PG EC S4-04 (DSE)

TWO YEAR MASTER'S DEGREE COURSE

(CBCS in Accordance with NEP 2020)

SEMESTER-IV

Enviromental Economics

ECONOMICS

Surya Kumar Bhuyan School of Social Sciences

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY

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CONTENTS

		Pages
Unit 1 :	**Basic Concepts of Environment and Environmental Economics** Environment, Ecology, Economy; Need to Study Environmental Economics, Environmental Economics vs. Resource Economics, Nature, Scope and Significance of Environmental Economics	**5-32**
UNIT 2 :	**Economics of Resources-I** Renewable Resources; Definition, Optimal Management of Renewable Resources;	**33-53**
UNIT 3 :	**Economics of Resources-II** Non Renewable Resources; Definition, Difference with Renewable Resources, Optimal Management of Non Renewable Resources	**54-69**
UNIT 4 :	**Property Rights and Environmental Resources** Various Types of Property Rights and Their Environmental Implication, Common Property Rights and Tragedy of Commons	**70-81**
UNIT 5 :	**Environment and Economic Development** Trade off Between Environment and Economic Development-Kuznets' Analysis; Population and Environment; Poverty and Environment; Exogenous and Endogenous Poverty	**82-93**
UNIT 6 :	**International Trade and Environment** Impact of International Trade on Environment-Positive and Negative Impacts; Environment as a Source of Comparative Advantage; Pollution Haven Hypothesis; Empirical Evidence of Industrial Concentration among 'North' (Developed Countries) and 'South' (Developing Countries), Latest Development	**94-111**
UNIT 7 :	**Market Failure and Externalities** Concept of Market Failure, Environment and Market Failure; Concept of Externalities, Types of Externalities, Relationship between Environment and Externality;	**112-131**

Coase

UNIT 8 : Valuation of Environment **132-153**

Various Types of Values of Environmental Goods-Use and Non Use Value; Methods of Valuation; Direct Methods-Contingent Valuation Method; Indirect Methods-Hedonic Pricing and Travel Cost Method;

Unit 9 : Sustainable Development **154-177**

Concept and Indicators of Sustainable Development; Significance and Importance; Policies for Sustainable Development; Related Concept of Sustainable Development

UNIT 10: Environmental Accounting **178-190**

Environmental Accounting, Auditing, Environmental Impact Assessment-Concept only

UNIT 11: Instruments of Environmental Protection-I **191-204**

Types of Instruments; Conventional Instruments-Command and Control (CAC) Measures; Importance of Conventional Instruments

UNIT 12: Instruments of Environmental Protection- II **205-216**

Non Conventional/Incentive Based Measures-Fees/ Tax, Tradable Pollution Permit, Liability Rules

UNIT 13: Environmental Protection and Economic Development- Indian Experience **217-236**

Structure of Indian Environmental Regulatory Policies; Monitoring and Enforcement

UNIT 14: Global Initiative towards Environmental Issues - I **237-258**

Global Conventions for Environmental Conservation; Concept of 'Common but Differentiated Responsibilities'; Cause of Non-Cooperative Behaviour among North and South

UNIT 15: Global Initiative towards Environmental Issues -II **259-281**

Global Environmental Issues, International Trade and Environmen

References **282-286**

COURSE INTRODUCTION

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

The first unit shall discuss basic concepts of enviromental economics such as enviroment and ecology. The second and third unit deals with economics of renewable and non-renewable resources respectively. Second unit basically includes defination and optimal management of economic of renewable resources. Similiarly, unit 3 explains defination, difference of renewable and non-renewable resources and optimal management of non renewable resources. Issues related to various types of property rights and their enviromental implication, common property rights and tragedy of commons are included in chapter 4. Unit 5 of this course basically deals with the relation between environment and economic development. Population and enviroment, poverty and enviroment and exogeneous and endogeneous poverty are the issues which are discussed in this chapter. The sixth chapter of this course basically discusses positive and negative impact of international trade on enviroment. Along with that, this unit discusses pollusion haven hypothesis, empirical evidence of industrial concentration among north and the south and latest development. The issues of market failure and externalities is included in unit 7. The unit of the course discusses concept of market failure, enviroment and market failure, concept of externalities, relationship between enviroment and externality. It also discusses internalisation of externalities by Pigou and Coarse. Unit 8 of the course enviromental economics discusses the issue of valuation of enviroment. Various types of values of enviromental goods, use and non-use value, both direct and indirect valuation methods are included in this course. The 9th unit of this course shall discuss the concept and indicators of sustainale development. Significance and Policies of sustainable development and related concepts of sustainable development will be discussed in this unit. As enviromental accounting is considered as one of the important aspect of enviromental

economics, it is included in unit 10 of the course along with enviromental impact assessment. There are different instruments of enviromental protection. For better understanding of the learner, these instruments are catagorised in to two braod catagories as instruments of enviromental protection I and instrument of enviromental protection II and are included in unit 11 and 12 respectively. The relation between enviromental protection and economic development is included in unit 13. The relation between these two will be discussed in relation to India. Global initiatiative towards enviromental issues such as global convention for enviromental conservation, concept of common but differentiated responsibilities, cause of non-cooperative behaviour among north and south, global enviromental issues are includedc in unit 14 and unit 15.

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

UNIT-I: BASIC CONCEPTS OF ENVIRONMENT AND ENVIRONMENTAL ECONOMICS

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Environment

1.4 Ecology

1.5 Inter-linkages of Ecology, Environment and Economy

1.6 Environmental Economics vs. Resource Economics

1.7 Objectives of Environmental Economics

1.8 Nature, Scope and Significance of Environmental Economics

1.9 Let Us Sum up

1.10 Further Reading

1.11 Answers to Check Your Progress

1.12 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

1.2 INTRODUCTION

In this universe, the Earth is the only planet, so far known by the human, to have an environment that can sustain life. The physical conditions necessary for the origin and survival of human beings, animals and plants are available in our planet Earth only. All human needs such as food, clothing, shelter, medicines, raw materials and even aesthetic pleasure and a liveable atmosphere is provided by the environment. Natural resources, both renewable and non-renewable, present in environment form the basis of our very existence on this terrestrial globe. On the other hand, Economics in general, studies the

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

1.3 ENVIRONMENT

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

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

- Natural environment
- Manmade or Human environment (Astrosphere)

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

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

- **Biosphere:** The Biosphere is the region which includes the Lithosphere, Hydrosphere and the Atmosphere where life exists. It extends from 6,000 meters below sea level to 10,000 meters above sea level.

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

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

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

1.4 ECOLOGY

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

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

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

- Inorganic substances (carbon, nitrogen, carbon dioxide, water, etc.) involved in natural cycles.
- Organic compounds (proteins, carbohydrates, humic substances, etc.)
- Air, water and substrate environment including the climatic regime and other physical factors.
- Producers, autotrophic (i.e., self-sustaining organisms) green plants that can manufacture food from simple inorganic substances.
- Heterotrophic (i.e., that depend on others for nourishment) organisms, mainly bacteria, fungi and animals which live on other organisms or particulate organic matter.
- Micro-consumers, decomposers, mainly bacteria, fungi which obtain their energy by breaking down dead tissues or by absorbing dissolved organic matter, extracted from plants or other organisms. The decomposers release inorganic nutrients that are utilised by producers. They also supply food for macro-consumers or heterotrophic organisms. Bacteria, fungi (and animals) often excrete hormone-like substances that inhibit or stimulate other biotic components of the ecosystem.

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

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

on environment is mostly interested in the pollutants in air and water, the effects of these pollutants on human health and finding the measures to remove these pollutants.

CHECK YOUR PROGRESS

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

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according to its Greek root, ecology deals with the “household of nature” while Economics deals with the “household of man”.

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

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

- **Resources for production:** The environment provides the economy with raw materials, which are transformed into consumer products by the production process, and energy, which fuels this transformation. These raw materials and energy return to the environment as waste products. The environment’s function as a supplier of natural resources or raw materials and energy is clearly a pivotal part of the economy-environment relationship. The identification of the natural world as resources reflects human priorities among the many options for satisfying needs. Resources are the social constructs rather than entities in the natural world. These resources provide the necessary inputs for production activities of mankind. Resources can be renewable or non-renewable and take the form of stocks and flows. Some resources can be easily substituted with other

resources, but are not substitutable. For some resources such as metals and timber, extraction rates can be slowed through recycling but for some resources recycling is not possible (e.g. in the case of oil and coal).

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

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

- **Life support:** Environment provides 'life support' to human. The environment performs numerous functions in its life-support capacity, many of which also relate to the maintenance of sufficient environmental stability for human survival – e.g. maintenance of the gaseous composition of the atmosphere, the regulation of the earth's temperature and maintenance of the weather pattern. The ability of the environment to provide life-support services will depend, in part, on the size of the population, state of food production technology and the demand for other environmental services.

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

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

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

Equity considerations, particularly income distributions are not built in to the economic system. It is the equity which the government must take into account while making various decisions regarding existing environmental problems. The values of human and physical resources are affected by changes in environmental regulations. For example, if a leather

tannery unit is forced to shut down, the owner will lose investment and employees will lose their jobs for which their source of income will be stopped.

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

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

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

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

CHECK YOUR PROGRESS

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

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

Q.6. What is assimilative capacity of environment?

1.6 ENVIRONMENTAL ECONOMICS V/S RESOURCE ECONOMICS

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

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

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

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

Both Environmental Economics and Resource Economics are concerned with the study of natural world. It is only the time element that differentiates the two. Generally,

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

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

1.7 OBJECTIVES OF ENVIRONMENTAL ECONOMICS

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

- To devise environmental strategies that are directed to achieve goals such as repairing of past environmental damages, shifting from waste management to pollution prevention, efficient utilisation of natural resources, creating a balance between environmental quality and development goals, addressing the issue of market failure, etc.
- To achieve a reasonable and equitably distributed level of economic wellbeing that can be maintained for many generations.

- To minimise the impact of human activities on the environment so that the life cycle of biotic and abiotic components shall be undisturbed.
- To set the achievable growth targets for the short run and long run that can be sustained.
- To develop inter-disciplinary approach towards the protection of the environment, so as to achieve acceptable level of pollution and to increase research and development on finding measures of standard of pollution.
- To undertake cost-benefit analysis of each future project meant for environmental protection and their long term sustainability.
- To enrich the global society through generation of regular updated reports on the different parameters of environmental quality and the direction of changes, if any.

CHECK YOUR PROGRESS

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

Q.8. Write two objectives of Environmental Economics.

1.8 NATURE, SCOPE AND SIGNIFICANCE OF ENVIRONMENTAL ECONOMICS

Environmental Economics is one of the fastest developing branches in Economics. Many factors are held responsible for the rapid growth of the subject. First, there is a mass consensus that many environmental goods or resources which were once considered as free, have now become scarce resources. If immediate action is not taken to prevent depletion or degradation of these resources, then the goal of sustainable growth may not be feasible. Second, scientific and engineering approaches to environmental problems can help in understanding the two-way linkage between ecological and economic systems, in identifying the causes of environmental degradation and in obtaining physical measurements of environmental damages but for many decisions making problems an economic approach is needed to obtain monetary value of the damages. Third, in framing environmental protection policy, many developed countries are gradually shifting from

command and control approach to economic or market-based instruments to achieve environmental policy goals. It is because, the economic or market-based instruments are incentive based and they provide an opportunity to economic agents to use their private information, which is not often available to the regulator, in their search for least cost option for compliance with the regulations. Fourth, every government have budget constraints. Thus, it requires cost-benefit analysis of environmental policy options with regard to changes in environmental legislations, resetting of environmental standards and introduction of new policy instruments for environmental protection. Fifth, in arriving at a binding international agreement on global environmental issues, economic analysis is very essential to assess the likely impact of different policy options on distributions of costs and benefits among the member nations and in devising a mechanism for sharing the costs and benefits in an equitable manner.

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

- **Positive and Normative Science:** There are two fundamental perspectives of economics and they are positive and normative. Environmental Economics is considered both as positive and normative science. Positive Economics is more value free, aiming to explain why markets and institutions have evolved as they have and how they work. For example, why the price of gasoline increases when Oil Producing and Exporting Countries (OPEC) meets to restrict production and how the spatial distribution of pollution emissions changes when a marketable permit system is established to regulate sulphur emissions. On the other hand, normative Economics attempts to use economic tools in designing government policies to intervene in the marketplace. When we study the working of Environmental Economics, it is not possible to restrict our attention solely to positive economics. For example, the fundamental issue of Environmental Economics is the notion of market failure. Corrections of market failure require government intervention. The kind of government intervention required to employ is the normative aspect.
- **Micro and Macro aspect**: Environmental Economics covers the micro and macro aspects of the pollution problem. There are many examples of micro and macro aspects of environmental problems in the present times. There are many cities which are crowded

with market places, industrial units and even large residential areas, people do not get enough fresh air. Solution of maintaining good air quality lies in micro level planning. On the other-hand, when the pollution problem is related to the economy as a whole such as rise in temperature and other climatic change, then it is related to macro aspect of environmental planning.

