cost (both private and social) would be c_0. Since the marginal cost (c_0) is greater than the price (p_0), the producers have to be given a per unit subsidy of ($c_0 - p_0$) if the output is to be maintained at the optimal level, q_0.

Then the producers will get c_0 per unit of output and the consumers would pay p_0. At least part of the subsidy ($c_0 - p_0$) x q_0 could possibly be collected from those who reaped the external benefits arising from the consumption of the good. Again, the net benefit to the society from the subsidy is measured by the area EST which is the excess of social benefit over the social cost over the range of output from q_1 to q_0.

2.5 MEASURES TO CORRECT EXTERNALITIES

Individuals who consider only their own private costs and private benefits will do too much of any activity that generates negative externalities, and too little of one that generates positive externalities. When an activity generates both positive and negative externalities, private and social welfare will coincide only in the unlikely event that these opposing effects happen to offset one this exactly. When externalities are present the individual pursuit of self-interest rarely results in maximum social welfare. When it does not, we have an outcome that is, by definition, inefficient. This, in turn, means that it is possible to rearrange things in a way that makes at least some people better off without harming others in the process. There is an economic rationale for some form of government intervention in markets where externalities are prevalent.

How can we take into account the third party effects that necessarily arise? The key is to internalise the externalities that exist - i.e. make the firms and consumer that create the externalities and take them into account when making their decisions.

2.5.1 Use of Prices to Correct Externalities

Consider changing the price of goods produced in the presence of externalities so that the social and private benefits and costs align.

- For a negative externality, levy a tax on production or consumption.
- For a positive externality, subsidize production or consumption.

These cases we already discussed in section 2.4.1 to 2.4.4

In the presence of negative externalities, economists often advocate for the use of a Pigouvian tax. It is a tax on an activity that causes a negative externality. This kind of tax serves to equate the external marginal cost imposed by an externality and designed to correct market failures and therefore improve societal welfare (rather than distorting markets like other taxes). Example: power plant. Similarly, in the presence of positive externalities, economists often advocate for the use of a Pigouvian subsidy. This is asubsidy for an activity that produces a positive externality and serves to equate the external marginal benefit imposed by an externality. Example: education.

2.5.2 The Coase Theorem

An alternative to pollution taxes and government regulation is for the polluters and those affected to come to a bargaining solution where the latter are compensated. Ronald Coase, from the University of Chicago, was the first to see that if property rights are fully assigned and if people can negotiate at low cost with one another they will arrive at efficient solutions to problems caused by externalities without the need for explicit government intervention in the form of regulation and/or taxation. This insight is called the Coase Theorem, and on the strength of it Coase was awarded the Nobel Prize in Economics in 1991. We shall discuss this theory in the next unit.



CHECK YOUR PROGRESS

Q 1: Pollution is an example of market failure because (Choose the correct option)

a) the equilibrium price is higher than the efficient price

b) the equilibrium price is less than the efficient price

c) property rights are poorly distributed

d) the market does not produce enough of the good

Q 2: Costs and benefits that affect unsuspecting third parties are called_____and_____externalities, respectively. (Fill in the blanks)

Q 3: What is market failure? (Write within 50 words)

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Q 4: Write a note on positive and negative externalities. (Write within 50 words)

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2.6 PUBLIC GOODS

Public goods provide a very important example ofmarket failure. Pure public goods have two defining features. One is 'non?rivalry,' meaning that one person's enjoyment of a good does not diminish the ability of other people to enjoy the same good. The other is 'non?excludability,' meaning

that people cannot be prevented from enjoying the good. Air quality is an important environmental example of a public good. Under most circumstances, one person's breathing of fresh air does not reduce air quality for others to enjoy, and people cannot be prevented from breathing the air. Public goods are defined in contrast to private goods, which are, by definition, both rival and excludable. A cup of tea or a glass of milk is a private good because one person's consumption clearly diminishes its value for someone else, and tea or milk are typically excludable to all individuals not willing to pay.

Using the definitions of excludability and rivalry, we can construct a table characterizing four types of goods. Table 2.1 is depicting the four types of goods based on excludability and rivalry.

Table 2.1: Four Types of Goods Based on Excludability and Rivalry

	Excludable *(Individual can be kept out from consuming)*	***Non excludable*** (Individual cannot be kept out from consuming)
Rival *(One individual's Consumption affects another's consumption).*	***Private good:*** *,Fish, cooking gas*	**Common resource:** Shared property, fisheries
Non rival (One individual's consumption has no effect on another's consumption).	**Club good:** satellite TV Service, private parks, movies	**Public good:**air quality, water quality, biodiversity

Many commons (environmental goods) are characterized as public goods, including water bodies, open space, biodiversity and a stable climate. These examples stand alongside the classic public goods of lighthouses, national defense etc.



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Private Good: A private good is rival and excludable. An example of a private good is BMW car own by a person. BMW has manufactured a

fixed number of 5 series sedans; there are not enough built for everyone to own one. That person's BMW is also excludable; he does not have to allow anyone else to drive or ride in his car.

Quasi-public or Mixed Good: Some goods have elements of both public and private goods.

Common Pool Resource: A perfect example of this type of good is a local fishing pond. The fishing pond has the non-excludable element of public goods (we cannot exclude certain people from fishing in the public place), but also has the rival element of a private good (There is a limited amount of fish in the pond). This type of good is called a common pool resource. Here, because each individual only catches a small fraction of the total number of fish, we see people over fishing the pond. This over fishing may lead to the depletion of the fishing utility offered by the pond.

Club Goods: On the other hand, club goods are non-rival, but are excludable. An example of a club good is cable TV. Your use of cable TV does not limit my ability to also view television shows on cable; as long are you live in an area where the necessary cable is present, you can get cable TV. However, it is excludable in that you have to pay the monthly fee. This is an example of an industry with a relatively flat marginal cost schedule; adding an additional user faces a small marginal cost.

2.6.1 The Optimal Level of Public Goods

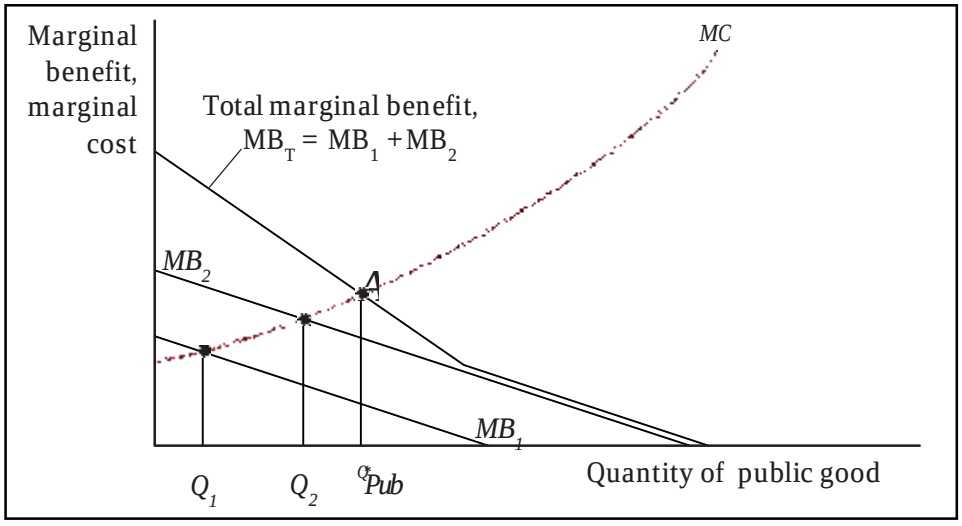
Market efficiency requires that a good be produced until the marginal benefits of production are equal to the marginal costs. Since public goods are non-rival, the marginal benefit of a given level of provision is the vertical sum of all individuals' marginal benefit curves.

Total marginal benefit is defined as

$MB_T = MB_i$, where i indicates each individual.

The cost side is the same as with any other good.

Figure 2.5 Efficiency in the Market for a PublicGood



The two consumers of the public goods have marginal benefit curve, MB1 and MB2 respectively. At the efficient point, both consumers consume Q*pub of the public good where their total marginal benefit curve MBT intersects the marginal cost curve.

There are two reasons markets will underprovide public goods. First one is non rivalry. This is illustrated by the figure 2.5 above. If individuals purchase the goods themselves, they will do so only until private marginal benefit equals marginal cost. The efficient level occurs when the total marginal benefits equal marginal cost.

A second problem results from the non-excludability of public goods.This is called the free-rider problem

2.6.2 The Free Rider problem

It is explained as a source of inefficiency resulting from individuals consuming a public good or service without paying for it. To see free riding at work, consider the challenge of constructing a bridge where the societal benefits of doing so would exceed the costs. How successful do you think a campaign would be to finance the bridge with voluntary donations? It is not hard to imagine how such a campaign would fail, because many (if not most) individuals would choose to make no donation, hoping others would contribute enough

to finance the bridge for everyone to enjoy. In this scenario, the market failure would be that no bridge is constructed despite the fact that a bridge would make everyone better off.

Seeking to prevent such under?provision of public goods is one of the primary economic rationales for government. While markets allocate private goods efficiently, governmental intervention is usually required for the efficient (or even reasonable) allocation of public goods. Indeed, this explains why goods such as bridges, parks, police protection and fire departments are usually financed with tax revenues that governments collect. Governments can thus serve as a coordinating mechanism that provides public goods for the benefit of society. The same public?goods rationale applies to environment. An example of this might be a country that does not want to cut down on their use of nuclear power or to combat the ozone depletion. Instead they will rely on other countries' action to combat the issues and will benefit from the results, though they are involved in the issue. The problem with this is that the countries that would be willing to step up to combat the ozone depletion then see the free-riders and realize the fact that free riders are enjoying healthy environment with the cost of resources and money of that country. This leads to no one doing anything and the environment simply get polluted more.

Because individuals and firms face free?riding incentives when it comes to protect the environment, policies are often put in place to limit pollution, restrict resource exploitation or create the right incentives to promote or protect environmental quality. Environmental policies that promote economic efficiency are those for which the societal benefits exceed the costs. Social cost?benefit analysis is the tool that economists use to make such determinations. Yet, with most environmental publicgoods, special techniques are often required to estimate the economic benefits or costsbecause environmental quality is rarely traded in markets and therefore does

not havedirectly observable prices. For example, there are certainly benefits of improving airquality, but how are such benefits to be quantified?

The answer is various techniques of so?called nonmarket valuation. These range from simply asking people their willingness to pay (or willingness to accept) for changes in environmental quality to various ways of using other markets to infer implicit values for the environment. There are stated?preference techniques that are based on survey methods and include contingent valuation and conjoint analysis. There are also revealed?preference techniques that use actual market behavior and include the hedonic?price method, the travel?cost method, and averting expenditures.

2.6.3 The Tragedy of the Commons

Another problem which arises in case of public goods is known as 'the tragedy of the commons'. The term 'the tragedy of the commons' was first introduced by Garrett Hardin (1968) in an important article in Science. 'The tragedy of the commons' arises when it is difficult and costly to exclude potential users from common-pool resources that yield finite flows of benefits, as a result of which those resources will be exhausted by rational, utility-maximizing individuals rather than conserved for the benefit of all. Because everyone has free access to a common resource, the resource is used more intensively than if it were privately owned, which leads to a decline of the value of the resource for everyone. This is another pervasive form of a negative externality. A common resourceis a good that all individuals can use freely and whose value to the individual consumer decreases as others use it. Example:Many lake, river, coastal, and ocean fisheries; public forests; reservoirs, aquifersand other sources of water; the atmosphere etc. Key characteristic is nonexcludability: consumers cannot be prevented from consuming the good once it is available.

Fishing grounds are the best known example of a potential

open access resource. Given that more fish caught by one party implies less fish for all others, all fishermen or women have an incentive to increase their fishing effort beyond the point where the market price for the fish equals the marginal cost of harvesting. Effort is expended to the level where market price equals the average cost of production. The scarcity value of the resource is ignored. The potential result is over fishing and a depletion of the stock to a level that cannot sustained itself. This has been explained with the help of Figure 2.6.