- **Static and Dynamic**: Classical and Neoclassical economists have applied both static and dynamic approaches in relation to environment. The application of economic welfare approach to environment is static in nature. The study of optimum allocation of natural resources is a static question. On the other hand, the time based resource allocation and exploitation that focuses regeneration of resources and regulation of resource use of both renewable and exhaustible such as forests, minerals, fossil fuels, water resources, etc. are dynamic issues.
- **As Social Science:** Environmental economics is not exclusively concerned with the natural environment. For example, man-made and cultural or social environments may also be a part of the nature of environmental economics. Environmental economics deals with economic and managerial aspects of pollution and natural resources. It interacts with human beings and their physical surroundings. It studies the impact of pollution on human beings and suggests rational utilisation of resources in a proper way so that there may be an increase in social welfare or minimisation of social costs.
- **Environmental Quality as an Economic Problem:**

Economic theory studies the aspects of economic life such as what to produce, how to produce, and for whom to produce, so that the scarce resources may be efficiently allocated to maximise human satisfaction. So long as natural resources were available in unlimited quantities, environmental issues were simply social issues. It is only with the transformation of environmental goods into economic goods that economists started applying economic principles and theories to environmental issues. The abuse of environmental resources has transformed environmental resources into economic goods, through a reversal in the demand-supply relationship of environmental quality. While the demand for environmental quality has registered a sharp increase, the supply of clean air, clean water and other resources have declined. At the verge of subsistence, people seldom worry about the quality of the environment in which they live. People think about other less immediate wants like enjoyment of environment quality and the expectation of healthier and longer life only after assuring the basic needs– food, clothing and shelter.

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

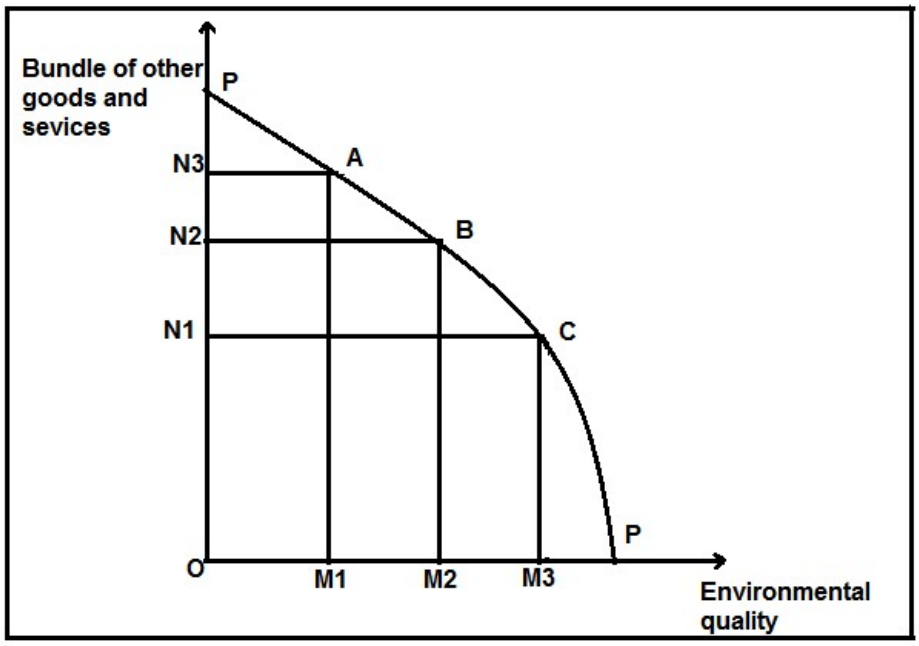


Figure-1.1: The production possibility frontier

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

The environment has got a very close relation with economics. The relation deals with the welfare of the society and the growth theories of economics. The economic analysis of environmental problems yields an understanding of the complex relationships among the different parameters of the economic system, inter-relationship between environment and economic development. With the emergence of many new areas the scope of

Environmental Economics is getting enriched and extended, some of which are discussed below:

- **Economic growth and Environmental Balance:** Economic growth and environmental balance move in the opposite direction. Higher economic growth requires higher amount of resource exploitation which lead to increased harmful impact on the environment. Environmental balance can be achieved only if resources are not exploited and pollution is not generated. But, un-exploitation of natural resources will lead to lower economic growth. The only solution to achieve balance is to control the scale of pollution and optimal use of environmental resources. Nowadays, nations are concerned about sustainable development which implies controlled use of resources without endangering the future generations. Thus, all economic projects have to undergo a cost-benefit analysis with regard to environmental consequences. An economic project is undertaken only when the benefits are larger than the costs but one cannot say that a benefit for today is better than harming the future.
- **Pollution Control and Environment:** Economic activities of human being result in pollution that has serious impact on the environment and the society. The cost of pollution resulting from production and consumption activities never gets through market mechanism. Pollution resulting from production and consumption activities is called negative externalities. The costs of clean-up and control of pollution today is rising which has to be ultimately borne by the consumers. The producers, who are the major polluters simply shift the cost of pollution to the consumers. On the other hand, consumers' sacrifices environmental standards and pollution control to avoid payment for the cost of achieving good environmental quality. There are various tools which are used to control such environmental market failure. The Command and Control (C&C) legislations involving identification of the type of environmentally harmful activity, imposition of specific conditions or standards on that activity and prohibition of forms of the activity that fail to comply with the prescribed standards are the direct method of regulating environmental pollution. On the other hand, imposition of pollution tax, provision of subsidies and incentives for clean technologies and practices and the creation of markets in either environmental protection or pollution are market based instruments.
- **Conservation of Resources:** Environmental Economics deals with conservation of natural resources also. The environment is the provider of all the resources– renewable and non-renewable. Each of these resources sometimes require centuries to form under

conditions that cannot be duplicated. In today's fast moving economic scenario of every country resources are being exploited in a rapid pace and can be exhausted very soon. Every natural resources are scarce and therefore they must be conserved. Optimal use of resources must be ensured and wastage must be avoided because absence of these resources means economic activities will not be there.

- **The Greening of National Income Accounts:** Now a days depletion of capital includes not just depreciation of physical capital but also depletion of natural resources, along with deterioration of environmental quality. There is an emerging measure of economic growth known as 'Environmentally Adjusted Domestic Product' referring to drawing up of national income accounts that subtracts environmental losses during the accounting year.
- **Population and Environment:** Another area that Environmental Economics covers is the relationship of population growth and environment. The Inter Academy Panel Statement on Population Growth has stated that rapid population expansion, resulting in many environmental problems such as rising levels of atmospheric carbon dioxide, global warming and pollution. There are some other associated problems of overpopulation. They are increased demand for resources such as fresh water, air and food, extraction and exploitation of natural resources faster than the rate of regeneration, starvation and malnutrition of the poor section, deterioration in the living conditions, etc. However, many thinkers believe that it is the overconsumption and generation of industrial wastes especially by the developed countries which exerts more pressure on the environment than population growth.
- **International Cooperation in Environmental Protection:** International cooperation among nations is very essential in dealing with many international issues such as hazards of trans-boundary shipments, unwanted substances and common property resources that includes sharing of river water, marine resources, forest land etc. There are many negative effects of inadequate toxic waste generated within countries and hazardous goods exported to other countries. Environmental protection is inherently a cross border issue and thus it leads to the creation of transnational regulations via multilateral and bilateral treaties. The United Nations Conference on the Human Environment held in Stockholm and the Earth Summit were the keys in the development of various international instruments for environmental protection.

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

CHECK YOUR PROGRESS

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

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

1.9 LET US SUM UP

- *The Webster's Universal College Dictionary* (2002) defines the term Environment as "the air, water, minerals, organisms, and all other external factors surrounding and affecting a given organism at any time.''
- The components of environment are broadly classified into two parts, namely, natural environment and manmade or human environment (Anthrosphere).
- Ecology is the scientific study of the relationships between organisms and their environment which are complex, varied and hierarchical. Ecology describes the relationships between living organisms and their environments, the interaction of organisms with each other and the pattern and cause of the abundance and distribution of organisms in nature.
- The terms "ecology" and "economics" are derived from the same Greek word "Oikos" referring to house or habitat. Ecology deals with the "household of nature" while Economics deals with the "household of man".
- Environment provide different services to the economy such as supply of resources, assimilation of waste, life support and amenities etc.
- Every economic system concerned with the four basic goals which are efficiency, equity (both are microeconomic variables), stability and growth (both are macroeconomic

variables). The achievement of all these four goals often put immense pressure on the environment.

- Economic development is the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human wants and to improve the quality of life.
- Environmental Economics is concerned with the impact of the economy on the environment, the significance of the environment to the economy, and the appropriate way of regulating economic activity so that balance is achieved among environmental, economic, and other social goals. On the other hand, Resource Economics deals with the study of natural resources. It is the field of study that concern with the flow of resources from nature to economic activity.
- As Environmental Economics covers diverse aspects relating to environment and the economy, its scope is very extensive.

1.10 FURTHER READING

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

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

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

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1.11 ANSWERS TO CHECK YOUR PROGRESS

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

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

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

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

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

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

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

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

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

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

Ans to Q No. 9: Environmental Economics covers the micro and macro aspects of the pollution problem. For example, there are many cities which are crowded with market places, industrial units and even large residential areas, people do not get enough fresh air. Solution of maintaining good air quality lies in micro level planning. On the other hand, when the pollution problem is related to the economy as a whole such as rise in temperature and other climatic change, then it is related to macro aspect of environmental planning.

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

1.12 MODEL QUESTIONS

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

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

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

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

Q.4: Write the objectives of Environmental Economics.

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

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

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

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

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

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

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

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UNIT 2: RESOURCE ECONOMICS-I

UNIT STRUCTURE

2.1 Learning Objectives
2.2 Introduction
2.3 Environment and Economy-The Material Balance Model
2.4 Natural Resource and Classification of Resources
2.5 Renewable Resources and its Optimal Management
2.6 Let Us Sum up
2.7 Further Reading
2.8 Answers to Check Your Progress
2.9 Model Questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

2.2 INTRODUCTION

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

2.3 ENVIRONMENT AND ECONOMY- THE MATERIAL BALANCE MODEL

Before we proceed to Resource Economics, it is very essential to understand the relationships between environment and the economic system. As stated in the previous unit, environment serves as supplier of natural resources on the one hand and act as

sink of waste disposal generated from the utilisation of these resources on the other. Thus there is a very close relationship between environment and economic activity of humankind. The relationship between environment and economy can be best explained with a model that is called the "Material Balance Model". The material balance approach of Allen Knees (1970) and R.V. Ayres (1969) visualises the total economic process as a physically balanced flow between inputs (resources) and outputs (waste/residuals).

The Material Balance Model is based on the first and second law of Thermodynamics. According to the first law, matters and energy can neither be created nor destroyed. In this model, it implies that in the long run the flow of materials and energy extracted from nature for production and consumption must be equivalent to the flow residuals into the environment from these activities. The environment has got a fixed amount of mass which takes the form of soil, plants, minerals, etc. This mass changes from one form to another due to environment or man-made influences but the entire mass does not change. For example, water takes different forms like ice, snow, vapour, etc. Even though water is split into oxygen and hydrogen, the total quantum of the elements is the same as that of the original water. Similarly, every resources drawn from nature for economic activities ends up as residual at different stages and the mass of these residuals is same as that of the original resources. Higher economic growth requires higher level of production and consumption which ultimately leads to increased extraction of resources from nature and disposal of wastes/residuals into the environment. The wastes or residuals when discharged causes significant amount of environmental damage. The second law of Thermodynamics known as Entropy law states that, nature's capacity to convert matter and energy is not without bound. During the conversion process some of the energy become unusable in another process although it still exists. Thus, the transformation of materials and energy is an irreversible transformation of useful materials into waste. Entropy is a measure of unavailability or disorderliness that describes the extent to which matter or energy is organised or structured. Higher the entropy lesser will be the organised or structured form of materials or energy and vice versa. Economic activities of production and consumption transforms matters and energy from low entropy to high entropy and the overall entropy of the system increases over time. Hence the fundamental process upon which economic activity depends is finite.