Figure 2.6: Open Access and the Prisoners' Dilemma

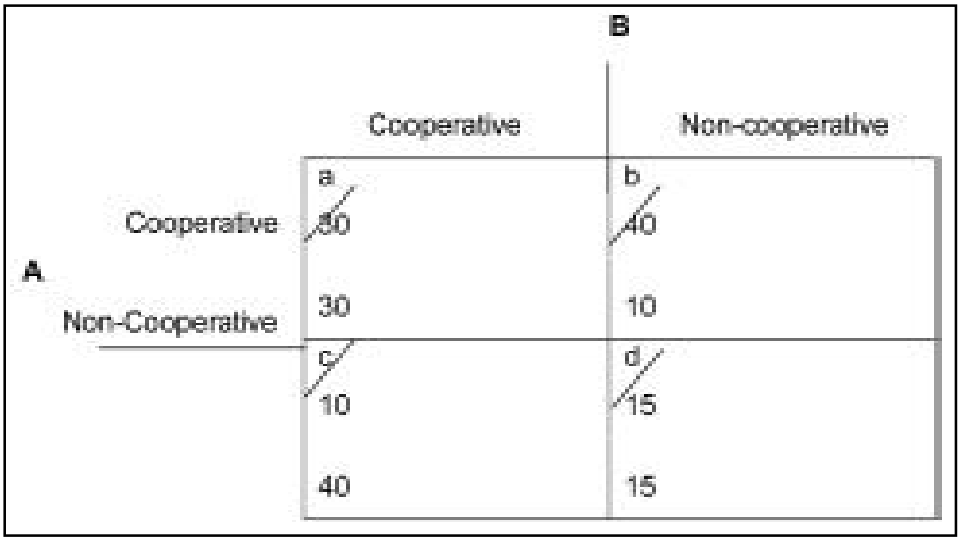


Figure 2.6 illustrates the incentive to over harvest and open access fishery. Suppose A and B both fish on big lake. A and B have a choice: they can either cooperate with each other by limiting their fishing fleet to one ship per day, or they can act noncooperatively by sending out three ships every day. If they cooperate and send out only one ship they can each earn net profits of 30 (box a in figure 2.6). But if A sends out three ships while B only sends out one, A can increase his net profits to 40 by capturing a disproportionate share of the rents. B would only earn net profits of 10 (box b). Sincenet profits of 40 exceed 30, A has an incentive to cheat and send out three ships. B has the same incentive if A cooperates and B does not, B can earn net profits of 40 while A only earns 10 (box c). If both

fall for this incentive to act noncooperatively by sending out three ships, they over fish big lake and their net profits fall to 15 each (box d). The end result is that both fishermen only earn total net profits of 30 (15+15), while the social optimum is total net profits of 60(30+30) when both cooperate.

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 players actions. In our example,the non-corporative strategy dominates the corporative one since 40>30 and 15>10. This outcome is called Nash equilibrium. Nash equilibrium exists if neither player will unilaterally change his strategy since a unilateral action would leave a player worse off without a reciprocal move by the other player.



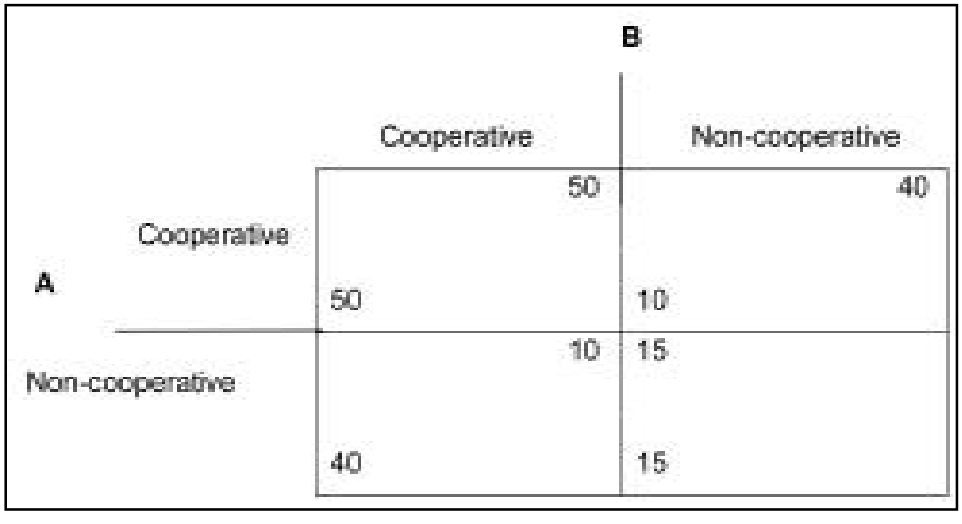
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Nash Equilibrium: In game theory, the Nash equilibrium, named after American mathematician John Forbes Nash Jr., is a solution concept of a non-cooperative game involving two or more players in which each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing only his own strategy.[1] If each player has chosen a strategy and no player can benefit by changing strategies while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitutes Nash equilibrium. The Nash equilibrium is one of the foundational concepts in game theory.

Our example of both players falling into the non-cooperative solution is the classic 'prisoners' dilemma' game: each prisoner has an incentive to betray his fellow partner in crime to secure a milder punishment for himself even though all are better off if they just keep their mouth shut (also see Ostrom 1990). Not all non-excludable

resources are defined by the prisoners' dilemma game where the players are doomed to exist in a downward spiral of misallocated resources. Commons can also be represented by the game presented in Figure 2.7- a coordination game. In this coordination game, there are two Nash equilibria, one where both players act non cooperatively as before and the other where both cooperate. Each outcome is a Nash equilibrium since neither has a unilateral incentive to deviate from the strategy. Cooperation is a Nash equilibrium since a player receive 50 if both cooperate and only 40 if B unilaterally cheats. Non corporation is still a Nash equilibrium because a player receives 15 if he cheats and only 10 if he cooperates while the other player does not. Obviously both players would prefer the corporative Nash equilibrium since the pay offs are the greatest, 50 each: society also prefers the corporative out come since the joint profits are the greatest: 50+50= 100.

Figure 2.7: Coordination Game



Though there is no guarantee that the players will coordinate their strategies in such a way that they achieve the preferred corporative solution,Ostrom(1990) documents several examples of actual common property resources where a group of players achieve a cooperative outcome. These groups established self-governing common property regimes without strict private property rules or government intervention. Successful self coordination of strategies

in actual common property regimes appears to depend, among other things, on the information and transaction costs of achieving a credible commitment to the collective, active rules to self-monitor and sanction violators, and the presents of boundary rules that define who can appropriate resources from the commons. Market failure need not always occur with commons but usually some boundary rules to exclude others is required.



CHECK YOUR PROGRESS

Q 5: Fill in the blanks

(a) Two characteristics of the public goods are ……. and …….

(b) Private goods are …… and ……..

Q 6: Why do economists use the word external cost to describe third-party effects that are harmful? (Write within 50 words)

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Q 7: What is Nash equilibrium in prisoner's dilemma? (Write within 50 words).

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2.7 LET US SUM UP

- Market failure is a situation where optimal allocation of resources cannot be done.

- Market failure occurs due to various cases. In this chapter, only externality and public goods are discussed.
- Externalities occur when costs and/or benefits are not completely captured by those making production and consumption decisions.
- In the cases of externalities discussed above we have obtained the following results:
- In the presence of externalities, the socially optimal level of output q0 is given by the condition MSB = MSC.
- The private production of output q1 is given by the condition MPB = MPC.
- To obtain the optimal level of output q0, we can use some appropriate tax and/or subsidy programmes.
- Due to non-excludability and non-rivalry characteristics, market fails to allocate the public goods efficiently in the society.
- Nonexcludable common pool goods are subject to overuse and/or underinvestment.
- Public goods are underprovided by private agents because of free riding and tragedy of common problem due to non-rivalry and non-excludable characteristics.



2.8 FURTHER READING

(1) Bhattacharya, R. N. (2013). *Environmental Economics.* New Delhi: Oxford University Press.

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2.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: c) property rights are poorly distributed

Ans to Q No 2: negative externalities and positive externalities

Ans to Q No 3: Market failure occurs when the price mechanism fails to account for all of the costs and benefits necessary to provide and consume a good. This imbalance causes allocative inefficiency, which is the over- or under-consumption of the good. The market fails by not supplying the socially optimal amount of a good.

Ans to Q No 4: A positive externality is a benefit that is enjoyed by a third-party as a result of an economic transaction. A negative externality is a cost that is suffered by a third party as a result of an economic transaction. In a transaction, the producer and consumer are the first and second parties, and third parties include any individual, organisation, property owner, or resource that is indirectly affected.

Ans to Q No 5: (a) non-excludability and non-rivalry, (b) excludability and rivalry.

Ans to Q No 6: In the presence of externality, another kind of cost occurs, i.e., external cost. These are external because although they impose real costs, firms do not take them into account when they decide about output rates. These are cost that is external to firms but internal to society as a whole. Example: cost inflicted on people through environmental degradation.

Ans to Q No 7: The concept of Nash equilibrium is used in The Prisoner's Dilemma problem. The Prisoner's Dilemma is a common situation analyzed in Game Theory that can employ the Nash Equilibrium. The Nash equilibrium in this example is for both players to betray each other.Each player improves their own situation by switching from "cooperating" to "defecting", given knowledge that the other player's best decision is to "defect". The prisoner's dilemma thus has a single Nash equilibrium: both players choosing to defect.

2.10 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: What is market? What is Pareto optimality in reference to market?

Q 2: What is externality?

Q 3: State theCoase Theorem in brief.

Q 4: Explain the characteristics of public goods.

Essay Type Questions (Answer each question in about 300-500 words).

Q 1: Explain the various types of externality.

Q 2: Explain various steps to correct externalities.

Q 3: State the concept of free riding problem. How is this related to public goods and market failure?

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UNIT 3: PROPERTY RIGHTS AND COASE THEOREM

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Property Rightsas a Way to Correct Market Failure of Environmental Goods

3.4 Coase Theorem

3.5 Criticisms of the CoaseTheorem

3.6 The Tragedy of Commons

3.7 Let Us Sum Up

3.8 Further Reading

3.9 Answers to Check Your Progress

3.10 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- discuss the concept of property rights and how it corrects market failure of environmental goods
- critically discusstheCoase theorem
- elaborate on the concept of the tragedy of commons.

3.2 INTRODUCTION

In the previous chapter,we discussed about why market functions and why market fails, particularly in the context of environmental goods. In this Unit, we will discuss how market failure can be corrected. There are two generic way to correct the market failure of environmental goods- correcting imperfect property rights and introducing administered prices for pollution (or Pigovian fees).Correction of imperfect property rights will be discussed in this unit and administered prices of pollutions will be discussed later in Unit 5.

3.3 PROPERTY RIGHTSAS A WAY TO CORRECT MARKET FAILURE OF ENVIRONMENTAL GOODS

A key requirement to avoid a market failure is that markets are complete- enough markets exist to cover each and every possible transaction so that resources can move to their highest valued use. Markets will be complete when traders without having to incur any cost can create a well-defined property rights system such that a market will exist to cover any exchange necessary. This well defined property rights system represents a set of entitlements that define the owner's privileges and obligations for use of a resource or asset and have the following general characteristics:

- **Comprehensively Assigned:** All assets or resources must be eitherprivately 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, 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 might 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 govt. The owner has an incentive to improve and preserve a resource while it is in his or her control rather than exploit the assets.

But most market failures with environmental assets can be linked to incomplete markets. Markets are incomplete because of the failure or inability of institutions to establish well-defined property rights.



CHECK YOUR PROGRESS

Q 1: What is property rights? (Answer in around 20 words)

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Q 2: What are the Characteristics of Property rights? (Answer in around 40 words)

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3.4 COASE THEOREM

The inability to assign property rights such that a complete set of markets can be created has provided the rationale for governments to intervene as an advocate of proper management of environmental resources. But Coase (1960) pointed out that if the assumption of zero transaction costs is maintained, the set of markets can be expanded beyond normal private goods to include many non-market assets as long as institutional constraints to assigning well-defined property rights are removed.

The Coase theorem postulates that disputing parties will work out a private agreement that is Pareto efficient, regardless of the party to whom unilateral property rights to the non-market assets are assigned initially. As long as these legal entitlements can be freely exchanged, government intervention is relegated to designating and enforcing well defined property rights.

The Coase theorem is based on the following assumptions:-

- Everyone has perfect information.
- Consumers and producers are price-takers
- There is a costless court system for enforcing agreements.

- Producers maximize profits and consumers maximize utility
- There is no income or wealth effect.
- There are no transaction costs.

Coase illustrates his analysis by considering a rancher and a farmer with adjoining properties. There is a negative externality in that the cattle tend to wander over to the firm and eat the crops, rather than staying on the ranch. What happens next depends on property rights, which are the rights that come with ownership.

One of three things might be efficient from a social perspective. It might be efficient to erect a fence to keep the cows away from the crops. It might be efficient to close down the farm. Finally, it might be efficient to close down the ranch, if the farm is valuableenough and if the fence costs more than the value of the ranch.

If the farmer has a right not to have his crops eaten and can confiscate the cows if they wander onto the farm, than the rancher will have an incentive to erect a fence to keep the cows away, if that is the efficient solution. If the efficient solution is to close down the ranch, then the rancher will do that, since the farmer can confiscate the cows if they go over to the farm and it is not worth building the fence by hypothesis. Finally, if the efficient solution to the externality is to close down the farm, then the rancher will have an incentive to buy the farm in order to purchase the farm's rights so that he can keep the ranch in operation. Since it is efficient to close down the farm only if the farm’s worth is less than the ranch, there is enough value in operating the ranch to purchase the farm at its value and still have money left i.e., there are gains from trade from selling the farm to the rancher. In all these cases, if the former has the property rights than the efficient outcome is reached.

Now suppose instead the rancher has the rights and the farmer has no recourse if the cows eat his crops. If shutting down the farm is efficient, then the farmer has no recourse but to shut it down. Similarly,if building the fence is efficient, then the farmer will build the fence to protect his crops. Finally, if shutting down the ranch is efficient, the farmer will buy the ranch

from the rancher in order to be able to continue to operate a more valuable farm. In all cases, the efficient solution is reached through negotiations.

Coase argued that bargaining can generally solve problems of externalities and the real problem is ill-defined property rights. If the rancher and the farmer can't transfer their property rights, then the efficient outcome may not arise.

3.5 CRITICISMS OF THE COASE THEOREM

There are several practical problems for the Coasean bargaining to work for controlling the environmental externalities.

- First, in reality, there is no zero transaction cost. The transaction costs or costs of bargaining are positive in reality.
- Second, one of the Coasean solution is that all externalities are captured in the value of property rights and there are incentives for gainful bargaining. But this can work well only for externalities on a smaller scale or local externalities of the type described by Coase.
- Third, Coasean bargaining arises in the context of defining the property rights for environmentalresources. The environmental resource is a stock affecting the welfare of both present and future generations. Capitalisation of future benefits from thisresource isnot possible because property rights to future generations of effected people cannot be defined.



CHECK YOUR PROGRESS

Q 3: State the Coase theorem. (Answer in around 30 words)

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Q 4: Mention the assumptions of Coase Theorem. (Answer in around 50 words)

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3.6 THE TRAGEDY OF COMMONS

The tragedy of commons is an economic problem in which every individual tries to reap the greatest benefit from a given resource. As the demand for the resource overwhelms the supply, every individual who consumes an additional unit directly harms others who can no longer enjoy the benefits. Generally, the resource of interest is easily available to all individuals; the tragedy of the commons occurs when an individual neglects the well being of society in the pursuit of personal gain

Understanding this economic theory requires a working definition of what is meant by "the commons". "The commons" includes any natural resources that are not owned by an individual or corporation. Rather, these resources are available for public use. This might include public pasture land, lumber, oil, the oceans, the atmosphere, wildlife and fish, and many other common resources.

Thus, the tragedy of the commons describes how people often take advantage of resources that are freely available to them. Often, they do not consider the fact that if everyone over uses the resource, this will lead to negative effects for everyone, including themselves.

The famous example given by Harding (1968) includes pastureland that people use to graze their cattle. It is to be expected that each herdsman will try to keep as many cattleas possibleon the commons. As a rational being, each herdsman seeks to maximize his gains. Explicitly or implicitly, more or less consciously, he asks, "What is the utility to me of adding one more animal to my herd?" This utility has one negative and one positive component, viz.,

- The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is +1

- The negative component is a function of additional overgrazing created by one more animal. Since, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of 1.

Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. Andthen another; and another. But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit- in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his best interest in a society that believes in the freedom of the commons.



CHECK YOUR PROGRESS

Q 5: What is meant by tragedy of Commons? (Answer in around 30 words)

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3.7 LET US SUM UP

- There are two ways to correct the market failure of environmental goods- correcting imperfect property right and introducing administrative prices for pollution.
- Property rights represent a set of entitlements that defines the owner's privileges and obligations for use of a resource or asset and have the Characteristics such as comprehensively assigned, exclusive, transferable and secure.
- Coase pointed out that if the assumption of Zero transaction costs is maintained, the set of markets can be expanded beyond normal private

goods to include many non-market assets.

- The Coase theorem postulates that disputing parties will work out a private agreement that is Pareto efficient, regardless of the party to whom unilateral property rights to the non-market assets are assigned initially.
- The tragedy of commons is an economic problem in which every individual tries to reap the greatest benefitfrom a given resource. It describe how people often take advantage of resources that are freely available to them.



3.8 FURTHER READING

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3.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Property rights represents a set of entitlements that define the owner's privileges andobligations for use of a resource or asset.

Ans to Q No 2: The main characteristics of property rights are- it is comprehensively assigned, exclusive, transferable and secure.

Ans to Q No 3: TheCoase theorem postulates that disputing parties will work out a private agreement that is Pareto efficient, regardless of the party to whom unilateral property rights to the non-market assets are assigned initially.

Ans to Q No 4: The assumptions of Coase theorem are:

(i) Everyone has perfect information.

(ii) Consumers and producers are price takers

(iii) There is costless court system for enforcing agreements.

(iv) Producers maximize profits and consumers maximize utility.

(v) There is no income or wealth effect

(vi) There are no transaction costs.

Ans to Q No 5: The tragedy of commons is an economic problem in which every individual tries to reap the greatest benefits from a given resource.The tragedy of common occurs when individual neglects the well being of society in the pursuit of personal gain.



3.10 MODEL QUESTIONS

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

Q 1: Discuss the concept of property rights.

Q 2: State the Coase theorem.

Q 3: Briefly discuss the concept of tragedy of Commons.

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

Q 1: Describe the different ways to correct market failure of environmental goods. In this context, how property rights corrects market failure? Explain.

Q 2: Critically explain the Coase theorem with an example.

Q 3: Explain the concept of ''Tragedy of commons'' with an appropriate example.

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UNIT 4: ENVIRONMENT AND DEVELOPMENT

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Environmental Kuznets Curve (EKC)

4.4 Diagrammatic Representation of the Kuznets Curve

4.5 Factors Affecting the Environmental Kuznets Curve

4.6 Justification for Environmental Kuznets Curve

4.7 Limitations of Environmental Kuznets Curve

4.8 Let Us Sum Up

4.9 Further Reading

4.10 Answers to Check Your Progress

4.11 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- discuss the relationship between economic development and
- environmental degradation
- critically explain the Environmental Kuznets Curve (EKC)
- get a clear knowledge about the justification of EKC
- explore the factors responsiblefor the relationship between economic development and environmental degradation.

4.2 INTRODUCTION

In the history of the world, the relationship between environment and economy has been the concern of all the societies. With the development of the economy; the nature, content and quality of environment change. Environment quality degrades at first along with the economic development, correcting itself at the later stages of development. This leads to an inverted U-shaped relationship between the two. Yet, the relationship is still not conclusive or an established fact. The debate is going on. Researchers

study the relationship on the basis of the empirical evidences. The inverted relationship between the two was established by Kuznets on the basis of empirical evidence.This is the subject matter of this unit.

4.3 ENVIRONMENTAL KUZNETS CURVE (EKC)

The Kuznets hypothesis was first proposed by Simon Kuznets in the 1950s and 1960s. The curve is represented by the inverted U-shaped. The Environmental Kuznets Curve (EKC) is a hypothetical relationship between environmental quality and economic development.

Before the EKC, it was generally assumed that the rich are the prime cause of environmental degradation. But with the introduction of EKC hypothesis, it is believed that along with the path of economic development, environmental degradation initiates. After reaching a favorable average income, people invest back the money to correct the environmental degradation. Rich can degrade the environment by over consuming Co_2 or So_2 at a faster rate (it is a well-known fact that by using A.C., refrigerator etc. CO_2 or SO_2 gases are released in the environment). Whereas the poor exploit the natural resources including timber, soil, water etc by depending on the environment for their livelihood. Hence 'Poverty is the greatest polluter'. To be precise, it is not so important whether the rich or the poor are responsible for environmental degradation. The concern is, if this degradation crosses the threshold limit, will it have irreversible effects on the environment? It means that If the degradation of environment is within the assimilative capacity of the habitat the particular environment can correct itself. If this degradation crosses the assimilative capacity or the threshold limit, then the environment cannot correct itself. Any public co operation or government pollution controlling measures is necessary.

When the economy is predominated by the agrarian society then the environment is free from the pressure of pollution. Pollution occurs when the economy shifts from the primitive agricultural society to industrial economy. The establishment and functioningofheavy and key industries create huge pressure on the environment leading to environmental

degradation. Economic growth continues with further industrialization. But the environmental quality corrects itself after attaining certain higher level of income. The economy is able to invest money for correcting environment by using latest technology. Consequently the EKC becomes an inverted U-shaped relationship between per capita income (GDP) and environmental degradation per capita. The empirical evidence of EKC is based on the time series data from individual countries, cross section data from a number of countries and panel data across countries.



CHECK YOUR PROGRESS

Q1: State whether the following statements are True or False (T/F).

(a) The Environmental Kuznets Curve is a U-shaped curve. (T/F)

(b) The Environmental Kuznets Curve describes the relationship between environmental quality and economic development. (T/F)

Q2: Define The Environmental Kuznets Curve. (Answer in about 30 words).

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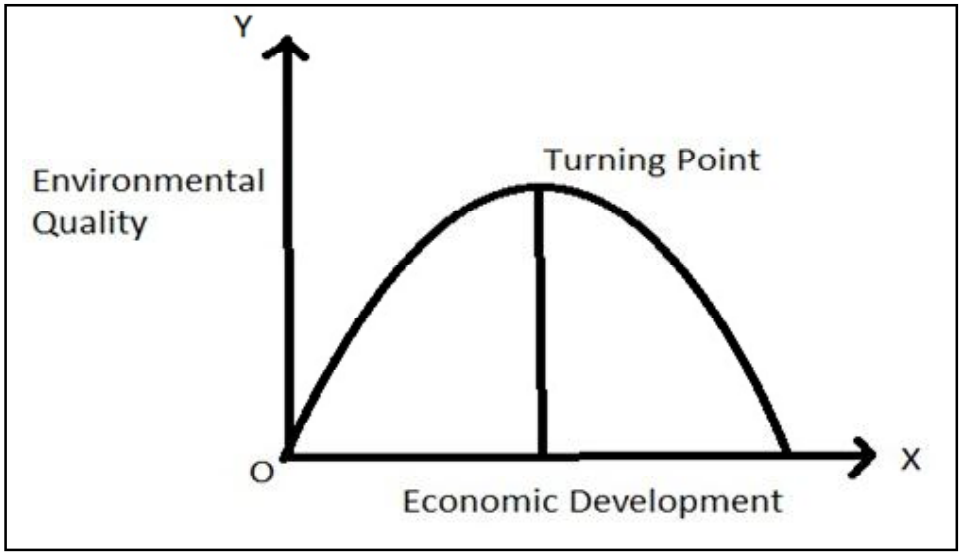
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4.4 DIAGRAMMATIC REPRESENTATION OF THE KUZNETS CURVE

Diagrammatically the environmental Kuznets Curve can be shown as the inverted U-shaped relationship between environmental quality and economic growth of a particular region. The quality of environment is represented in the vertical axis and economic growth measured in terms of per capita income (GDP) is expressed in the horizontal axis.