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

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

$$R = F + W_1$$

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

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

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

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

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

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

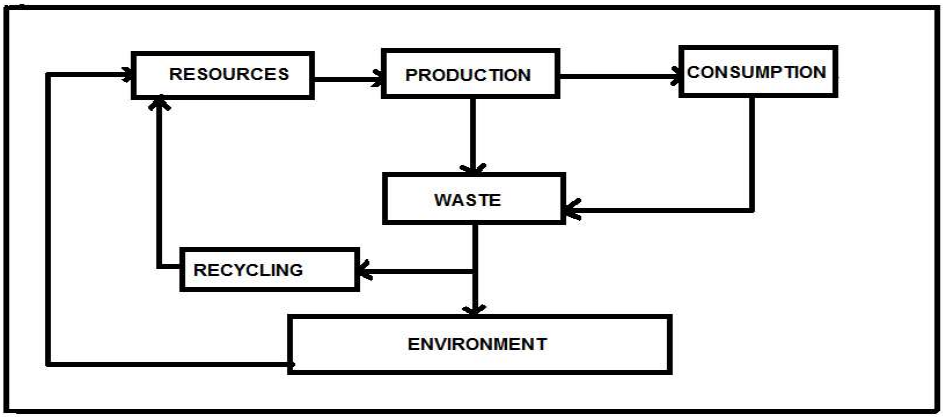


Figure-2.1: Material Balance Model

CHECK YOUR PROGRESS

Q.1. Who propounded the Material Balance Model?

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

2.4 NATURAL RESOURCE: DEFINITION, CLASSIFICATIONS AND CHARACTERISTICS

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

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

- **Renewable Resources:**

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

➢ Biological resources consist of the various species of plants and animals. They have one distinctive feature that is important for consideration here. While these resources are capable of self-regeneration, they can be irreparably damaged if they are exploited beyond a certain critical threshold. Hence, their use should be limited to a certain critical zone. Examples of this type of resource are fisheries, forests, livestock, and all forms of plants.

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

- **Non-Renewable Resources:**

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

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

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

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

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

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

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

Resources have three main characteristics and they are-

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

exhaustible resources are present in certain amount, so over-exploitation may result in depletion of stock.

CHECK YOUR PROGRESS

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

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

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

2.5 RENEWABLE RESOURCES AND ITS OPTIMAL MANAGEMENT

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

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

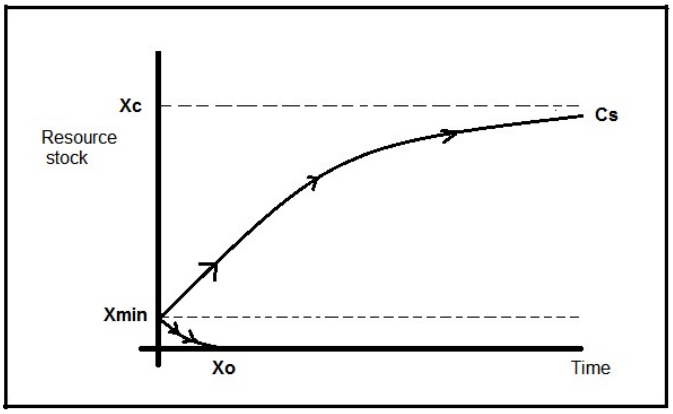


Figure-2.2. Logistic growth curve of renewable resource

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

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

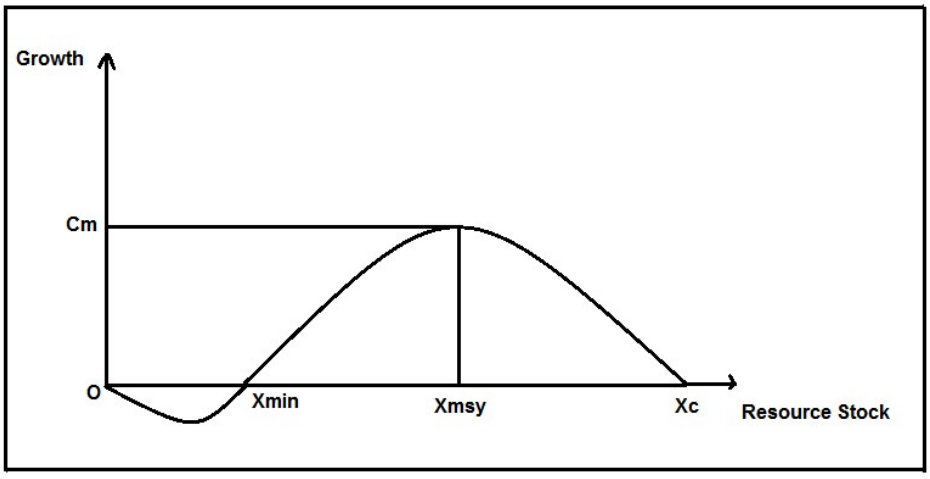


Figure-2.3: Resource stock and growth

The growth of fish stock cannot exceed a given level, such as Xc in Figure 2.3 because of environmental constraints. The growth rate is slow at low stock levels because of the difficulties of fish finding other fish to breed with. It increases to a maximum level Cm at the turning point of the curve, then declines to Xc, the maximum carrying capacity. The growth of fish stocks slows down as fish compete for food supplies until the maximum

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

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

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

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

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

H= rate of harvest

X= growth of stock of the resource

Rewriting the above equation we have-

$H = EX$

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

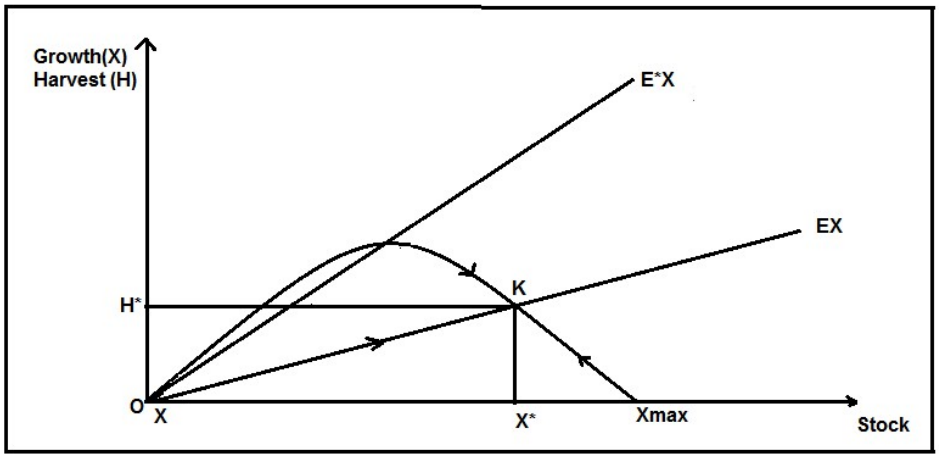
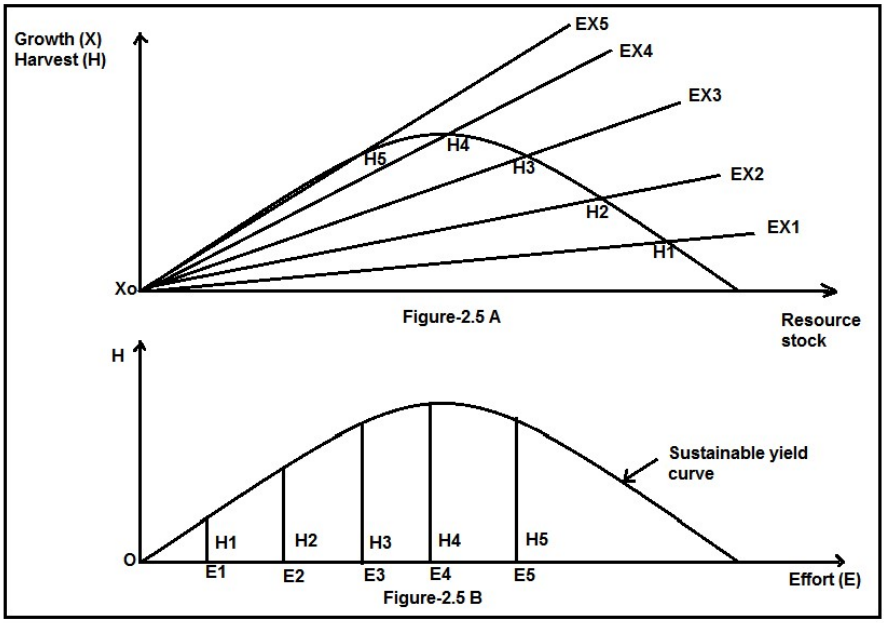


Figure-2.4: The relationships between harvest, population size and effort

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

After determining the relationship of harvest and stock level we have to determine the sustainable yield curve and for this we need to introduce costs and revenue in the analysis. The introduction of revenue and costs require establishment of relationship between harvest (yield) and the level of effort. Fig. 2.5 A shows the equilibrium level of harvest for different degrees of efforts put in the harvesting. Subsequently, the levels of efforts and the associated harvest levels are shown in Fig. 2.5 B. It is important to note that each level of effort is associated with an equilibrium population size that is unique to the effort in question. For example, in both Figures 2.5 A and 2.5 B, the effort level E1 is related not only to the sustainable harvest of H1 but also to the same equilibrium population. By joining the different combinations of efforts and level of harvest we will obtain a curve similar to natural growth curve and it is called sustainable yield curve of renewable resource (Figure-2.5B). The sustainable yield curve is nothing more than the natural growth curve expressed in terms of effort. Each point along the sustainable yield curve assumes an equilibrium population size that corresponds to a given level of effort. However, the levels of effort and the equilibrium population size are inversely related which is seen from the figures 2.5 A and 2.5 B. That is, the larger the level of effort, the smaller the size of the equilibrium population and vice versa. This also suggests that excessive harvesting of a renewable resource could lead to its irrevocable destruction or extinction. Thus, in this sense, renewable resources are potentially destructible.



Now if we assume that effort is the only factor of production, then total cost will be equal to the level of efforts multiplied by the price of effort. The price of effort may be taken as the wage rate, W and thus total cost of harvest, TC = WE. Since firms in the fishery are assumed to be price-takers, the total cost curve will be a straight line with a constant slope equal to the market price of effort, W. Similarly, total revenue from the harvest can be obtained by multiplying quantity of harvest (H) with price of harvest per unit (P) that is, TR = PH. The total revenue curve will have the same shape as the sustainable yield curve. In fact, it is nothing more than the monetised version of the sustainable yield curve.

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

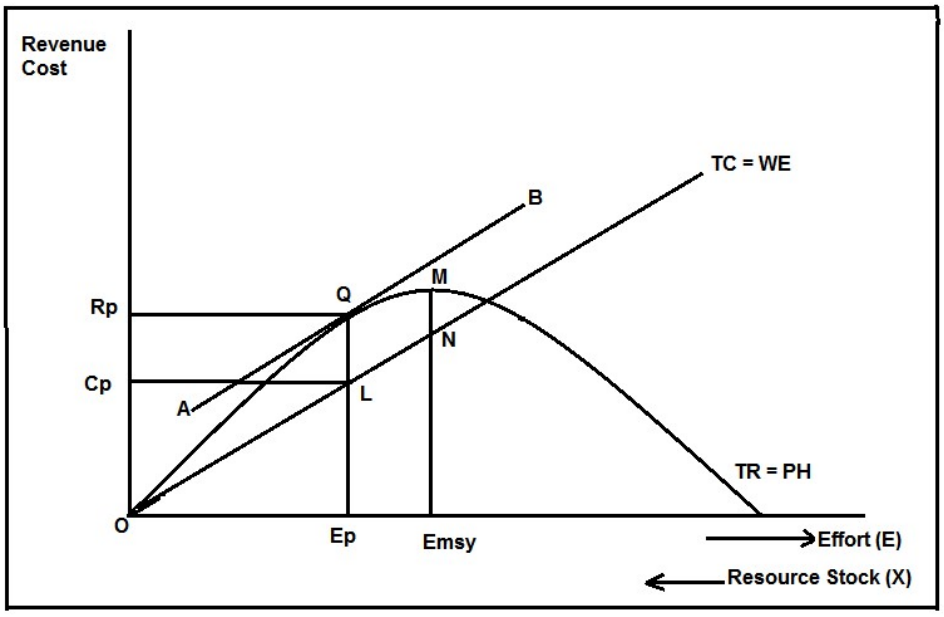


Figure-2.6: Determination of profit maximising or optimal level of harvest

In Fig. 2.6 fishing costs are introduced on the horizontal axis, increasing from left to right along with fishing effort. At high levels of fish stocks or low level of effort costs are lower. Costs increase as the size of the fish stock declines or level of efforts increase. Now to determine the profit maximising level of harvest we need to locate the point where the difference between total revenue and total costs is maximum or profit is maximum. This can be obtained by equating marginal revenue and marginal cost also. The slope of the marginal cost and total cost provide the marginal revenue and marginal cost curves. In Fig. 2.6, AB is the slope of the total revenue curve at point Q. At point Q the slopes of the total revenue and total costs curves become equal i.e. marginal cost equals marginal revenue which is the profit maximising condition. Thus, the profit maximising level of harvest (optimal level of resource use) is determined at Q. The profit is shown by the distance between the total revenue and the total cost curves and it is QL. On the other hand, the difference between total revenue and total costs at the maximum sustainable yield is MN and in the Figure-2.6, QL > MN. Thus, profit at profit maximising effort (Ep) is higher than the profit at maximum sustainable yield (Emsy) level of effort. The profit maximising level of fishing effort Ep gives a larger size of fish population than the maximum sustainable yield, Emsy level of effort. If costs of harvest increases, then the profit maximising level of harvest will fall. On the other hand, if costs of harvest decreases then the profit maximising catch will come closer to the maximum sustainable yield. The profit maximising harvest would be equal to the maximum sustainable yield level of harvest only if there is no cost of harvest i.e. if fishing cost is zero.