Figure 4.1: Environmental Kuznets Curve



As revealed in the Figure 4.1, you can see that the EKC is at first increasing at an increasing rate. After reaching its highest point (turning point) the curve slopes down. The environmental quality degrades along with economic development in the initial level of economic development. On the other hand the environmental quality improves along with economic development in the later stages of economic development.

4.5 FACTORS AFFECTING THE ENVIRONMENTAL KUZNETS CURVE

Due to various factors, environmental quality degrades at first along with economic development. The factors are discussed as follows:

- **Increasing level of Production and Consumption:** The economic development takes place along with the increasing levels of production of the economy. Economic development is a result of the shift of production pattern from traditional to modern technical and industrial arena. As a result of the improved production, preferences for consumption change. Changing preferences for consumer and luxurious goods leads to additional production of these goods. This increasing industrial production leads to environmental degradation.

- **Ignorance of the people to Environmental Quality:** In the initial level of economic development generally people are either ignorant or unaware about the environmental quality. Hence they do not bother about the condition of environment. As a result along with the increasing population as well as production, the environmental quality degrades.
- **Huge Levels of Poverty:** In the initial phases of economic development, there is existence of mass poverty in any economy. These poor people live in the environmentally vulnerable areas as well as they depend on the environment for their livelihood. In that sense they overuse the environment compelling it to degrade.
- **High Income Inequality:** There is existence of high income inequality, in the initial stages of development. The rich people excessively use the industrial product leading to environmental degradation. On the other hand, as you all know the poor are overusing the natural resources. This income inequality between the rich and the poor can be claimed as one of the causes of environmental degradation in the initial stages of economic development.
- **Lack of Community Level Institutions:** There is lack of community level institutions to create awareness among the people to protect the environment. At the initial level of development, the government do not also have sufficient fund to utilize in awareness campaign regarding environmental protection. All these lead to environmental degradation.
- **Increasing Returns to Scale associated with Pollution Abatement:** There is increasing returns to scale associated with pollution abatement. This also leads to environmental degradation in the initial stages of economic development.
- **Technological Changes:** Generally, there is improvement in technology in the later stages of economic development. In such cases there is a possibility of dropping down of the amount of pollution. For example, any pollution controlling technology can be developed along with the economic development.
- **Improvement in Efficiency in the use of Energy Resources:** As technology develops along with economic development, the efficiency

of using energy resources improves. For example liquid petroleum gas (LPG) can be replaced for timber for household cooking purpose. This improvement will lead to improvement of environmental quality in a region.

Possibility of Substitution by Resources not linked to Environmental Resources:If there is any possibility of finding a substitute that is not linked to environmental resources, then there will be reduction of environmental degradation. The cost of this substitute may be high, but it will not adversely affect the environment. For example: solar energy can be replaced for any of the environmental resources.

- **Increased Awareness among People about the Protection of Environmental Quality:** Along with the increasing economic development, awareness about the protection of environmental quality increases among the people. Environmental movements like 'Chipko' or 'Narmada Bachao' in the Indian scenario can be mentioned in this regard.
- **Better Implementation of Environmental Regulations:** As the economy develops, government can shift their preference of investment for better implementation of environmental regulations; rather than simply investing for expansion of industrial product. Along with national regulations for protecting the environment, the government can also implement regulations of global environmental summits.

You can also find out various other factors causing the inverted relationship between environment quality and economic development in your own locality.



CHECK YOUR PROGRESS

Q 3: Write two factors causing environmental degradation along with economic development. (Answer in about 50 words)

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Q 4: Why environmental quality improves in the later stages of economic development? (Answer in about 50 words)

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4.6 JUSTIFICATION FOR ENVIRONMENTAL KUZNETS CURVE

I **Empirical Evidence of declining pollution level with economic growth:** When the economy reaches certain higher levels of income, then they are in a position to invest additional amount of money for correcting environmental degradation. Different studies have been made by researchers to examine the existence of Kuznets' curve. Grossman and Krueger (1993, 1995), found evidence of similar relationship between economic development and environmental quality as Kuznets: They observed that as the country's economic grows; it first faces a higher environmental degradation, and from a certain turning point on, starts to reduce its environmental contamination again. In this connection, one could also observe an inverted U-shaped curve by plotting the environmental degradation, measured in pollution concentration, against economic growth, measured in per capita income. Again, Dasgupta et.al (2002) stated that at first the industrial economies focus more on eliminating poverty than having a strong environmental regulation. But when the income increases, people can afford to pay more attention to the environment, thus regulatory institutions become more effective and the industrial sectors cleaner. Pollution control policies such as command and control approach or incentive based approach like taxes, liability

law and tradable pollution permit can be introduced in this regard. There is also empirical data to establish the fact that level of pollution declines with economic growth.

- **Spare income with growth:** With the increasing level of income, people have some spare income in their hands then the previous time. Now they are able to spend this spare income either for purchasing a safety chimney to limit the level of pollution, or they can spend money for plantation programme.
- **Focus on living standard as opposed to real GDP:** People start to focus on a better standard of living than to real GDP, when their income level rises. They prefer a good environmental quality which is free from any environmental hazards. Spending money to protect and prevent the environment leads to the decreasing shape of the Kuznets Curve.
- **Improved technology:** With the pre-mature technology, the level of pollution increases along with the economic development. But further economic development results in mature latest technology to correct the level of pollution. These forces illustrate the inverted U-shaped EKC.
- **Use of Backstop:** When there is economic development along with the consciousness of the people regarding environmental quality, the economy shifts its preference of using environmental resources to a backstop. Use of backstop improves the quality of environment without hampering economic development.



LET US KNOW

The Backstop is a resource or technology that can provide at a higher cost the same service as the non renewable natural resource. It is not supposed to be exhausted in any meaningful time period.

- **De-industrialization:** Along with the increasing economic development, the economy shifts from its industrial stage to de-industrialization stage i.e. service sector. In this stage the level of pollution is less than the

increasing level of income of the economy establishing the EKC.

- **Role of Government Regulation:** From time to time the government assesses the status of environmental quality, frame new policies, rules and regulations to correct the degradation if there is any.
- **Diminishing Marginal Utility of Income:** The marginal utility of income decreases along with the increasing level of income. Subsequently, the willingness to pay for correcting the environmental quality increases at individual levels.



CHECK YOUR PROGRESS

Q 5: How does the level of pollution decline along with economic development? (Answer in about 100 words)

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Q 6: What are the pollution controlling policies? (Answer in about 50 words)

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Q 7: What is a backstop? (Answer in about 50 words)

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4.7 LIMITATIONS OF ENVIRONMENTAL KUZNETS CURVE

Though Kuznets had claimed an inverted relationship between environmental quality and economic development, the empirical evidence collected by some other researchers donot accept the fact. This is the main limitation of EKC. The reasons for non acceptance of EKC can be discussed as follows.

- **Empirical Evidence is mixed:** The empirical evidence regarding the relationship between environmental quality and economic development is mixed. Some researcher found a positive relationship between the two, while others found a negative relationship. Hence the relationship between the two is still inconclusive.
- **Pollution is not only a Function of Income:** Pollution is not only a function of income alone but of many others. Pollution cannot always be claimed as the cause of economic development and sometimes the opposite is true. Hence there is the saying "Poverty is the greatest polluter".
- **Global Pollution:** Sometime high level of pollution of any locality may occur due to the global pollution and not because of the local pollution of that particular region. In that case the EKC can take any shape which will not be the actual function of the local environment.
- **N-Shaped:** Some economists argue that environmental degradation decreases in the post industrialization period. But if the economy continues to expend, there will be increasing amount of the use of resources. This will give an N-shape to the relationship between environmental quality and economic development instead of the referred U-shaped.

  For a country like India, which has shifted its economy from a traditional agricultural society to service sector economy without spending much time in the industrial sector, the EKC may not exactly take the inverted U-shaped. Yet, in many regions of the country where the industrial set up of the country is made, this shape can be present.



CHECK YOUR PROGRESS

Q.8: State whether the following statements are True or False (T/F).

(a) The empirical evidence of the relationship between environmental quality and economic growth is always positive. (T/F)

(b) Pollution is a function of income alone. (T/F)



4.8 LET US SUM UP

- There is a debate regarding the relationship between environmental quality and economic development. On the basis of some empirical evidences Simon Kuznets had suggested an inverted U-shaped relationship between the two. Yet it is still not a conclusive result for all the researchers. The debate is still going on.
- In the initial stages of economic development environmental quality degrades along with economic development; correcting itself in the later stages of economic development after reaching the turning point.
- The rich and the poor are equally responsible for the environmental degradation of any region.
- Environmental degradation is not a function of the income alone but of many other factors. Hence economic development is the sole cause of environmental degradation.
- The environmental quality of one particular region may sometime be affected by the global pollutant and not because of the local pollutant.
- Awareness among the people regarding protection and prevention of environmental quality, spending their spare income in correcting environmental degradation and better implementation of environmental regulations can improve the environmental quality of a region alongwith economic development.

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4.10 ANSWRES TO CHECK YOUR PROGRESS

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

Ans to Q No 2: The Environmental Kuznets Curve (EKC) is a hypothetical relationship between environmental quality and economic development. It is an inverted U-shaped curve.

Ans to Q No 3: Ignorance of the people of environmental quality and high level of poverty in the initial level of economic development are the two factors causing environmental degradation along with economic development.

Ans to Q No 4: Environmental quality improves in the later stages of economic development due to various reasons via technical changes, improvement in efficiency in the use of energy resources, possibility of substitution by resources not linked to environmental resources, increased awareness among people about protection of environmental quality, better implementation of environmental regulations.

Ans to Q No 5: The level of pollution declines with economic growth due to investment of additional money in pollution controlling techniques as well as because of the implementation of pollution controlling policies such as market based and incentive based.

Ans to Q No 6: There are different pollution control policies; such as command and control approach or incentive based approach like taxes, liability law and tradable pollution permit.

Ans to Q No 7: The Backstop is a resource or technology that can provide at a higher cost the same service as the non renewable natural resource. It is not supposed to be exhausted in any meaningful time period.

Ans to Q No 8: (a) False (b) False



4.11 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: Briefly discuss the concept of Environmental Kuznets Curve.

Q 2: Why does the Environmental Kuznets Curve take an inverted U-shaped function?

Q 3: Give two justifications for the Environmental Kuznets Curve.

Q 4: Why does an N-shaped environmental curve occur?

Q 5: What is the role of a backstop?

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

Q 1: "Poverty is the greatest polluter". Explain.

Q 2: Discuss the factors responsible for the Environmental Kuznets Curve.

Q 3: How can the government play a vital role in correcting environmental degradation? Discuss.

Q 4: "Global pollution affects the Environmental Kuznets Curve" Justify.

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UNIT 5: ENVIRONMENTAL REGULATION AND POLICIES

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Pollution and Its Types

5.4 Control and Management of Pollution

5.5 Instruments used for Management of Environment

5.6 Command and Control, Pollution Taxes and Marketable Pollution Permits

5.7 Let Us Sum Up

5.8 Further Reading

5.9 Answer to Check Your Progress

5.10 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- discussthe concept ofenvironmental pollution and its various types
- describe the different measures to control and manage pollution
- explain the various instruments used by the Government or institutions to manage pollution.

5.2 INTRODUCTION

There is worldwide consensus today that the problem of environmental pollution has become an extremely serious issue. There is general agreement that the present state of affairs cannot be allowed to continue and something must be done about it. At the same time, there is considerable debate about the appropriate management strategy that should be adopted to address the problem. In this unit, we will discuss about environmental pollution and its types along with the various instruments used by the government to control and manage pollution.

5.3 POLLUTION AND ITS TYPES

Pollution, also called environmental pollution, means the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radio activity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form. Although environmental pollution can be caused by natural events such as forest fires and active volcanoes, use of the word 'pollution' generally implies that the contaminants have an anthropogenic source- that is, a source created by human activities. The major kinds of pollution are air pollution, water pollution and noise pollution. Modern Societies are also concerned about specific types of pollutions such as land pollution, light pollution and even plastic pollution.