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

CHECK YOUR PROGRESS

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

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

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

2.6 LET US SUM UP

- Resource Economics studies the allocation of scarce resources. Resource Economics is mainly concerned with the flow of resources from nature to economic activities and provide an extensive idea about the availability, scarcity and potentiality of resource base of the nature.
- There is a very close relationship between the environment and economic activity of humankind. The relationship between environment and economy can be best explained with a model what is called the “Material Balance Model”. This approach visualises the total economic process as a physically balanced flow between inputs (resources) and outputs (waste/residuals).
- The Material Balance Model is based on the first and second law of Thermodynamics. According to the first law, matters and energy can neither be created nor destroyed. In the material balance model, it implies that in the long run the flow of materials and energy extracted from nature for production and consumption must be equivalent to the flow residuals into the environment from these activities. The second law of Thermodynamics known as Entropy law states that, nature’s capacity to convert matter and energy is not without bound. During the conversion process some of the energy becomes unusable in another process although it still exists. Thus, the transformation of materials and energy is an irreversible transformation of useful materials into waste.
- Natural resources are the natural assets (raw material) occurring in nature that can be used for economic production or consumption. It is anything derived from the nature that is directly used by human beings.
- There are numerous ways to classify natural resources they are- regeneration capacity, source of origin, stages of development etc.
- On the basis of regeneration capacity natural resources are classified into two major categories: renewable and non-renewable natural resources. On the basis of source of origin resources are classified into biotic resources and abiotic resources. On the basis of stages of development resources are classified into potential, actual, reserve and stock resources.
- Although, renewable resources are regenerative in nature, the ability to regenerate is not unlimited. The natural process of regeneration requires a time frame and it has certain limit. Such resources must be managed in a sustainable way so that only additions to stocks, or the ‘sustainable yield’ are harvested. Thus, optimal management of renewable resources is a crucial concern of resource economics i.e. to determine the optimum rate of use of renewable resources over time or over generations.
- The natural growth path of any biological resource is a function of time.
- The maximum sustainable yield (MSY) of a renewable resource is the amount of the resource which can be harvested without depleting the stock. A ‘sustainable yield’ would be a size of harvest which equals the growth rate of the stock of the resource.

- For a given population size of a renewable resource, the higher the level of effort, the larger will be the harvest or catch; and given the level of effort, the larger the population size, the larger will be the harvest.
- The optimal level of harvest of renewable resource is determined at the harvest yield level where the difference between total revenue and total cost is maximum.

2.7 FURTHER READING

Eugine, T. (2009). *"Environmental Economics",* Vrinda Publications (P) Limited, Delhi.
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Tietenberg, T. & L. Lewis (2012). *''Environmental and Natural Resource Economics",* 9th Edition, Pearson.

2.8. ANSWERS TO CHECK YOUR PROGRESS

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

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

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

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

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

Ans to Q No 6: The maximum sustainable yield (MSY) of a renewable resource is the amount of the resource which can be harvested without depleting the stock. A 'sustainable yield' would be a size of harvest which equals the growth rate of the stock of the resource.

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

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

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

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

2.9 MODEL QUESTIONS

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

Q.1: Write a note on the Material Balance Model.
Q.2: Define natural resource. Discuss how resources are classified.
Q.3: Write a short note on maximum sustainable yield.

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

Q.1: Define renewable resources. Diagrammatically explain the concept of maximum sustainable yield of renewable natural resources.
Q.2: What are the different types of renewable resources? Explain the process of determination of optimal level of renewable resource use.

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UNIT 3 : ECONOMICS OF RESOURCES-II

UNIT STRUCTURE

3.1 Learning Objectives
3.2 Introduction
3.3 Non Renewable Resources: Concepts and Types
3.4 Difference between Renewable and Non-Renewable Resources
3.5 Optimal Management of Non-Renewable Resources
3.6 Backstop Resources: A Renewable Substitute
3.7 Optimal Extraction Path with Increasing Marginal Cost
3.8 Let Us Sum up
3.9 Further Reading
3.10 Answers to Check Your Progress
3.11 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

3.2 INTRODUCTION

Conventionally, natural resources are classified as renewable resources and non-renewable resources based on their rate of regeneration. In this unit, we shall deal with economics behind the non-renewable resources. Here, we are going to discuss the different concepts relating to non-renewable resources and their significance; also how non-renewable resources are different from renewable resources and how to allocate non-renewable resources among the generations, i.e., optimal management of these resources. Non-renewable resources are exhaustible due to its finite availability. Consequently, it involves the challenge for managing the stock of these declining resources among generations. Therefore, management of these resources has become an important issue in modern planning for development.

3.3 NON-RENEWABLE RESOURCES: CONCEPTS AND TYPES

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

➢ *Current reserves* are defined as known resources that can profitably be extracted at current prices. The magnitude of these current reserves can be expressed as a number.

➢ *Potential reserves* are most accurately defined as a function rather than a number. The amount of reserves potentially available depends upon the price people are willing to pay for those resources—the higher the price, the larger the potential reserves. Higher prices enable not only more expensive measures to recover more of the resources from conventional sources, but also measures to extract resources from previously untapped unconventional sources.

➢ The *resource endowment* represents the natural occurrence of resources in the earth's crust. Since prices have nothing to do with the size of the resource endowment, it is a geological, rather than an economic concept. This concept is important because it represents a physical upper limit on the availability of terrestrial resources.

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

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

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

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

But all non-renewable resources are not recyclable; there are certain non-renewable resources which are irreversibly transformed if they are in use, they are known as non-recoverable or non-recyclable resources. For example, if energy resources (such as oil, coal etc.) are combusted and turned into heat energy, the heat dissipates into the atmosphere and becomes non-recoverable. Current use of non-renewable non-recyclable resources precludes future use; hence, the issue of how they should be shared among generations has gained significant importance.

3.4 DIFFERENCE BETWEEN RENEWABLE AND NON RENEWABLE RESOURCES

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

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

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

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

CHECK YOUR PROGRESS

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

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

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

3.5 OPTIMAL MANAGEMENT OF NON-RENEWABLE RESOURCES

It is known that non-renewable resources are limited in quantity and are not reproducible. Extraction and consumption of a unit today of these resources involves an *opportunity cost,* i.e., the value that might have been obtained at some future date. This opportunity cost is also termed as *user cost*. The concept of user cost is the central issue of management of non-renewable resources. Non-renewable resources have a user cost as consumption or extraction of these resources at present reduces its availability in the future, as non-renewable resources are not reproducible like renewable resources. Therefore, the user cost must be taken into account while determining how to allocate the resource over time. As a result, instead of the usual efficiency condition,

Price = marginal cost

We have,

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

This is the first condition of optimal depletion. As shown in Fig. 1, it implies that less of the resource will be extracted today than if it were producible. Given the demand $P = P(y)$,

where *p* is price and *y* is quantity, only *y** units will be extracted by a planner or resource manager seeking to allocate extraction efficiently over time, leaving a positive difference '*AB'* between the price and the marginal cost of production or extraction.

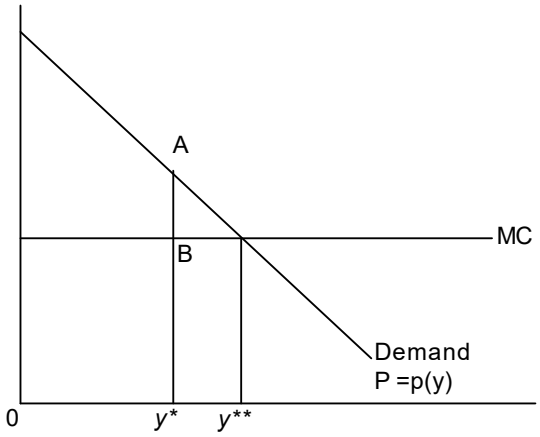


Figure 1: Relationship between marginal cost and price for an exhaustible resource

The second condition of optimal depletion describes the behavior of the user cost over time. To know the behavior of user cost over time, let us assume, for simplicity, a two period model. The owner of the resource can extract and sell the resource today, or it can leave the resources in the ground until the next period. Suppose a non renewable resource, say oil, is in fixed quantity, *q* and also the marginal cost of extraction remains constant, *c*. The demand in period *t (t* = 0,1) is given by the equation $p_t = (q–y_t)$, where p_t is price at time 't' and y_t is output that can be extracted at time 't', and the rate of discount is '*r'*. Here, rate of discount 'r' is the rate at which present value of a stream of output levels extracted over a period of time 't' is computed, so that allocation over the period 't' can be made possible. Now the question is what allocation of output between the two periods will yield the greatest net benefit? For efficient or optimal extraction of non renewable resources, it is important to determine what quantities to be extracted today and how much to leave it in the ground for future usages.

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

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

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

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

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

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

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

Subject to

$$y_0 + y_1 = q$$

For maximization, the Lagrangian function will be

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

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

$(q - y_0) - c - \lambda = 0$ ..... (2)

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

$q - y_0 - y_1 = 0$ ..... (4)

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

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

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

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

Then the equation for the time path of price is

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

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

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

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

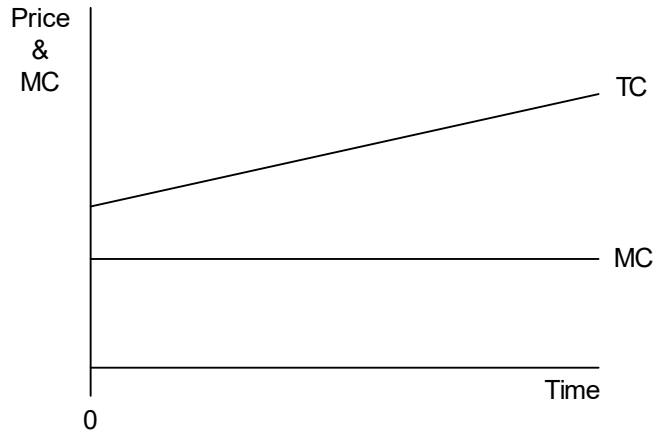


Figure 2: Time path of price and its relationship to resource costs (marginal cost of extraction and user cost)

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

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

3.6 BACKSTOP RESOURCE: A RENEWABLE SUBSTITUTE

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

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

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

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

$$P_t = MC_b$$

Now, we have

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

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

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

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

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

CHECK YOUR PROGRESS

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

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

3.7 OPTIMAL EXTRACTION PATH WITH INCREASING MARGINAL COST

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

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

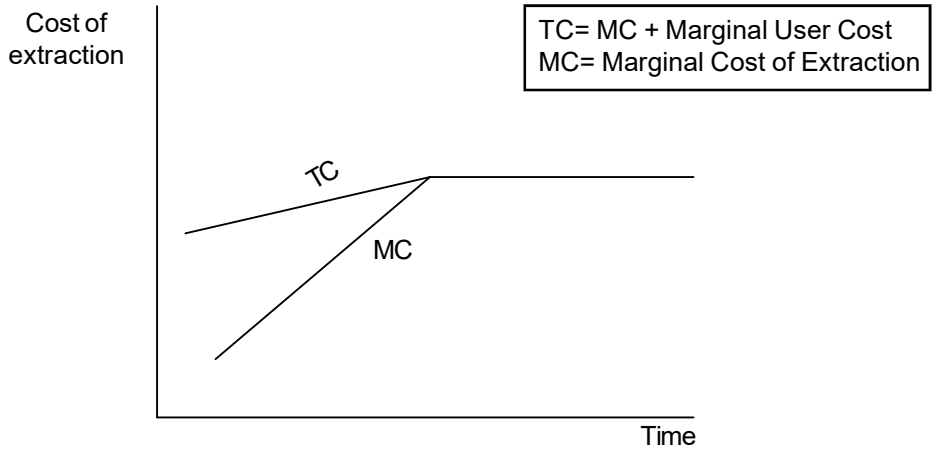


Figure 3: Increasing Marginal Extraction Cost with Substitute Resource

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

The two cases are also different in terms of depletion of the non-renewable resource. In the constant-cost case, the resource ultimately gets exhausted. However, in case of increasing cost, the resource does not deplete completely; something will be left in the ground because it is more expensive than the backstop.

CHECK YOUR PROGRESS

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

3.8 LET US SUM UP

- Three separate concepts are used to classify the stock of non-renewable resources: *current reserves*, *potential reserves* and *resource endowment.*

- Non-renewable resources can be classified as *recyclable resources* and *non-recyclable resources.*

- Non-renewable resources can be distinguished from renewable resources primarily on the ground of rate of replenishment, availability and storage services.