Air Pollution: Air pollution is an essentially urban and industrial phenomenon. Some air pollution may be found in rural areas due to smoke from combustion of firewood for domestic cooking and heating as well as smoke from chimneys of rural industries such as brick kilns and rice mills. In the major cities, the main source of air pollution is vehicular pollution or emissions from the exhaust of automobiles. There has been a phenomenal growth in the number of motor vehicles being operated in the larger metros since the 1980s.

Air pollution occurs when suspended particulate matter (SPM) and noxious gases occur in the air. Smoke, ash and dust are major constituents of SPM and sulphur and nitrogen based compounds. Sulphur dioxide, nitrogen dioxide, carbon monoxide and carbon dioxide are the main constituents of noxious fumes in the air.

Air pollution is caused by every industrial activity where fossil fuels are burnt. Steel, cement and other processing industries are next in line for generating chimney smoke also called top-of-stack emissions. Chemical and fertilizer plants are also responsible for letting noxious substances in the air during production. Dust pollution in the cities is mainly created by construction activity of every kind. Besides, open quarries, from where stones are extracted by blasting, can cause severe dust pollution.

The most notable impact of air pollution is on the health of the affected population. Air pollution causes diseases of the respiratory organs ranging from common cold, bronchitis and asthma to lung cancer. It also affects animals andplants. It can cause serious disease and even death in cattle, cats, dogs and other small animals.

There are basically two ways to deal with the problem. First, pollution causing inputs and processes may be replaced with those that are relatively pollution free. Second is direct pollution abatement. This is done through the use of electrostatic precipitators and scrubbers to reduce smoke, or water spraying to reduce dust.

Water Pollution: While 70 percent of the surface of the earth is covered by water, the water in the oceans and the seas is saline and therefore not fit for drinking, agricultural or industrial purposes. The main storehouses of freshwater are found in the downhill phase of the hydrological cycle and in the form of lakes, ponds, reservoirs, rivers, streams and aquifers. Humans draw water from these sources for drinking, domestic purposes, irrigation and industrial purposes. Moreover, bulk of the fishing takes place in these sources and yields sources of livelihoods. Water bodies provide considerable environmental and aestheticbenefits and are crucial for the preservation of the biodiversity.

This water wealth of the world is in danger of being rendered unusable due to severe water pollution. There are three major sources of pollution-industrial water, urban sewage and solid waste and agricultural pollutants.

Industrial pollutants in water mainly occur when water used in an industrial process is discharged into a waterbody. This waste water often carries with it several pollutants that make the water impure and unfit for human use. Urban sewage and solid wastes dumped into a river or lake may contain all the elements of industrial pollutants. Additionally, it contains a sizeable bulk of organic waste such as food waste, dead animals and plants and excreta. Agricultural pollutants are mainly fertilizer and pesticide residue washed away by rain into water bodies or ground water.

Noise Pollution: Noise pollution is unique in the sense that it is not materially related but activity related. It is essentially an urban industrial

phenomenon arising out of congested living. The effect of this on human health is relative but it can cause nervous disorders and deafness. The major sources are industrial machinery and processes, surface and air transport, construction and other community activity.



CHECK YOUR PROGRESS

Q 1: What is environmental Pollution? (Answer in around 20 words)

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Q 2: What are the types of environmental Pollution? (Answer in around 40 words)

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5.4 CONTROL AND MANAGEMENT OF POLLUTION

Environmental resources suffered massive degradation due to free market exploitation and government management of them has been seen as a solution. Some environmental resources were managed efficiently as common property by local communities much before government property was seen as an alternative to private property for managing them. Recent developments in the management of environmental resources suggest mixed regimes consisting of more than one institution to control pollution or to manage forest resources.

All the institutional alternative for the management of environment have to be considered for designing environmental policy. The institutional alternatives are market, government and community or association of people. The management of environment cannot be left to any one of these institutions.

5.5 INSTRUMENTS USED FOR THE MANAGEMENT OF THE ENVIRONMENT

The government has been seen as the most important alternative institution to market and manage the environment. Government can use two types of instruments- non-market based and market based or economic instruments or a combination of the two. Non market policy instruments include command and control and market based instruments include pollution taxed and marketable pollution permits.

Non-market based Instruments: Command and Control:Command and Control is the dominant form of environmental regulation in the world. The basic concept of command and control is for the regulator to specify the steps individual polluters must take to solve a pollution problem. The essence of command and control is that the regulator collects the information necessary to decide the physical actions to control pollution. The regulator then commands the polluter to take specific physical steps to control the pollution.

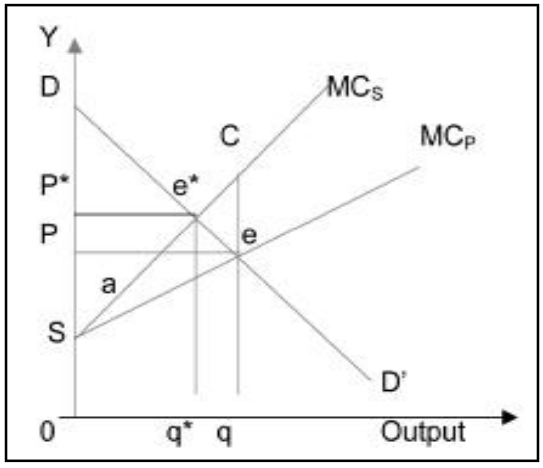
The command and control instruments are in the form of fines, penalties and threats of legal action of closure of the polluting factories and imprisonment of the owner. They can be used either for facilitating the use of specific technologies for environmental management or for the realisation of specific environmental standards.

Market based or Economic Instruments: Economic instruments can be divided into three categories: Price based instruments, quantity based instruments and hybrid instruments. These instruments are known as market based instruments since they complement the market processes to achieve Pareto efficiency even with the presence of externalities.

- **Price-based Instruments- Pollution Taxes:** The price based instruments were first suggested by Pigou in the form of taxes and subsidies to deal with detrimental and beneficial environmental externalities in production and consumption. They are pollution taxes on a polluting commodity either through its production or consumption or on polluting input. Pigou argued for the imposition of taxes on generators

of pollution since the social cost of pollution is an excess of the private cost to the polluter, the government should intervene with a tax, making pollution more costly to the polluters. If the pollution is more costly to produce, the polluter will produce less pollution. This tax has come to be called a Pigovian fee or Pigovian tax. A Pigovian fee is a fee paid by the polluter per unit of pollution which is exactly equal to the aggregate marginal damage caused by the pollution when evaluated at the inefficient level of pollution. The fee is generally paid to the government. This has been explained with the help of Figure 5.1.

Figure 5.1: Pigovian Tax



In Figure 5.1, DD' is the market demand curve. MCp is the private marginal cost curve and MCs is the social marginal cost curve. At the private optimum, 'e', Where MCp=Price=P, the marginal social cost is higher than the marginal private cost by the amount 'ec', the social optimum is at 'e', Where MCs=P*. The marginal social cost isthe sum of marginal private cost (q*a) and the external cost (ae*). Therefore, the Pigovian tax per unit of output is equal to ac*. It is assumed that pollution per unit of output is constant and hence tax on the output is equivalent to a pollution tax. When production is at the point 'e', the net social welfare is the sum of consumer's surplus and producer's surplus minus the external cost, i.e., SeD less thanSec. The social welfare at 'e* is se*D which is higher than the one at 'e', by e*eC. The producer bears the external cost (Sae*) and consumers pay a higher price `p*', instead of 'P'.

- Quantity Based Instruments- Marketable Pollution Permits: D.H. Dales (1968) suggested an alternative to the pollution tax, a system of pollution rights for the management of the environment. He has proposed that property rights be assigned to environment and offered for sale to the highest bidder. In this process, a market for pollution permits is created in which trading in permits takes place up to the point at which the aggregate supply of permits is equal to the aggregate demand for permits and the equilibrium permit price is equal to the marginal cost of abatement to each firm. This system like tax can achieve the specified environment target at minimum cost.

There are some problems for the practical application of this system. First, the transaction costs for polluters are very high. Second, this method requires the analysis to be done in terms of a fixed set of receptor points.

In an alternative system which is known as the Environment permit system (EPS), the permits are issued by the environmental authority in terms of emissions from the sources. The air shed is divided into zones and within each zone sources will trade emission entitlements on one-for-one basis. The transaction costs for polluters will be less in this method since each source has to trade in one zone or one market. However, this system cannot achieve the least cost solutions.



CHECK YOUR PROGRESS

Q 3: What is meant by Pigovian tax or Pigovian fee? (Answer in around 30 words)

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5.7 LET US SUM UP

- The problem of environmental pollution has reached extremely serious proportion.
- Pollution means the addition of any substance or any form of energy to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled or stored in some harmless form.
- Various types of pollution are- air pollution, water pollution, noise pollution, land pollution, light pollution and plastic pollution.
- There is considerable debate about the appropriate management strategy that should be adopted to address the problem of environmental pollution.
- Government can use two types of instrument for the management of the environment. These are market based and non-market based instruments.
- Non-market based instruments includes command and control while market based instruments include pollution taxes and marketable pollution permits.



5.8 FURTHER READING

(1) Bhattacharya, R. N. (2013). *Environmental Economics.* New Delhi: Oxford University Press.

(2) Hanley N., Shogren J. F. and White, B. (2013). *Introduction to Environmental Economics.* New Delhi: Oxford University Press.

(3) Kolstad, C. D. (2010). *Environmental Economics.* New Delhi: Oxford University Press.

(4) Shankar, V. (2001). *Environmental Economics.* New Delhi: Oxford University Press.



5.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Environmental Pollution means addition of any substance or any form of energy to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled or stored in some harmless form.

Ans to Q No 2: The main types of environmental pollution are air pollution, water pollution and noise pollution. Besides. Modern society is also concerned about specific types of pollutants such as land pollution, light pollution and plastic pollution.

Ans to Q No 3: A Pigovian tax is a tax on any market activity that generates negative externalities. The tax is intended to correct an undesirable or inefficient market out come by setting a tax or fee equal to the social cost of the negative externalities.



5.10 MODEL QUESTIONS

Short Questions (Answer each question in around 50-75 words)

Q 1: What is meant by environmental pollution?

Q 2: Discuss the main types of environmental pollution.

Q 3: Mention the market based instruments to control environmental pollution.

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

Q 1: Discuss the various ways to manage the problem of environmental pollution.

Q 2: Explain the market based instruments of controlling or managing the environment.

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UNIT 6: SOLID WASTE MANAGEMENT

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 What is Solid Wastes?

6.3.1 Different Categories of Solid Wastes

6.4 Causes and Effects of Urban and Industrial Wastes

6.4.1 Sources of Urban Wastes

6.4.2 Sources of Industrial Wastes

6.4.3 Effects of Urban and Industrial Wastes

6.5 Measures to Control Urban and Industrial Wastes

6.6 Let Us Sum Up

6.7 Further Reading

6.8 Answers to Check Your Progress

6.9 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- define the term solid waste and discuss its different categories
- outline the reasons for enormous increase in solid waste
- trace the Sources of solid waste
- describe the effects of urban and industrial waste on environment, society and human health
- put forward the different control measures of urban and industrial waste.

6.2 INTRODUCTION

All human activities viz., domestic, commercial, industrial, healthcare, agriculture, generate solid waste. The quantity and nature of the waste vary with the activity and with the level of technological development in a country. The characteristics and quantity of the solid waste generated in a region is

not only a function of the living standard and lifestyle of the region's inhabitants, but also of the abundance and type of the region's natural resources.

Global Municipal Solid Waste (MSW) generates approximately 1.3 billion tons per year and this is expected to increase to approximately 2.2 billion tons per year by 2025. There has been a significant increase in Municipal Solid Waste (MSW) generation in India in last few decades. This is largely because of rapid population growth and economic development in the country. As per the information available on the website of ***TERI***, in 1947, cities and towns in India had generated an estimated 6 million tonnes of solid waste, whereas in 2010, it was about 65 million tonnes per year. A study on a comprehensive dataset of 366 Indian cities revealed that annual waste generation by these cities is expected to increase from 47.3 million tons in the year 2011 to 71.2 million tons in 2021.