- There are basically two conditions for optimal management of non renewable resources. First, price should incorporate both marginal cost of extraction and user cost. Second, the present value of the user cost must be the same in all periods or, i.e., the undiscounted user cost must rise at the rate of interest.

- Opportunity cost increases with increasing scarcity of non renewable resources.

- Backstop resources not only to set an upper limit on the price of non-renewable resources but also determines the initial price by determining the initial user cost to be added to the marginal cost of extraction.

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

3.9 FURTHER READING

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3.10 ANSWERS TO CHECK YOUR PROGRESS

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

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

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

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

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

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

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

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

3.11 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

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

Q 2: In a two period model framework, find out the price for each period and also the net social benefit, when the demand function is $P_t = (10 - Y_t)$, marginal cost of extraction is \$2 *and* quantity of the resource that can be extracted is fixed at 10 units.

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

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

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

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

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UNIT 4: PROPERTY RIGHTS AND ENVIRONMENTAL RESOURCES

UNIT STRUCTURE

4.1 Learning Objectives
4.2 Introduction
4.3 Various Types of Property Rights
  4.3.1 Private Property Regime
  4.3.2 State Property Regime
  4.3.3 Common Property Regime
  4.3.4 Open Access Regime
4.4 Property Rights and Their Environmental Implications
4.5 Common Property Resources (CPRs) and Tragedy of Commons
4.6 Tragedy of the Commons: A Game Theoretic Approach
4.7 Let Us Sum Up
4.8 Further Reading
4.9 Answers to Check Your Progress
4.10 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

4.2 INTRODUCTION

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

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

- *Comprehensively assigned:* All assets or resources must be either privately or collectively owned, and all entitlements must be known and enforced effectively.
- *Exclusive:* All benefits and costs from use of a resource should accrue to the owner, and only to the owner, either directly or by sale to others. This applies to

resources that are owned in common as well as to resources for which private property rights have been assigned.

- *Transferable:* All property rights must be transferable from one owner to another in a voluntary exchange. Transferability provides the owner with an incentive to conserve the resource beyond the time he or she expects to make use of it.
- *Secure:* Property rights to natural resources should be secure from involuntary seizure or encroachment by other individuals, firms or the government. The owner has an incentive to improve and preserve a resource while it is in his or her control rather than exploit the assets.

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

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

CHECK YOUR PROGRESS

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

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

4.3 VARIOUS TYPES OF PROPERTY RIGHTS

Let us discuss the various types of property rights and how they influence the interaction between human and the natural environment. There are mainly four types of

property rights and we call them as “property right regimes”, namely private property, state property, common property and open access.

4.3.1 Private Property Regime

Under *private property* regime, an individual or corporation has the right to exclude others and to regulate the use of the resources. This regime provides the institutional arrangement for a successful exclusion because this type of property is more effective in making the government enforce their rights. Private property regimes appear to be stable and adaptive because they have the social and legal sanction to exclude others and effectively to resist unwanted intrusions (through power of the state). Examples are privately owned land, privately owned machines, livestock ownership, etc.

4.3.2 State Property Regime

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

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

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

4.3.3 Common Property Regime

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

4.3.4 Open Access Regime

In *open access* regime, no one owns or exercises control over the resources. Use of the resources is free and open to all. Resources can be exploited on a first-come, first-served basis because no individual or group has the legal power to restrict accessibility. An open access regime can be efficient only if the ‘shadow price’ of the resource is zero. That means if there is no social cost of extracting or using a marginal unit of the resource, it is beneficial for the society not to assign specific property rights over it. This regime is also known as *Res nullius* property right regime. This regime has also given rise to what

has become popularly known as the “tragedy of the commons”, which will be discussed in the later section.

4.4 PROPERTY RIGHTS AND THEIR ENVIRONMENTAL IMPLICATIONS

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

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

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

CHECK YOUR PROGRESS

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

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

4.5 COMMON PROPERTY RESOURCES AND TRAGEDY OF THE COMMONS

If we look deeply into the Common Property Resources (CPRs), we get to know that CPRs can be governed through shared private ownership regimes or government ownership regimes with community participation in its management. A resource is likely to be commonly owned or managed when its territorial division is either not feasible (such as the fish in the ocean) or very costly to enforce. There are two basic characteristics that all the CPRs have:

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

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

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

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

CHECK YOUR PROGRESS

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

4.6 TRAGEDY OF THE COMMONS: A GAME THEORETIC APPROACH

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

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

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

Technically, the choice of non-cooperation is the dominant strategy for each player. A dominant strategy gives a player a greater pay-off regardless of the other player's actions. In our example, the non-co-operative strategy dominates the co-operative one since 80 > 60 and 30> 20. This outcome is called Nash equilibrium, obtained when each player choose to send three animals for grazing on the field. Here, the tragedy is that even though the strategy of co-operation would be better for both the herdsmen, but due to

their individual rationale, they opt for the strategy of non-co-operation. This may benefit them individually but society will not benefit from it. Maximization of individual output will lead to complete destruction of the resource, i.e., the grazing land.

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

4.7 LET US SUM UP

- Property rights represent a bundle of entitlements that define the owner's privileges and obligations for use of a resource or an asset. Property rights are very much essential for a market to operate efficiently. Otherwise, without property rights, market cannot rely upon for efficient management of natural resources.
- Property right regimes can be classified as: private property regime, state property regime, common property regime and open access regime.
- None of the property right regimes is regarded as best for conservation of environmental resources. Although private property right has some efficiency over the other regimes, sometimes it can also lead to depletion/destruction of the resource.
- Common property resources can lead to the problem of the 'tragedy of the commons' due to its unique characteristics.
- In game theory, the 'tragedy of the commons' is a situation where participants choose a sub-optimal strategy even if there is optimal strategy available to them.

4.8 FURTHER READING

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4.9 ANSWERS TO CHECK YOUR PROGRESS

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

Ans to Q No 2: When well defined property rights are not available in system, it becomes difficult to enable people to reveal their willingness to pay for the good or service it provides. Everyone will try getting it free of cost, which may result in free rider problem. In such a case, it is not possible for the market to operate efficiently, even if possible; market allocation can never be efficient.

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

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

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

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

4.10 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

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

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

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

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

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

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UNIT 5: ENVIRONMENT AND ECONOMIC DEVELOPMENT

UNIT STRUCTURE

5.1 Learning Objectives
5.2 Introduction
5.3 Trade-off between Environment and Economic Development – Kuznets' Analysis
5.4 Population and Environment
5.5 Poverty and Environment
5.6 Exogenous and Endogenous Poverty
5.7 Let Us Sum Up
5.8 Further Reading
5.9 Answers to Check Your Progress
5.10 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

5.2 INTRODUCTION

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

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

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

The natural environment plays important role in an economy. The natural environment acts as the provider of inputs for production of goods and services. Environmental resources such as minerals, fossil fuels etc. help in the production activities. Growing production activities directly contribute towards increase in the rate of economic growth. The environment also acts as sequestering carbon, filtering air and soil formation. All these activities help in the functioning of economic activities.

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

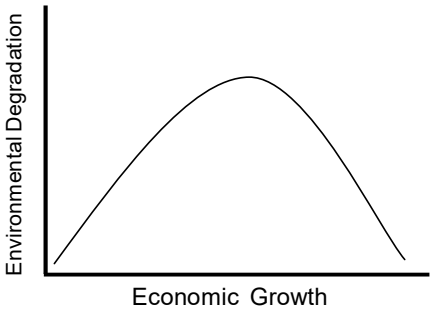
5.3 TRADE-OFF BETWEEN ENVIRONMENT AND ECONOMIC DEVELOPMENT – KUZNETS' ANALYSIS

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

capita increases the environmental quality goes on decreasing (environmental pollution increases). However, beyond a certain point, increase in economic growth that is GDP per capita leads to reductions in environmental damage. The Environmental Kuznets Curve can be explained more specifically by the following points:

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

Figure: 5.1 The Environmental Kuznets Curve



The Environmental Kuznets Curve (EKC) is an inverted U shaped curve because of the inverse relationship between economic growth and economic degradation. At the early stage of economic growth that is in the developing stage, an economy does not take care of the environment. Therefore, the environment continuously degrades. The highest point on the curve is called the turning point. After reaching a certain level of economic growth, the economy starts taking the environmental consequences under consideration. Therefore, the economy develops various technologies to clean up the environment and environmental degradation starts declining. The downward sloping portion of the curve reflects where economic growth leads to fall in enviromental degradation.

CHECK YOUR PROGRESS

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

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

Q.3: What is sustainable development?

5.4 POPULATION AND ENVIRONMENT

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

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

Over population leads to over use of the natural resources such as forests, water, fisheries and mineral resources etc. If use of these resources surpasses the capacity to regenerate, it leads to environmental degradation. Continuous growth of population also accelerates the environmental degradation and that would severely compromise the ability of both the present as well as future generation to meet their needs.

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

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

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

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

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

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

- **Problem from exploitation of mineral resources-**
  With the growth of population, demand for mineral resources increases which leads to more and more extraction of minerals from the earth's crust. Extraction of minerals results in many environmental pollutions such as air, water, soil and noise pollution. It also harms the biodiversity due to destruction of forest around the mining fields.
- **Problem from the generation of waste-**
  Increasing consumption increases waste generation. Man dumps waste in the environment. If it crosses the absorption capacity of the environment, it results in environmental degradation in the form of air and water pollution.

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

5.5 POVERTY AND ENVIRONMENT

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

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

Environmental scarcities of arable land and water result in loss of livelihoods. These are some of the key factors causing poverty. The loss of agricultural land due to drought, flood and land degradation affect the poor. The poor often live on steeply sloped

hilly areas, where they are at higher risk of landslides and resulting loss of life during storms and floods.

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

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

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

5.6 EXOGENOUS AND ENDOGENOUS POVERTY

As discussed above, there is an inter-linkage between poverty and environmental degradation. On the basis of this linkage, poverty can also be categorised into exogenous and endogenous poverty. Exogenous poverty among the population is initially caused by external factors rather than environmental factors. But, endogenous poverty among the population is often induced by exogenous poverty. Excessive pressure on agricultural land, soil and forest by population leads to further environmental degradation. This ultimately gives a boost on the vicious circle of poverty.

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

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

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

CHECK YOUR PROGRESS

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

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

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

5.7 LET US SUM UP

- The EKC explains that at the initial stage of development, economic growth leads to environment degradation and thereafter, environmental degradation goes on increasing at this stage but after reaching a particular level of economic development that is the turning point, the economy starts taking care of the environmental consequences that are resulted by development activities by taking various measures to clean up the environment along with sustaining the economic development.

- Continuous increase in population leads to over extraction of environmental resources and thus degrades the environment.

- The poverty is considered as the greatest polluter of the environment. On the other hand, environmental damages hurt mostly the poor.

- The two important types of poverty are exogenous poverty and endogenous poverty. When poverty is caused by factors other than environmental degradation, called exogenous poverty. If poverty is caused by environmental degradation, it is called endogenous poverty. The distinction between these two types of poverty becomes important while framing government policies to eradicate poverty.

5.8 FURTHER READING

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3) Todaro, M.P. & Smith, S.C. (2013). Economic Development, Pearson Education Limited

4) UNDP-UNEP Poverty Environment Initiative, Working Paper (2016)

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

5.9 ANSWERS TO CHECK YOUR PROGRESS

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

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

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

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

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

Ans to Q No 5: The linkages between poverty and environment which is also called as poverty-environment nexus. Poverty is considered as a factor responsible for environmental degradation. Again, environmental degradation affects the society as a whole but mostly affect the poor because the struggle of the poor to survive is a core cause of problems such as deforestation, desertification and unsanitary water.

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

5.10 MODEL QUESTIONS

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

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

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

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

Q 1: Explain the Environmental Kuznets Curve.

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

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

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

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UNIT 6: INTERNATIONAL TRADE AND ENVIRONMENT

UNIT STRUCTURE

6.1 Learning Objectives
6.2 Impact of International Trade on Environment
6.2.1 Positive and Negative Impacts
6.3 Environment as a Source of Comparative Advantage
6.4 Pollution Haven Hypothesis
6.5 Empirical Evidence of Industrial Concentration among North (Developed countries) and 'South' (Developing Countries)
6.6 Latest Development
6.7 Let Us Sum Up
6.8 Further Reading
6.9 Answers to Check Your Progress
6.10 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

6.2 INTRODUCTION

Trade and environment is one of the most debated topic in the studies of economics over the years because of the increasing concerns on how international trade affects environment and vice versa. The debate is not new, it emerged in the early 1970s with concerns such as environmental protection, environmental policies on trade and the impact of trade on environment. Most of the developed economies expressed interests on environmental degradation linked with the globalization process, for instance, industrial pollution. In the 1980s, environmental concerns increased as more complex environmental issues were raised such as the climate change and the depletion of the ozone layer. Later in the 1990s, the sustainable development concept was introduced as trade liberalization and the globalization process accelerated.

Effective environmental policies and institutional frameworks are needed at the local, regional, national, and international levels. The impact of trade liberalization on a country's welfare depends on whether appropriate environmental policies are in place within the

country in question (e.g. correctly pricing exhaustible environmental resources). Stringent environmental policies are compatible with an open trade regime as they create markets for environmental goods that can subsequently be exported to countries that follow suit on environmental standards – the so-called first-mover advantage. This is especially true for complex technologies such as renewable energies.

6.2.1 Positive and Negative Impacts

Negative Impacts:

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

Moreover, trade is related to numerous environmental problems. The Handbook on Trade and Environment emphasizes that trade acts as facilitator of the "international movement of goods that, from an environmental perspective, would best never be traded. With hazardous wastes and toxic materials, the environmental risks increase the further the goods are transported, since spillage is always possible. Equally, such 'goods' may end up being dumped in countries without the technical or administrative capacity to properly dispose of them, or even assess whether they should be accepted. Trade also makes possible the over-exploitation of species to the point of extinction—there is rarely enough domestic demand to create such pressure." Examples include the threats to species such as elephants, due to trade in ivory, the deterioration of air quality in parts of China attributed to export-led growth, and unsustainable harvest rates in tropical rainforests due to trade in timber.

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

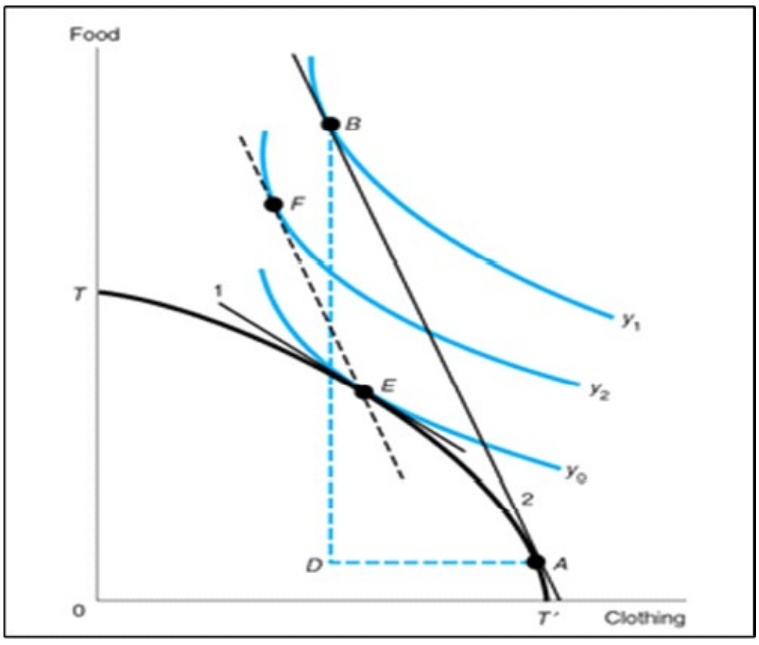
Positive Impacts:

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

Similarly, trade and investment liberalization can provide firms with incentives to adopt more stringent environmental standards. As a country becomes more integrated within the world economy, its export sector becomes more stringent environment standards. As a country becomes more integrated within the world economy, its export sector becomes more exposed to environmental requirements imposed by the leading importers.

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

Figure 1



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

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

- The Scale factor: Trade can amplify some existing problems such as weak environmental policy in some countries.

- The income effect: The quantity of greenhouse gases and toxin produced by countries with high GDP per capita is extremely high compared to households in developing countries.

- Pollution haven effect: It arises from the competitive aspect of trade. Polluting industries tend to implement themselves in countries with relatively low environmental regulation in order to avoid the cost of good environmental regulations in countries with higher standards.

CHECK YOUR PROGRESS

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

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

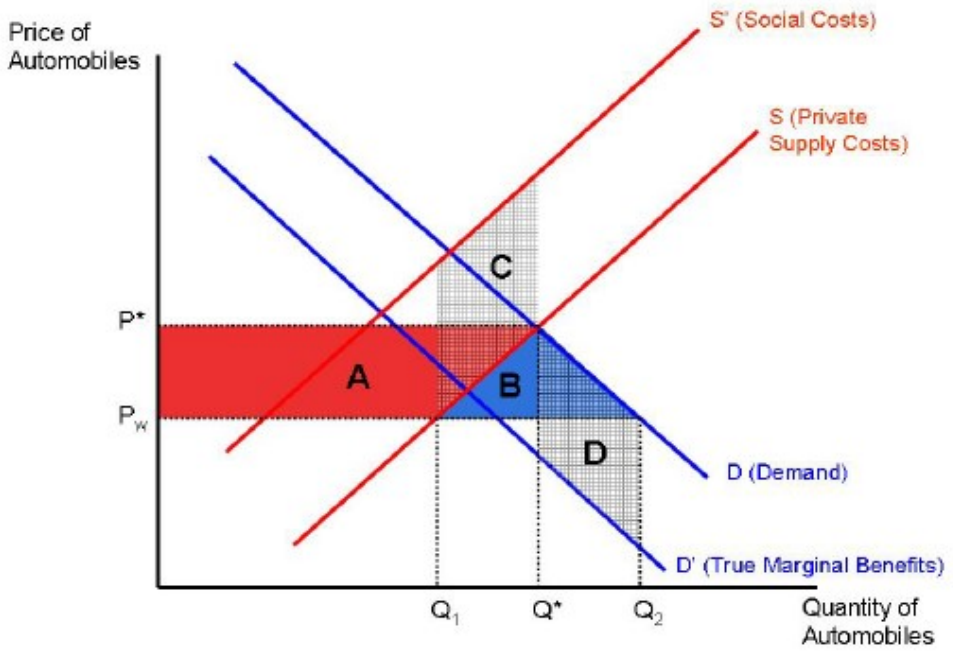
6.3 ENVIRONMENT AS A SOURCE OF COMPARATIVE ADVANTAGE

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

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

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

Figure 2



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

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

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

CHECK YOUR PROGRESS

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

6.4 POLLUTION HAVEN HYPOTHESIS

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

Pollution haven hypothesis (1)

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

Pollution haven hypothesis (2)

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

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

CHECK YOUR PROGRESS

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

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

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

The Global South is dependent on and vulnerable to the Global North. There is an unequal strength between the Global North and the Global South. The Global North being stronger than the Global South, the unequal strength between the two is manifested not only in the dominant power of the Global North to control the pattern of international trade and agreement regulating it but also in their ability often to dictate the terms whereby technology, foreign aid, and private capital are transferred to Global South. This has acted as a factor in contributing to the persistence of low levels of living, rising unemployment, and growing income inequality in the Global South compared to the Global North.

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

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

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

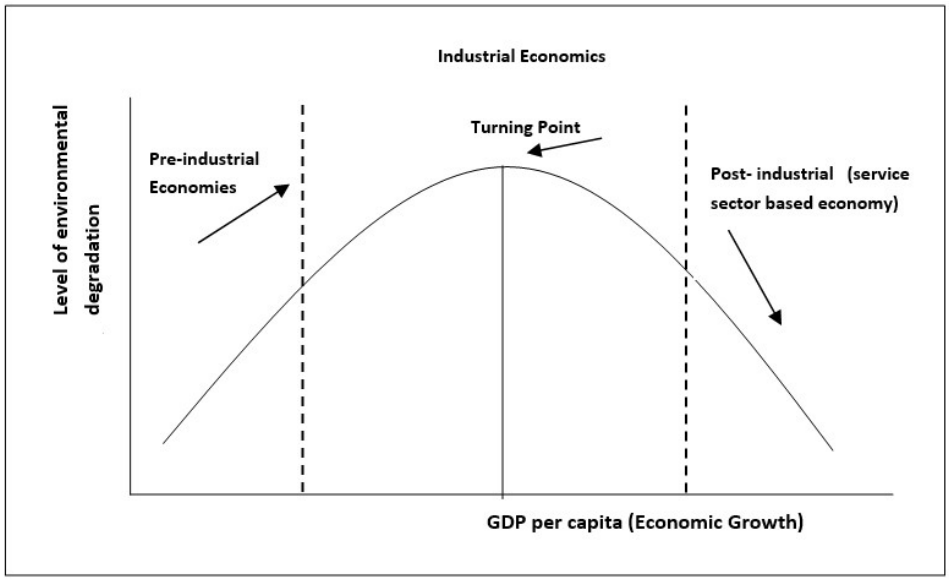
At every point and in every level of development, countries need to make choices between often conflicting goals. Developing countries desire to ensure energy for all at a competitive price to achieve and sustain economic growth and poverty reduction. The energy poverty experienced in these regions has been linked with the high level of income and non-income poverty in the regions. In their desire to develop and improve the standards of living of their citizens, these countries will opt for the goals of economic growth and cheap energy for all. This may lead to environmental pollution and degradation. More so, energy access, and at a lower price, is necessary to make the industries in developing countries competitive and contribute to economic growth, job creation and development. Ensuring energy access to the population and enhancing the competitiveness of local industries may require providing energy at lower prices through energy subsidies. This will encourage energy over-consumption, waste and inefficiency and also fuel environmental pollution.

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

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

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

Figure 3



Causes of Environmental Kuznets Curve:

1. **Empirical evidence of declining pollution levels with economic growth:** Studies found that higher economic growth in the US led to increased use of cars, but at the same time – due to regulation, levels of air pollution in particular sulphur dioxide levels declined.
2. **Spare income with growth:** With higher rates of economic growth, people have more discretionary income after paying for basic necessities; therefore, they are more amenable to paying higher prices in return for better environmental standards.
3. **Focus on living standards as opposed to real GDP:** Traditional economic theory concentrates on increasing real GDP and rates of economic growth. But there is a growing awareness the link between economic growth and living standards can be weak. Focusing on living standards can become politically popular.
4. **Improved technology:** The primary driving force behind long-term economic growth is improved technology and higher productivity. With higher productivity, we can see higher output, with less raw materials used. For example, since the 1950s, the technology of car use has significantly improved fuel efficiency. In the 1950s, many cars had very low miles per gallon. In recent years, car manufacturers have made strides in reducing fuel consumption and have started to develop hybrid technology.
5. **Solar and renewable energy:** A good example of how improved technology has reduced potential for environmental damage is the progress in solar technology. In recent years, the cost of solar energy has significantly fallen – raising the prospect of clean technology.
6. **De-industrialisation.** Initially, economic development leads to shifting from farming to manufacturing. This leads to greater environmental degradation. However, increased productivity and rising real incomes see a third shift from industrial to the service sector. An economy like the UK has seen industrialisation shrink as a share of the economy. The service sector usually has a lower environmental impact than manufacturing.

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

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

In conclusion, developing countries in their quest for economic development and poverty reduction are expected to put economic growth, energy for all and industrialization at the fore front of their goals before giving consideration to environmental issues. Therefore, compelling developing countries like those in Sub-Saharan Africa and South Asia to pursue environmental goals, particularly reduction in CO2 emissions, will require substantial economic, technological and financial support from developed countries and the international community to compensate for the economic losses associated with reducing pollution.

CHECK YOUR PROGRESS

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

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

6.6 LATEST DEVELOPMENT

Sustainable development and protection and preservation of the environment are fundamental goals of the WTO. They are enshrined in the Marrakesh Agreement (1994), which established the WTO, and complement the WTO's objective to reduce trade barriers and eliminate discriminatory treatment in international trade relations. While there is no specific agreement dealing with the environment, under WTO rules members can adopt

trade-related measures aimed at protecting the environment provided a number of conditions to avoid the misuse of such measures for protectionist ends are fulfilled.

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

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

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

6.7 LETS US SUM UP

- International trade has both positive and negative impacts on environment. Positive impact implies that international trade leads to increase in economic welfare of the country. Negative impacts imply international trade affects the environment quality of a country due to higher industrial activities.
- If stricter environmental regulation increases the relative cost of production for polluting industries, one would expect these to relocate to countries with laxer regulation. This means, lax environmental regulation is a potential source of comparative advantage in polluting industries.
- The companies that cause a lot of environmental pollution generally prefer to set up their factories and other facilities in developing countries that have lax environmental regulations – 'pollution havens'.
- There is an unequal strength between the Global North and the Global South. In addition, the Global South country's levels of labour productivity (output per worker) are

extremely low compared with those in the Global North. Low productivity leads to low income, which may lead to low capacity and low productivity.

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

6.8 FURTHER READING

Copeland, R. B. (1994). North-South trade and the environment. *The Quarterly Journal of Economics.* Vol.109, No. 3. Pp. 755-787

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6.9 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Increased trade, by supporting economic growth, development and social welfare, contribute to a greater capacity to manage the environment more effectively. More importantly open markets can improve access to new technologies that make local production process more efficient by diminishing the use of inputs such as energy, water and other environmentally harmful substances.