TERI: The Energy and Resources Institute (TERI) is a research institute based in New Delhi that conducts research work in the fields of energy, environment and sustainable development.

In 1991, estimated waste generated in Guwahati was about 193.8 metric tonne per day which was increased to 311.5 metric tonne per day with an increase of 117.7 metric tonne per day in 2001. It is projected that the waste generation will increase to 1772 metric tonne per day till the year 2025.



Basel Convention:The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries. The Convention was opened for signature on 22 March 1989, and entered into force on 5 May 1992. As of February 2018, 185 states and the European Union are parties to the Convention.

6.3 WHAT IS SOLID WASTES?

Any useless, unwanted discarded material that is not a liquid or gas is referred as solid waste or refuse. According to the ***Basel Convention***, United Nations Environment Programme, "Wastes are materials that are not prime products (that is products produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products and other human activities. Residuals recycled or reused at the place of generation are excluded.

6.3.1 Different Categories of Solid Wastes

Solid wastes are grouped or classified in different ways. These different classifications arenecessary to address the complex challenges ofsolid waste management in an effective manner. Various categories of solid waste are:

- **Municipal solid waste:** The term municipal solid waste (MSW) isgenerally defined as waste collected by municipalities or other local authorities. MSW use to describe most of the non-hazardoussolid waste from a city, town or villagethat requires routine collection and transport toa processing or disposal site. Sources of MS Winclude private homes, commercial establishmentsand institutions etc. It includes waste like demolition debris, sewage sludge, mining wastes or agricultural wastes.
- **Bio- Medical waste:** These wastes include materials like plastics syringes, animal tissues, bandages, cloths etc. Some countries choose to include these items in the MSW. Medical waste is usually incinerated. However, some of them may be disposed in MSW stream.
- **Hazardous waste:** Waste oil, waste solvents, ash, cinder and other waste with hazardous nature such as flammability, explosiveness, causticity and toxicity are included in hazardous waste. Hazardous waste are generally collected, treated and disposed separately from non-hazardous MSW and industrial waste streams.

6.4 CAUSES AND EFFECTS OF URBAN AND INDUSTRIAL WASTES

As discussed above, solid wastes are the material that arises from various human and economic activities. It is being produced since the beginning of civilization. Ever increasing population growth, urbanization and industrialization are contributing to the generation of solid waste in huge

quantities. Since the industrial revolution, small and traditional trades have been replaced by large industrial factories. Industrialization has been the result of rapid developments in technology and the increasing demands in our daily lives. These industries are essential to the progress of human civilization. There is almost no alternative to industrialization for meeting the high worldwide demand for goods. The major causes of urban and industrial wastes and pollution include the following:

- **Lack of Policies to Control Pollution:** Lack of effective policies as well as proper implementation and monitoring mechanism have allowed many industries to bypass laws made by the pollution control board which has resulted in mass scale pollution that affected the lives of many people.
- **Unplanned Industrial Growth:** Unplanned growth of industrial townships and gross violation of rules and norms in their establishment also have adversely affected the environment with both air and water pollution.
- **Use of Outdated Technologies:** Most industries still rely on age old, outdated technologies to produce products that generate a large amount of waste to avoid high cost and expenditure of installation. This has resulted in producing more pollution in the environment.
- **Inefficient Waste Disposal:** Inefficiency in the disposal of waste material often cause water and soil pollution. Long term exposure to polluted air and water leads to chronic health problems, making the issue of industrial pollution into a severe one.
- **Leaching of Resources from Our Natural World:** Industries do require a large amount of raw material to make them into finished products. This requires the extraction of minerals from beneath the earth. The extracted minerals may also cause soil pollution when spilled on the earth. Leaks from vessels can cause oil spills that may prove harmful for marine life.
- **Effects of Industrial Pollution on Environment:** Some of the major effects of industrial and urban waste/pollution include the following:

- **Water Pollution:** The effects of industrial pollution are far-reaching and may have lasting adverse impact on the ecosystem for many years to come. Most industries consume a large amount of water for their production units. When involved in a series of processes, the water comes into contact with heavy metals, harmful chemicals, radioactive waste, and even organic sludge.

  Industrial wastes are either dumped into open oceans or rivers. As a result, many of our water sources often have to carry a high amount of industrial waste causing serious impacts on the health of our ecosystem. The same water when is used by farmers for irrigation purpose, may affect the quality of food that is produced.

  Water pollution has already rendered many groundwater resources useless for humans and wildlife. It can at best be recycled for further usage in industries.
- **Soil Pollution:** Soil pollution is causing adverse effects on agriculture and had led to the destruction of local vegetation. It also causes chronic health issues to the people that come in contact with such soil on a daily basis.
- **Air Pollution:** Air pollution has caused many illnesses and it continues to affect us on a daily basis. With so many small, mid and large scale industries coming up, air pollution has taken the toll on the health of the people and the living environment.
- **Wildlife Extinction:** By and large, the issue of industrial pollution shows us that it causes natural rhythms and patterns to fail, meaning that the wildlife is getting affected in a severe manner. Habitats are being lost, species are becoming extinct and it is harder for the environment to recover from each natural disaster. Major industrial accidents like oil spills, fires, the leak of radioactive material and damage to property are harder to clean-up as they have a higher impact in a shorter span of time.
- **Global Warming:** Due to the increase in industrial pollution, global warming has been increasing at a steady pace. Smoke and greenhouse gases are being released by industries into the air which causes an

increase in global warming. Different studies indicate that melting of glaciers, extinction of polar bears, floods, tsunamis, hurricanes are few of the effects of global warming.

Thus, it has been seen that waste can contaminate surface water, groundwater, soil and air which causes more problems for humans, other species and ecosystems. Waste treatment and disposal produces significant green house gas (GHG) emissions, viz., methane, which are contributing significantly to global climate change. Waste dump in the river and seas severely affects the marine ecosystem.

Many of the environmental burdens cited above are more often borne by marginalized groups, such as racial minorities, women and residents of developing nations. However, the need for expansion and site of waste treatment and disposal facilities is increasing worldwide.



CHECK YOUR PROGRESS

Q 1: Solid waste generation has increased largely due to ..... and .....(Fill in the blanks)

Q 2: Biomedical waste is a type of (choose the correct option)

a) Municipal waste

b) Hazardous waste

c) Solid waste.

Q 3: What is solid waste? (Write within 50 words)

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Q 4: Write a note on hazardous waste. (Write within 50 words)

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Q 5: What are the causes of waste generation? (Write within 50 words)

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Q 6: Explain the various health effects of wastes? (Write within 50 words)

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6.5 MEASURES TO CONTROL URBAN AND INDUSTRIAL WASTES

The increase in urban and industrial waste can be controlled by proper waste management techniques. Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers.

An integrated waste management strategy includes three main components, viz., (a) source reduction, (b) recycling and (c) disposal.

Source reduction is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.

Recycling is reusing some components of the waste that may have some economic value. Recycling has readily visible benefits such as conservation of resources reduction in energy used during manufacture and reducing pollution levels. However even if recycling is a viable alternative, it presents several problems. The problems associated with recycling are either technical or economical. Plastics are difficult to recycle because of the different types of polymer resins used in their production. Since each type has its own chemical makeup different plastics cannot be recycled together. Thus separation of different plastics before recycling is necessary. Similarly in recycled paper the fibers are weakened and it is difficult to control the colour of the recycled product. Recycled paper is banned for use in food containers to prevent the possibility of contamination. People should be educated regarding the concept of 4 R's i.e. Reduce, Reuse, Recycling, Recovery for the proper treatment of the municipal waste.

Disposalof solid waste is done most commonly through a sanitary landfill or through incineration. The commonly used methods of disposal are

- **Salvage or Manual Component Separation:** Before ultimate disposal, the manual separation of solid waste components is accomplished to achieve the recovery and reuse of materials. Cardboard, newsprint, high quality paper, glass, metals, wood and aluminum cans etc. are manually sorted out or salvaged either for recycling or for resale.
- **Compaction or Mechanical Volume Reduction:** After separation of reusable or disposable articles, compacters are used to compress the waste materials directly into large containers or to form bales that can be then placed in large containers. Compaction increases the useful life of landfills.
- **Incineration:** Highly combustible wastes like plastics, cardboard, paper, rubber and combus-tible wastes like cartons, wood scrap, floor sweepings, food wastes etc. are subjected to incineration i.e. burning at very high temperatures. Incineration results in air pollution and so proper control equipment needs to be installed to avoid contamination of environment.

- **Open Dumping:** Open dumping of solid wastes is done in low lying areas and outskirts of towns and cities. Being comparatively cheaper, this method of disposal is used extensively in India.
- **Sanitary Land filling or Controlled Tipping:** Sanitary land filling involves the disposal of municipal wastes on or in the upper layers of the earth's mantle especially in degraded areas in need of restoration. In land filling, the solid wastes are compacted and spread in thin layers each layer being uniformly covered by a layer of soil.
- **Pyrolysis or Destructive Distillation:** In this disposal method, the solid wastes are heated under anaerobic conditions (i.e. burning without oxygen). The organic components of the solid wastes split up into gaseous liquid and gaseous fractions (CO, CO_2, CH_4, tar, charred carbon). Unlike the highly exothermic process of combustion, pyrolysis is a highly endothermic process and that is why it is also called destructive distillation.
- **Land farming:** In this waste disposal method, the biodegradable industrial wastes are treated by the biological, physical and chemical processes occurring in the surface of the soil. The organic wastes are either applied on top of the land or injected below the soil surface with suitable equipment, where they undergo bacterial and chemical decomposition.
- **Composting or Biodegradation:** Bacterial decomposition of the organic components of the municipal solid wastes result in formation of humus or compost and the process is known as composting. In this process a compost pile is constructed by making alternate layers of or-ganic matter and soil (source of micro-organisms).



CHECK YOUR PROGRESS

Q7: .....is one of the fundamental ways to reduce waste. (Fill in the blanks)

Q8: What do you mean by solid waste management? (Write within 50 words)

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Q9: Explain one of the components of solid waste management strategy. (Write within 50 words)

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6.6 LET US SUM UP

- Due to rapid growth of population, industrialisation, urbanisation and globalisation municipal solid waste has increased enormously.
- There are various categories of solid waste such as urban waste, industrial waste, bio-medical waste and hazardous waste.
- Waste can affect human health and environment adversely.
- Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials.
- An integrated waste management strategy includes three main components, viz., (a) source reduction, (b) recycling and (c) disposal.
- People can help themselves to treat municipal waste by following four concepts of R's i.e. Reduce, Reuse, Recycling, Recovery.



6.7 FURTHER READING

(1) Bhattacharya, R. N. (2013). *Environmental Economics.* New Delhi: Oxford University Press.

(2) Hanley N., Shogren J. F. and White, B. (2013). *Introduction to Environmental Economics.* New Delhi: Oxford University Press.

(3) Kolstad, C. D. (2010). *Environmental Economics.* New Delhi: Oxford University Press.

(4) Shankar, V. (2001). *Environmental Economics.* New Delhi: Oxford University Press.

6.8 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: c) population growth and economic development.

Ans to Q No 2: Solid waste.

Ans to Q No 3: Any useless, unwanted discarded material that is not a liquid or gas is referred as solid waste or refuse. According to the Basel Convention, United Nations Environment Programme "Wastes are materials that are not prime products (that is products produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products and other human activities. Residuals recycled or reused at the place of generation are excluded."

Ans to Q No 4: Waste oil, waste solvents, ash, cinder and other waste with hazardous nature such as flammability, explosiveness, causticity and toxicity are included in hazardous waste. Hazardous wastes are generally collected, treated and disposed separately from non-hazardous MSW and industrial waste streams.

Ans to Q No 5: The causes of waste generation arerapid population growth, industrialisation, urbanisation and modernisation. Ever increasing population growth, industrialisation, urbanization, and modernisation is contributing to the generation of urban waste in huge quantities. Since the industrial revolution, small and traditional trades have been replaced by large industrial factories. Industrialisation has been the result of rapid developments in technology resulting increase in demands for food and other essentials in our daily lives. This has resulted to rise in the amount of waste being generated by each household, commercial unit and industry every day.