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

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

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

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

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

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

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

6.9 MODE L QUESTIONS

Long Questions (Answer in about 300-500 words)

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

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

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

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UNIT 7: MARKET FAILURE AND EXTERNALITIES

UNIT STRUCTURE

7.1 Learning objectives

7.2 Introduction

7.3 Market Failure

7.4 Environment and Market Failure

7.5 Concept of Externalities

7.6 Types of Externalities

7.7 Relationship between Environment and Externalities

7.8 Internalisation the Externalities- Solution by Pigou and Coase

7.9 Let Us Sum up

7.10 Further reading

7.11 Answer to check your progress

7.12 Model questions

7.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

7.2 INTRODUCTION

Market failure occurs when individuals acting in rational self-interest produce a less than optimal or economically inefficient outcome. Market failure can occur in explicit markets where goods and services are bought and sold outright, which we think of as typical markets. Market failure can also occur in implicit markets as favours and special treatment are exchanged, such as elections or the legislative process. On the other hand, an externality stems from the production or consumption of a good or service, resulting in a cost or benefit to an unrelated third party. Externalities lead to market failure because a product or service's price equilibrium does not accurately reflect the true costs and benefits of that product or service. Equilibrium is the ideal balance between buyers' benefits and producers' costs, while market failure is the inefficient distribution of goods and services in the market.

7.3 MARKET FAILURE

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

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

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

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

7.4 ENVIRONMENT AND MARKET FAILURE

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

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

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

The factors leading to habitat destruction and the loss of biodiversity originate in several sources of market failure. First, habitat destruction arises from public ownership of large areas of land with open access property right regimes and limited government capacity to manage the land. These economic incentives encourage the overexploitation of wildlife, timber, grazing lands and crop lands. Second, land tenure is often insecure since the locals in remote rural areas have little or no influence over the national laws, policies, social changes and economic forces. Lack of secure land tenure provides little incentive to maintain the habitat necessary for biodiversity conservation. The local residents have little incentive to conserve if they are unsure their kin will have access to the same land. This is because of the lack of well defined property rights.

CHECK YOUR PROGRESS

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

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

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

Q.2. Explain the concept of market failure.

Q.3. How public goods create market failure?

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

7.5 CONCEPT OF EXTERNALITIES

The concept of externalities is as relevant to the field of economics as when Arthur Pigou first postulated the idea in 'The Economics of Welfare' (1924). An *externality* is a cost or benefit that *stems* from the production or consumption of a good or service. An externality exists when the consumption and production choices of one person or firm enter the utility or production function of another entity without that entity's permission or compensation. Say, if an individual wants to play his stereo loudly, his neighbours must listen as well. This causes a divergence between the internal or private and social marginal costs or benefits of the good in question. Again for more examples, pollution caused by factories, power houses, railways, transport vehicles etc. is a cost to the society but not to the individual undertakings. Similarly, beneficial externalities of social overheads like roads etc. cause a divergence between private and social marginal benefits.

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

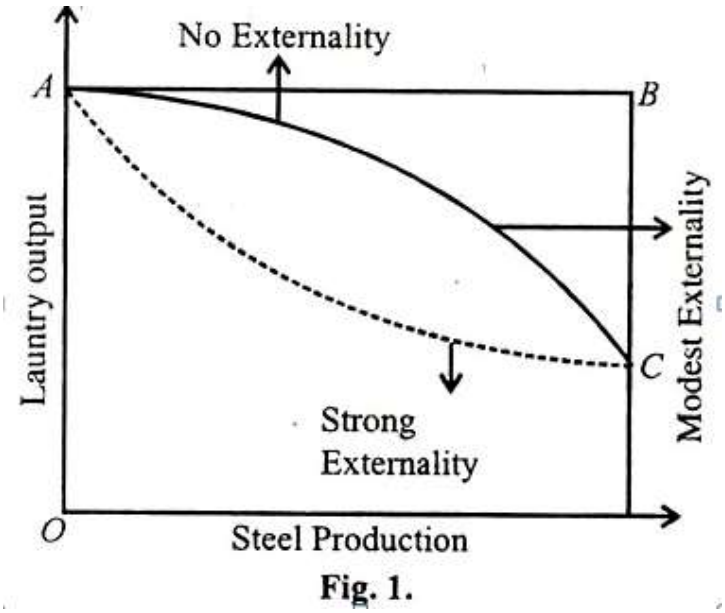


Fig. 1.

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

7.6 TYPES OF EXTERNALITIES

Externalities can be both positive and negative. They exist when the actions of one person or entity affect the existence and well-being of another. In economics, there are four different types of externalities—positive externalities and negative externalities. As implied by their names, positive externalities generally have a positive effect, while negative ones have the opposite impact.

7.6.1 Negative Externalities

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

7.6.2 Positive Externalities

Now let's take a look at the relationship between positive externalities like education and market failure. Obviously, the person being educated benefits and pays for this cost.

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

Externalities, which can be either positive or negative, can affect an individual or single entity, or it can affect society as a whole. The *benefactor* of the externality—usually a third party—has no control over and never chooses to incur the cost or benefit.

7.7 RELATIONSHIP BETWEEN ENVIRONMENT AND EXTERNALITIES

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

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

Let us take the example of a factory that produces the good X, maximizing its profit. In order to decide the optimum level of production, the cost of production has to be taken into account in the economic calculus. If the factory can dispose freely of its waste in the

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

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

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

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

CHECK YOUR PROGRESS

Q.5. State whether the following statements are True or False:
(a)Pure public goods are not characterized by the existence of externalities [False]
(b)In negative externalities, the producer does not bear all costs [True]
Q.6. Define externalities.

Q.7. Distinguish between positive and negative externalities.

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

7.8 INTERNALISING THE EXTERNALITY

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

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

7.8.1 Internalisation of the Externalities- Solution by Pigou and Coase

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

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

Pigou's thoughts on technological externalities are correct, while his proposition on pecuniary externalities was fundamentally wrong. If an in-dustry enjoys external economies, a subsidy should not be required. The im-plied gains in efficiency are adequately signalled by the input price, and profit-maximizing output levels by the firms are socially efficient. So unlike technological externalities, pecuniary externalities do not result in inefficiency, and thus do not warrant corrective action. In fact, it is the abil-ity of firms to inflict pecuniary losses that generates efficiency in competitive markets. Efficiency merely requires that people have clearly defined property rights over the ownership of property but not over the market value of that property. We may even rule out pecuniary exter-nalities, as they ultimately arise from technological external economies from somewhere within the system.

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

Coase argued that the same optimum result could have been achieved through private bargaining between the two parties. The ruling dictated that the doc-tor had the legal right to prevent the confectioner from using his machinery. Intuitively, the doctor would have been willing to receive a payment from the confectioner for him to continue using his

machinery, so long as this was greater than the cost to the doctor of moving premises, or building a wall etc. This relates to the fact that Pigou failed to take into account the concept of op-portunity cost. If the shoe was on the other foot i.e. the confectioner had the legal right to use his machinery, the outcome would be analogous. The doc-tor would simply have to pay the confectioner to stop using his machinery. If the doctor's income would have fallen more through continued use of this machinery than it added to the income of the confectioner, then there would clearly be room for bargaining.

Such rearrangement of legal rights through the market would take place whenever this led to an increase in the value of production. When we take transaction costs into account, this will only take place if the increase in pro-duction is greater than the cost involved in bringing it about.

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

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

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

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

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

CHECK YOUR PROGRESS

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

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

7.9 LET US SUM UP

- Market failure occurs when individuals acting in rational self-interest produce a less than optimal or economically inefficient outcome.
- Market failure can occurs both in explicit market and implicit market.
- The common types of market failures include *externalities, monopoly,* information asymmetries, and factor immobility.
- The economic outcomes under market failure deviate from what economists usually consider optimal and are usually not *economically efficient*.
- The factors leading to habitat destruction and the loss of biodiversity originate in several sources of market failure.
- As an example of market failure, we can cite the case of Madagascar, one of the ecologically richest, but economically poorer, countries in the world regarding habitat destruction and the threat to biodiversity.
- Pure public goods are characterized by the existence of externalities.
- An externality is a cost or benefit that stems from the production or consumption of a good or service.
- Externalities can be both positive and negative.
- The concept of externality is not specific to environmental issues: it is used to define situations where the activities of one (or more than one) economic agent(s) have consequences on the economic well-being of other agents, without any kind of exchange or transaction occurring between them.
- Internalization of externalities is the effect of changing incentives to allow people to consider behaviour changes through which people generally became aware about the external effects of their actions.
- The solutions to externalities put forward by the two schools of thought; that of Pigou advocated the public policy means of taxes and subsidies and Coase advocated the private resolution approach.

7.10 FURTHER READING

- Coase, R. H., 1960. The Problem of Social Cost. *Journal of Law and Economics* 3, 1–44.
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7.11 ANSWER TO CHECK YOUR PROGRESS

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

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

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

Ans to Q No 4: Biodiversity in and of itself has no value reflected by market prices. In contrast, the commodity resources of the habitat (for example, chemicals, minerals, timber, game) are valued on the market, and the supply and demand reflect the relative scarcity of these goods. The factors leading to habitat destruction and the loss of biodiversity originate in several sources of market failure. For example, Madagascar is one of the

ecologically richest, but economically poorer, countries in the world regarding habitat destruction and the threat to biodiversity.

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

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

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

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

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

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

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

7.12 MODEL QUESTIONS

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

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

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

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

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

Q 2: Discuss how externalities are related with environment.

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

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UNIT 8: VALUATION OF ENVIRONMENT

UNIT STRUCTURE

8.1 Learning objectives
8.2 Introduction
8.3 Types of Values of Environmental Goods
  8.3.1 Use Value and Non-use Value of Environment
8.4 Methods of Valuation
  8.4.1 Direct Method
  8.4.2 Indirect Methods
8.5 Contingent Valuation Method
  8.5.1 Willingness-to-Pay (WTP) and Willingness-to-Accept-Compensation (WTAC)
8.6 Hedonic Pricing
8.7 Travel Cost Method
  8.7.1 Tourism Expenditure Approach
8.8 Measures of Non-use Values
8.9 Let Us Sum Up
8.10 Further Reading
8.11 Answer to Check Your Progress
8.12 Model Questions

8.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

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

8.2 INTRODUCTION

Environmental goods and services are the biogeochemical processes, attributes or the products thereof that relate to the self-maintenance of an ecosystem, provision of wildlife habitat, cycling of carbon, nitrogen, phosphorus, sulphur, water or the trapping of nutrients, etc. and make the basis of sustenance as well as prosperity to the human society. Only some environmental goods and services have markets, and therefore, prices of only a few of them are available as data. These prices too, are only the indicators of the minimal payments at which the consumers and the producers have agreed to enter into transactions. At these prices, there may be substantial consumer and/or producer

surpluses that may go unaccounted. The worth of environmental goods and services include these unaccounted surpluses, but their prices do not generally reflect their worth. However, a greater part of environmental goods and services have no markets and, therefore, no prices at which they are available to the consumers. Valuation of such goods and services is much more relevant.

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

The objective of the present chapter is to discuss various methods that are suggested or applied to find a pecuniary measure of the worth of environmental goods and services and evaluate them from the viewpoint of institutionalism. In this regards the direct and indirect methods of valuations are disused in this chapter. Moreover, the methods that we are going to discuss suffer from some flaws too. However, we must be aware of these biases in the back of our mind while discussing what follows for a better environmental valuation.

8.3 TYPES OF VALUES OF ENVIRONMENTAL GOODS

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

8.3.1 Use Value and Non-Use Value of Environment

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

The Non-Use value or existence value corresponds to the value that an individual may assign to an environmental good, despite that he/she is not directly using the good; for example, how much would someone be willing to pay for the giant panda to continue to exist in the wild, despite the fact that the person does not expect to ever see a giant

panda in the wild? Therefore, the non-use value is the gain in person's utility without the person actually using the good directly. It refers to the increase in productivity, well being etc. The non-use value can be categorised into: existence value, option value, bequest value and existence value.

8.4 METHODS FOR VALUING THE ENVIRONMENT

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

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

8.4.1 Direct Method

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

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

8.4.2 Indirect Methods

Indirect Valuation Methods examine the value of an environmental good based on the existing relationship between the quality of the environment and market-priced goods (for example, rich fishing water and the price of licenses for fishing. The indirect methods are revealed preferences, i.e., in such cases real choices of people are observed in some market and information are inferred on the trade-offs between money and the environmental goods. The most commonly used indirect methods are Hedonic Pricing (HP) Method and Travel Cost Method (TCM).

CHECK YOUR PROGRESS

Q.1. State whether the following statements are True or False:
(a)**The use value of environment** corresponds to the value that people gain from the direct use of the product [True]
(b)Indirect methods of valuations are not revealed preferences [False]
Q.2. Why environmental goods should have value? Justify.