Ans to Q No 6: Waste has adverse effect on human health. Direct handling of solid as well as hazardous waste can result in various types of infectious and chronic diseases. If these wastes directly dump near water sources, it causes contamination of the water bodies or the ground. This results in accumulation of toxic substances in the food chain through the plants and animals that feed on it. Disposal of hospital and other medical waste requires special attention as these are the direct sources of many diseases and infections.

Ans to Q No 7: Source reduction.

Ans to Q No 8: Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials.Waste management practices differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers.

Ans to Q No 9: Source reduction is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.



6.9 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: What is meant by solid waste? Explain briefly the reasons of present day increase of solid waste.

Q 2: Write about causes and effects of solid waste dumping.

Q 3: Write about hazardous waste, how does it differ from other wastes.

Q 4: Explain the concepts of 4 R's. How does it help in controlling waste generation?

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

Q 1: Explain the adverse effects of waste on human health and environment.

Q 2: Explain the control measures of urban and hazardous waste.

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UNIT 7: VALUATION OF ENVIRONMENTAL GOODS AND SERVICES

UNIT STRUCTURE

7.1 Learning Objectives

7.2 Introduction

7.3 Basic Concepts in Environmental Goods and Environmental Valuation

- 7.3.1 Meaning of Environmental Goods
- 7.3.2 Values Associated with Environmental Goods and Services
- 7.3.3 Environmental Valuation
- 7.3.4 Need of Valuation of Environmental Resources

7.4 Techniques of Environmental Valuation

- 7.4.1 Subjective Preference-Based Valuation - Willingness to Pay
- 7.4.2 Revealed Preference-Based Valuation
- 7.4.3 Stated Preference Method

7.5 Let Us Sum Up

7.6 Further Reading

7.7 Answers to Check Your Progress

7.8 Model Questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- describe the concept of valuation of environmental goods
- discuss and comprehend the need and importance of valuation of environmental goods in economic development of the country
- examine the drawbacks of valuation of techniques of environmental goods
- appreciate the application of the valuation techniques of environmental goods.

7.2 INTRODUCTION

The growth of any economy in the world is based on dominance, transformation and impact of the nature due to human intervention. The human needs and desires are culprit of extensive damage of natural resources resulting in widespread damages to the productive activities. With the rising damage to the environment it is of utmost importance and challenge to protect environment. In many of the developed countries like USA, UK etc., there has been growing demand for examining the government investments in projects by evaluating the cost/benefit analysis. Apart from the cost/benefit valuation, the major projects that are assumed to have any adverse effect on the environment are now undergoing environmental impact assessment which is aimed to evaluate and judge the costs incurred on the projects and compared with the likely benefits that shall exceed the costs of the project on the environment. However, the question arises of the methods to place values on these cost/benefits associated to the environment. The answer to the question is the concept of economic appraisal emerges as a measuring tool of environmental goods and services and of the impacts of environmental degradation and depletion, determining the direct and indirect costs and benefits of qualitative and quantitative changes. It is gathering importance in the evaluation of investment projects, governmental policies and international trade.

7.3.1 Meaning of Environmental Goods and Services

Environmental goods are generally known as public goods as they have certain typical characteristics which make it difficult to assign a value to them. These goods may have some or all of the following characteristics-

- The consumer may gain other than use value from the existence of the goods. For example the value of an area of landscape to a consumer is not necessarily limited to the pleasure gained from visiting the site.

- Changes in the supply or availability of the goods are likely to be more or less irreversible, which means that goodsonce destroyed, cannot be replaced at later date by a perfect substitute.
- The supply of and demand for the goods is more or less uncertain;
- Supply of the goods is finite, available only in discrete lumps, and the goods may be unique without any substitutes;
- They are likely to be a natural rather than a man-made feature.

7.3.2 Values Associated with Environmental Goods and Services

Environmental goods are classified as public goods because these types of goods are not marketed and people may be unfamiliar with the process of placing values on them. The valuation of environment goods and services differ from the other economic resources because of lack of conventional markets for environmental goods. Also economists believe that while attaching the value to the environmental goods and services, there are other additional dimensions which should be taken into account for judicious valuation. These additional dimensions include direct cost/benefit (DCB) to production and its proposed impact on the environment or proposed utility enhancement of the consumers of the goods.

Non-use (NUV) or passive value is another dimension to be added for valuation which includes the intrinsic value of maintaining the environmental goods in their nature state. Option value (OV) is the values that are assigned to the extracted and non-extracted resources or uses by producers and/or consumers. It can also be said as thevalue associated with peculiar characteristics of the goods or services which makes it a potentially beneficial source in future as opposed to its present utilization (for example the environmental goods in Amazon rain forest offer lot of speculations for production of medicines or products which are yet unknown to humankind).

Existence value (EV) is the satisfaction that people would obtain by using the environmental goods and services for various reasons other than their expected personal use. Simply put, it means assessing the willingness to pay by people at large, to ensure that an area continues to exist undisturbed regardless of whether or not people shall use it or may even visit the area. Bequest value (BV) or Legacy Value (LV) is the value which the present generation places for environmental goods and services in order to make the goods and services transferrable in their present form, to the future generations.

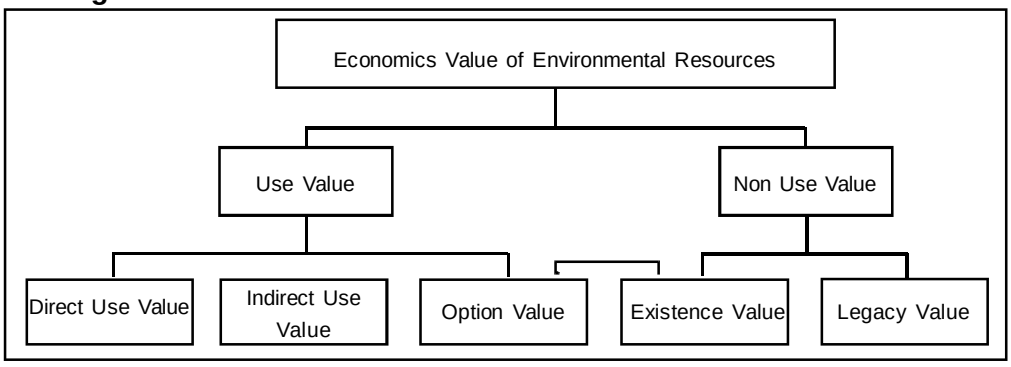
7.3.3 Environmental Valuation

Economic valuation - Economic valuation is a process of assigning the value for goods and services of the environment. The valuation is done for the majorly two items of the environment resources that shall include - a) Stock of environmental goods and services of the environment, and b) the change in the functions of these environmental goods and services of the environment. The main motive is to obtain a single denominator valuation of the environmental goods and services.

- Use value -the use value (UV) is the value attributed by people who use or usufruct of the environmental good to satisfy their needs. The use value includes direct use value (direct cost/ benefit value), indirect use value, and option value.
- Non-use value - The non-use value (NUV) is dissociate of the use because it derives from a moral, cultural, ethical or altruistic position regarding the rights of existence of other living species or the preservation of natural assets although that do not represent current or future use for them. Non-use value includes existence value and legacy value (behest value).
- Total Economic Value - The total economic value is summation of use value and non-use value of environmental goods and

services. Mathematically , it can be represented as - TEV = UV + NUV

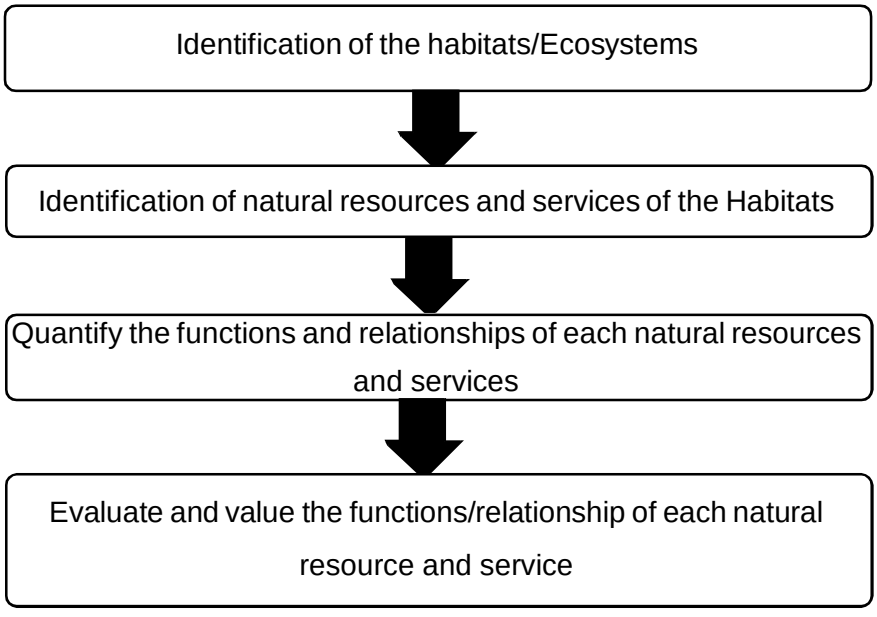
Figure 7.1: Different economic values of environmental resources



Source: https://www.researchgate.net/publication/200041693

There is an inverse relationship between increase in environmental appraisal difficulty and the use of resources. The study of environmental resources requires sound understanding of the ecological dynamics. It is necessary to define the purpose of study to establish relationship, need for valuation, ensure apt availability of information and rational hypotheses for providing direction to the valuation objectives.

Figure 7.2: Stages of economic valuation of environmental resources



The environmental economics is the combination of production function and demand function methods (May and Motta in 1994). The valuation techniques in production function methods include - marginal

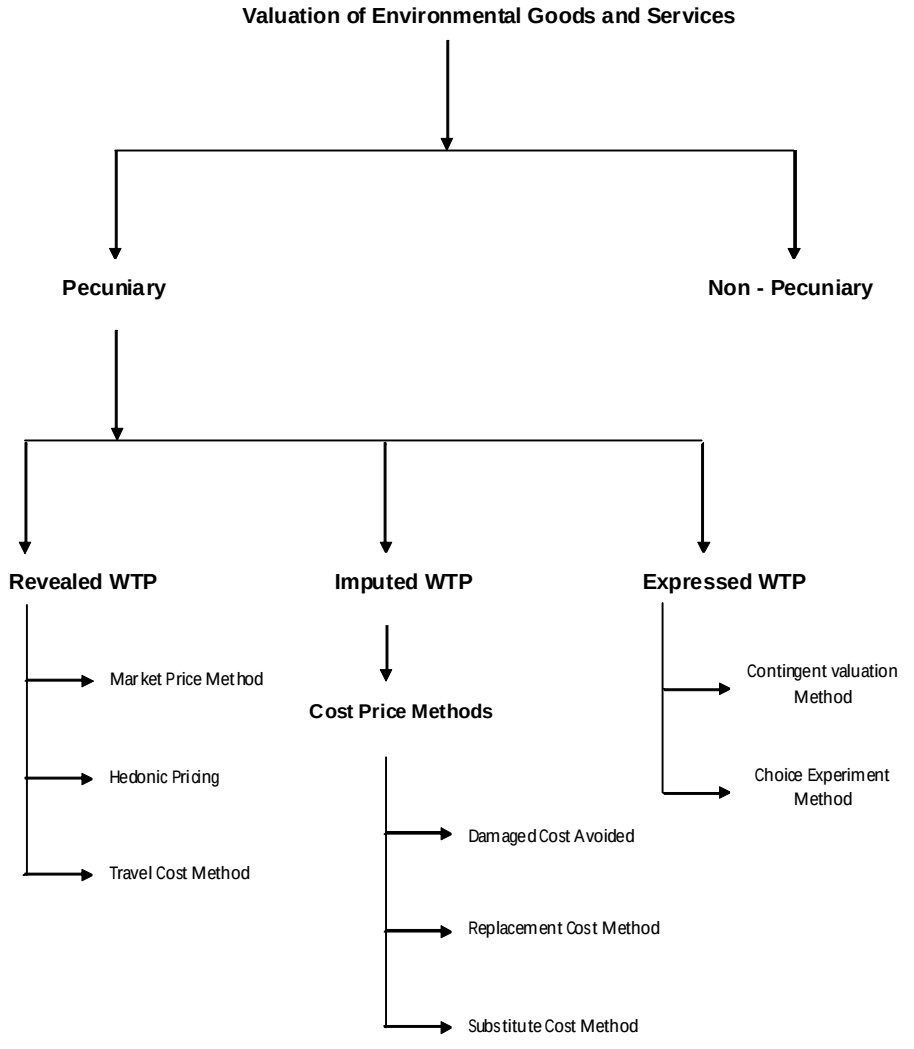
productivity method and markets of substitute goods method - and that in demand function methods includes - methods that utilize markets of complementary goods (hedonic prices and travel costs methods) and hypothetical markets (method of contingent valuation). They referred that production function methods is meant to analyze the environmental resources that are associated towards the production of the private goods and, generally, assumes that the variations in supply does not influence the market prices.

On the other hand, the demand function methods agree that any changes in the availability of resource leads to modification of individual's wellbeing and, thus, it is possible to identify individual measures of Willingness to Pay (WTP) or Willingness to Accept (WTA) to measure the degree of such variations.

Economic valuation methods can be grouped into two categories viz., pecuniary and non-pecuniary. Pecuniary valuation methods obtain the 'money equivalent' of these goods and services - money is used as the numéraire, while non-pecuniary methods, more general in nature, may use any numéraire for valuation. Our primary concern here is to discuss only the methods of pecuniary valuation. The applicability of any of the methods depends on the objectives of study and the level of familiarity with different methods.

The appropriate selection of the method depends on many factors such as - (i) type and number of objects to be valued; (ii) relevant population (e.g. users or non-users or both; geographical scope (local, regional, national, international); (iii) data availability (e.g. restricted data access - data on house values); (iv) available time and financial resources; (v) team (e.g. experience).

Figure 7.3: Types of valuation of environmental resources



Source: https://msu.edu/user/schmid/mishra.htm

7.3.4 Need of Valuation of Environmental Resources

The need for environmental valuation may be underlined considering the following points Support for environmental litigation - Till now the government has been applying the traditional techniques of non-market demand valuation to examine the compensation for any damage and for making amendments in environmental policies.

- Assistance towards environmental dispute resolution - The major environmental disputes crop-up in case of high investment projects such as new mines, resorts development, new water

storage, logging, etc., which requires vital decision making as these development may have long-term impact on the ecological balance of the area. Thus, it is necessary to evaluate the environmental resources at stake, in order to take informed decisions which must be duly and transparently indicated to stakeholders.

- Guide to environmental regulations - In order to make amendments in the rules, regulations and policies, it is necessary to have the valuation to estimate the cost of environmental damage to understand and implement the levels of damage control.
- Evaluation platform for environment programmes - These valuation techniques assist the government efforts to implement the cost-benefit framework for public, at large, to make them awareness about the ecological systems, reasons of imbalances, impact of imbalances and control programmes, to be evaluated by assessing its impact on various socio-environmental dimensions.

7.4 TECHNIQUES OF ENVIRONMENTAL VALUATION

In this section, we shall discuss some of the techniques used in environmental valuation.

7.4.1 Subjective Preference-Based Valuation - Willingness to Pay

Economic valuation techniques mainly rely on the Willingness to Pay (WTP) of the individuals for any environmental resources. As per survey based contingent valuation method it is an individual's willingness-to-pay for achieving certain derived level of any good or service for an improved environment. The measure of WTP is applied in case of absence of market prices. The valuation of environmental goods and services can be calculated through Revealed WTP,

Imputed WTP and Expressed WTP. The WTP measure indicates the monetary equivalent that would be necessary to compensate for the welfare loss from the change.

7.4.2 Revealed Preference-Based Valuation

Revealed preference methods are based on the actual market behavior of the consumers of environmental goods and services but it is limited to only few such goods and services those are available for consumption.

- **Market Price Method:** The market price method estimates the economic value of goods or services that are bought and sold in markets. The market price method can be used to value changes in either the quantity or quality of a good or service. It uses standard economic techniques for measuring the economic benefits from marketed goods and services, based on the quantity people purchase at different prices, and the quantity supplied at different prices. Market price represents the value of an additional unit of that good or service, assuming the good or service is sold through a perfectly competitive market (that is, a market where there is full information, identical products being sold and no taxes or subsidies). The market price method uses prevailing prices for goods and services traded in markets, such as timber, fuel-wood, non-wood forest products (e.g., mushrooms, berries, aromatic and medicinal plants, etc.).
- **Cost Based Methods:** The cost based methods also known as imputed willingness to pay methods (damage cost avoided, replacement cost, and substitute cost methods) are related methods that estimate values of ecosystem goods and services based on either the costs of avoiding damages due to lost services, the cost of replacing environmental assets, or the cost of providing substitute goods or services. The damage cost avoided method uses either the value of property protected, or

the cost of actions taken to avoid damages, as a measure of the benefits provided by an ecosystem. The replacement cost method uses the cost of replacing an ecosystem or its goods and services as an estimate of the value of the ecosystem or its goods and services. Similarly, the substitute cost method uses the cost of providing substitutes for an ecosystem or its goods and services as an estimate of the value of the ecosystem or its goods and services. These methods might be applied for valuing improved water quality, erosion protection services, water purification services, storm protection services, and habitat and nursery services.

- **Hedonic Method:** The hedonic pricing method (HP) relies on market transactions for differentiated goods to estimate the economic benefits or costs associated with environmental quality. The basic premise of the HP method is that the price of a marketed good is related to its characteristics, or the services it provides. For example, the price of a house is related to the characteristics of the house and property itself, the characteristics of the neighborhood and community, and environmental characteristics. Thus, if non-environmental factors are controlled, then any remaining differences in price can be attributed to differences in environmental quality. For example, if all characteristics of houses and neighborhoods throughout an area were the same, except for the level of air pollution, then houses with better air quality would cost more. This higher price reflects the value of cleaner air to people who purchase houses in the area. The hedonic prizing method is mainly used to estimate economic values for economic benefits or costs associated with environmental quality (e.g., air pollution, water pollution, or noise) and environmental amenities (e.g., aesthetic views or proximity to recreational sites).
- **Travel Cost Method:** The travel cost method is used to estimate the value of recreational benefits generated by ecosystems. It

assumes that the value of the site or its recreational services is reflected in how much people are willing to pay to get there. There are several varieties of the travel cost method: simple zonal travel cost method (using mostly secondary data), individual travel cost method (using a more detailed survey of visitors and statistical analysis), and random utility travel cost method (using survey and other data, and statistical techniques). The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the value of access to the site. Thus, peoples' willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples' willingness to pay for a marketed good based on the quantity demanded at different prices. The travel cost method is used to estimate use values associated with the recreational services that ecosystems or sites provide. The method can be used to estimate the economic benefits or costs resulting from (i) changes in access costs for a recreational site, (ii) elimination of an existing recreational site, (iii) addition of a new recreational site or (iv) changes in environmental quality at a recreational site.

7.4.3 Stated Preference Method

Stated preference methods, also known as expressed willingness to pay, are applicable to all types of environmental goods and services, but it suffers with the drawback of hypothetical assumptions which makes it complicated, tedious and resource-consuming affair.

- **Contingent Valuation Method:** The contingent valuation method is a questionnaire based technique that seeks to discover individual preferences for an environmental change. These are the only methods that can assess non-use values of ecosystems but can also be used to estimate use values generated by the ecosystems. In addition, due to their hypothetical nature, these

methods can be used to assess social preferences ex-ante, i.e., for changes that have already not taken place. The basic premise of the contingent valuation method is that individuals are sensitive to a given environmental change and that their preferences could be measured in terms of their willingness to pay to undergo (or their willingness to accept a compensation to avoid) this change. Therefore, the given change is presented to individuals through a survey where the environmental change is presented and where people are asked to state their willingness to pay or their willingness to accept the given environmental change. The contingent valuation method is used to estimate non-use values that ecosystems provide, but can simultaneously estimate use values such as recreational values associated with these ecosystems. The method can be used to estimate the economic benefits or costs resulting from an environmental change that has an impact on (i) non-use values, such as existence values people hold for biodiversity, (ii) use-values such as recreational values or landscape values people hold for a given natural site.

- **Choice Experiment Method:** The choice experiment method is a questionnaire based technique that seeks to discover individual preferences for simultaneous changes in the attributes that compose an environmental good or service. States preference methods are the only methods that can assess non-use values of ecosystems but can also be used to estimate use values generated by the ecosystems. In addition, due to their hypothetical nature, these methods can be used to assess social preferences ex-ante, i.e., for changes that have already not taken place. The basic premise of the choice experiment is that a forest good or service can be decomposed in a bundle of attributes or features and those individuals are sensitive to changes in these attributes. Therefore, individuals are asked through a survey to state their willingness to pay to undergo these changes. The

choice experiment method is used to estimate non-use values that ecosystems provide, but can simultaneously estimate use values such as recreational values associated with these ecosystems. The method can be used to estimate the economic benefits or costs resulting from an environmental change that has an impact on (i) non-use values, such as existence values people hold for biodiversity, (ii) use-values such as recreational values or landscape values people hold for a given natural site.



CHECK YOUR PROGRESS

Q 1: State whether the following statements are True (F) or False (F):

(a) Environmental goods are also known as public goods. (T/F)

(b) Option value (OV) includes the intrinsic value of maintaining the environmental goods in their nature state.(T/F)

(c) Economic valuation methods can be classified into 2 categories - pecuniary and non- pecuniary. (T/F)

(d) Cost Price method is also known as imputed willingness to pay. (T/F)

(e) Contingent valuation method and choice experiment method are the types of revealed preference based valuation.(T/F)

Q 2: Expand the following:

(a) UV : ……

(b) TEV : ……

(c) LV : ……

(d) DCBV : ……

(e) WTA : ……

Q 3: What are the different types of travel cost methods? (Write within 30 words).

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7.5 LET US SUM UP

- The valuation of environmental goods and services provides an understanding regarding the initiatives to be taken by the government towards conservation, protection and development of the environmental eco-system.
- These valuations assist the government to assess the initiatives taken for the betterment of environment and for the awareness of national population to avoid damaging and contributing in protecting the environmental resources.
- The valuation techniques provide a strong base for decision making pertaining to policy amendments and seriousness of its implementation.
- These techniques need further development to enhance their applicability and acceptance by people at large.



7.6 FURTHER READING

(1) Bhattacharya, R. N. (2013). *Environmental Economics.* New Delhi: Oxford University Press.

(2) Hanley N., Shogren J. F. and White, B. (2013). *Introduction to Environmental Economics.* New Delhi: Oxford University Press.

(3) Kolstad, C. D. (2010). *Environmental Economics.* New Delhi: Oxford University Press.

(4) Shankar, V. (2001). *Environmental Economics.* New Delhi: Oxford University Press.



7.7 ANSWERS TO CHECK YOUR PROGRESS

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

Ans to Q No 2: (a) Use Value. (b) Total Economic Value. (c) Legacy value (d) Direct Cost/benefit valuation (e) Willingness to accept.

Ans to Q No 2: The types of travel cost methods includes - simple zonal travel cost method (using mostly secondary data), individual travel cost method (using a more detailed survey of visitors and statistical analysis),

and random utility travel cost method (using survey and other data, and statistical techniques).

7.8 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: Differentiate between Willingness to pay and Willingness to accept.

Q 2: Write a short note on contingent valuation method.

Q 3: Briefly describe the types of cost based methods.

Q 4: Differentiate between hedonic method and travel cost method.

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

Q 1: State the meaning and characteristics of environmental goods and services.

Q 2: Briefly discuss the types of values associated with valuation of environmental goods and services.

Q 3: Examine the need of valuation of environmental goods and services.

Q 4: Explain briefly the methods of revealed willingness to pay.

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