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

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

8.5 CONTINGENT VALUATION METHOD (CVM)

The CVM may be a modern name for the survey method. Only difference being is that the CVM elicits, thorough appropriately worded questions, how people would respond to hypothetical changes in some environmental service. These questions may be in the form of referendum (yes or no) or a payment card, apart from the direct questioning of the exact amount an individual / household is willing to pay. However, the direct questioning has been criticised as a difficult proposition to elicit the requisite information. The referendum approach includes dichotomous-choice, closed-ended, or take-it or leave-it question formats while the payment card format specifies a range of values he or she would be willing to pay. Another way of eliciting information is through a bidding game procedure, which is somewhat similar to the payment card approach, where the respondent is offered different hypothetical bids until range is generated. In this, the true willingness to pay is expected to lie between positive and negative responses rather than on a single point. All these approaches are tested for their validity. In this regard, while conducting CVM different steps are followed. The most commonly used hypothetical questions simply ask people what value they place on a specified change in an environmental amenity, or the maximum amount they would be willing to pay to have it occur. The responses, if truthful, are direct expressions of value and would be interpreted as measures of compensating surplus (CS). The term Contingent Valuation Method (CVM) is conventionally used to refer to approaches based on this form of question.

Second major types of hypothetical questions ask for a yes or no answer to the question. 'Would you be willing to pay Rs X..? Each individual's response reveals only an

upper bound (for a No) or a lower bound (for a Yes) on the relevant welfare measure. Questions of this sort are often referred to as referendum questions because of the analogy with voting on such things as bond issues. Discrete choice methods can be used to estimate willingness to pay functions or indirect utility functions for data on responses, and on the characteristics of the people surveyed.

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

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

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

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

supplied to the respondents. The *hypothetical bias* arises from the fact that the payments, as revealed through WTP, are usually hypothetical. The *operational bias* may occur if the respondent is not familiar with the good or service to be valued. Some of these biases are specific to CVM whereas others are endemic to all survey methods.

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

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

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

Many CVM researchers found that WTP measures were much less than WTAC measures for the same change in environmental quality. Initially, it was thought that this problem was unique to CVM, possible owing to the hypothetical nature of the exercise. However, an increasing body of evidence from the experimental economics literature also showed considerable divergences between the two measures. Moreover, this difference seemed to exist independently of income effects, transactions costs or how often the good was traded. This evidence suggests that people systematically value losses more highly than equivalent gains, and reductions in losses more highly than forgone gains.

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

CHECK YOUR PROGRESS

Q.5. State whether the following statements are True or False:
(a) CVM is also the modern name of survey method. [True]
(b) CVM suffers from the problem of how to estimate aggregate values [True]
Q.6. Explain briefly the concept of CVM.

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

Q.8. Distinguished between WTP and WTAC?

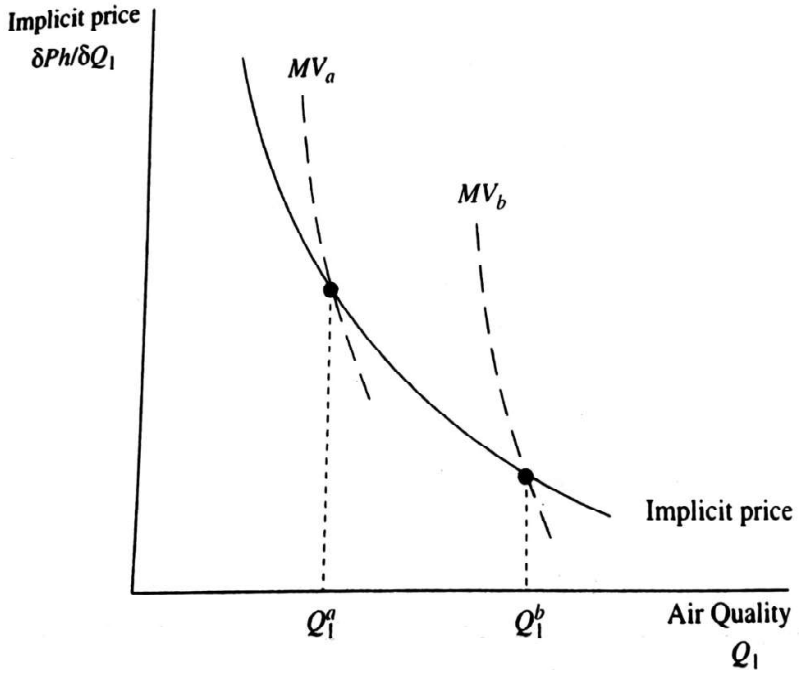
8.6 HEDONIC PRICING (HP)

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

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

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

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



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

The hedonic price technique is a method for estimating the implicit prices of the attributes that differentiate closely related products in a product category. Generally speaking, if the product class contains enough models with different combinations of attributes, it should be possible to estimate an implicit price relationship that gives the price of any model as a function of the quantities of its various attributes. This relationship is called the hedonic price function. The partial derivative of the hedonic price function with respect to any attribute gives its marginal implicit price. For example, prices of land in a residential area may include premiums for location in a clean and safe area and discounts for dirty and unsafe areas. If they do, it is then possible to estimate the demand for such environmental amenities as clean air from the price differentials revealed in private markets. Where environmental changes affect producers of market goods, values can also be observed indirectly through examination of changes in product and factor prices and in producers' quasi-rents. Indirect Observed Methods involve a kind of detective work, in which clues about the values individuals place on environmental services are pieced together from the evidence that people leave behind as they respond to prices and other economic signals.

8.7 TRAVEL COST METHOD (TCM)

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

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

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

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

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

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

used to draw up a demand curve for the resource. The area under the demand curve (the consumer surplus) is used to estimate the WTP for the amenity.

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

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

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

8.7.1 Tourism Expenditure Approach:

A simpler and less precise way of estimating tourism or recreational benefits is to use the tourism expenditure approach. This does not capture any WTP above the actual price paid and hence the estimated value excludes the consumer's surplus. Neither does it

establish a relationship between price and demand, nor can it be used to forecast demand at different entry prices. It is however relatively easy to calculate as it assumes that the value of an area for tourism, recreation or scientific tourism can be based on how much people spend to travel and stay in the location.

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

8.8 MEASURE OF NON-USE VALUES

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

8.8. 1 Option Value (OV):

Weisbrod introduced the concept of option value in 1964. Weisbrod argued that an individual who was not sure as to whether he would visit a site such as National Park would be willing to pay a sum over and above his expected consumer's surplus (CS) to guarantee that the site or the National Park would be available should he wish to visit in future. He called this extra sum the option value of the site. If Option Price (OP) is defined as the maximum sum the individual would be willing to pay to preserve an option for the future use before his own demand uncertainty is removed, then the excess of OP over the expected consumer surplus can be called OV. It was argued that OV should be measured, if possible, and added to the expected CS in order to obtain the full measure of the value of providing an environmental service or amenity. According to Freeman III, OV is the algebraic difference between the expected value of the consumer's surplus and the state- independent willingness-to-pay. Since these two points on the willingness-to-pay curve represents alternative ways of measuring the same welfare change, the difference between their expected values cannot be a separate component of value. Furthermore, OV cannot be measured separately, it can only be calculated if we have enough information about people's preferences to estimate both OP and CS. In view of this, Freeman III is of the view that OV should not be considered as possible benefit from environmental protection.

8.8 2 Existence Value (EV):

Existence values arise from preventing the extinction of a species or preventing the complete destruction of a natural resource or an environmental amenity. John. F. Krutilla first introduced the concept of EV in mainstream economics literature in 1967. It would be pertinent to state here that although the source of existence of EV is related to someone's use, it is independent of any use made of the resource by the person holding the EV.
The existence of non-use values is based on the hypothesis that people impute economic values on natural resources and environmental amenities and services independent of their present use of those resources. Based on this hypothesis, we presume that people might be willing to pay for conservation of some environmental services / amenities such as the valley of flowers, endangered species and biodiversity. In the environmental economics literature, resource values that are independent of people's present use of the resource are variously called 'existence', 'intrinsic', 'non-user', and 'non-use' values. These values may arise from various motives such as desire to bequeath certain natural resource to one's heirs, or future generations or a sense of stewardship, or altruism, or an ethical concern.

CHECK YOUR PROGRESS

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

Q.10. Explain briefly the Travel Cost Method.

8.9 LET US SUM UP

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

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

8.10 FURTHER READING

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8.11 ANSWER TO CHECK YOUR PROGRESS

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

Ans to Q No 2: Environmental goods and services are the biogeochemical processes and only some environmental goods and services have markets but their prices do not generally reflect their worth. However, these goods and services have a limit to their bearing capacity, beyond which they cannot sustain their use. Crowding on their use can decrease users' utility. Public goods often suffer free-riders' problem. Although each user

values them, none has an incentive to pay to maintain them. That necessitates a collective action for their upkeep, which incurs considerable public cost. Hence, the valuation such goods and services may help the resource managers to deal with the effects of market failures, by measuring it in a proper way.

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

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

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

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

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

Ans to Q No 8: Many CVM researchers found that Willingness to Pay (WTP) measures were much less than Willingness to Accept Compensation (WTAC) measures for the same change in environmental quality. Individuals judge all gains and losses from a reference point, which is either existing entitlement to resources. Any decrease in the resource below this level cause a greater loss in welfare than the increase in welfare caused by an equivalent increase in the good. The implication is that we should expect WTAC to exceed WTP; and that, where a loss in welfare below the reference point is

concerned, this should always be evaluated using a WTAC measure sine WTP would understate the loss. Similarly, WTP measures should be used for environmental gains.

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

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

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

Ans to Q No 10: The travel cost method is often used in research to assess recreational or ecotourism values of a recreation site such as a national park or a hill station. The method could also be used for valuation of water supply and fuelwood. It is based on the recognition that the cost of travelling to a site is a major component of the full cost of a visit. It is also assumed that the amount of money people are prepared to spend to travel to a site, and the opportunity cost (value) of the time involved, can serve as a proxy for their willingness-to-pay (WTP) for the visit. The simplest version of the TCM involves collecting data on visits to a site (V) from different parts of the surrounding country (zones, i) and explaining the visit rate per capita (Vi / Pi) as a function of travel costs, Ci. These costs are assumed to be some function of both distance and time spent travelling (travelling time is usually allocated a positive value to reflect the scarcity of leisure time) and of socio-economic variables Si. Therefore, Vi/Pi =f (Ci, Si)

8.12 MODEL QUESTIONS

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

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

Q 2: Define Option Value and Existence Value.

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

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

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

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

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UNIT- 9 : SUSTAINABLE DEVELOPMENT

UNIT STRUCTURE

9.1 Learning Objectives

9.2 Introduction

9.3 Concept of Sustainable Development

9.4 Indicators of Sustainable Development

9.5 Significance and Importance of Sustainable Development

9.6 Policies for Sustainable Development

9.7 Related Concept of Sustainable Development

9.8 Let Us Sum UP

9.9 Further Reading

9.10 Answer to Check Your Progress

9.11 Model Questions

9.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- understand the meaning of sustainable development.
- understand the indicators of sustainable development.
- know the significance and importance of sustainable development.
- know the different policies regarding sustainable development.
- familiar with some important concepts related to sustainable development.

9.2 INTRODUCTION

The major objectives of development are the satisfaction of human needs and aspirations. In developing countries, huge numbers of people are not able to meet their basic needs and beyond their basic needs these people have legitimate aspirations for an improved quality of life. A country where large numbers of people are not getting basic needs and inequity is endemic always directly depends on ecology. This leads to ecological and other crises. Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life. Living standards that go beyond the basic minimum are sustainable only if consumption standards everywhere have regard for long-term sustainability. Many people live beyond the world's ecological means. Perceived needs are socially and culturally determined, and sustainable

development requires the promotion of values that encourage consumption standards that are within the bounds of the ecological possible and to which all can reasonably aspire. In this unit we will look into the concept of sustainable development, indicators of sustainable development, significance and importance of sustainable development, policies for sustainable development and also some related concepts of sustainable development.

9.3 CONCEPT OF SUSTAINABLE DEVELOPMENT

Sustainable development is one of the most commonly used terminologies since the later part of the 20th century throughout the world. In 1972, a report was published by the Club of Rome regarding exponential economic and population growth with a finite supply of resources. The report revealed that given the business as usual, i.e. no changes to historical growth trends, the limits to growth on earth would become evident by 2072, leading to 'sudden and uncontrollable decline in both population and industrial capacity'. This was the thought that forced countries of the world to think about sustainable development in organized way. In 1983, the United Nations General Assembly realized that there was heavy deterioration of the human development and natural resources. The *World Commission on Environment and Development (WCED)* organized countries to work and pursue sustainable development together and the United Nations decided to establish Brundtland Commission, which defined sustainable development later on.

It should be mentioned here that in 1977, John Hartwick proposed a rule for ensuring non-declining consumption through time, in the case where an economy made use of a non-renewable resource in its economic process. Hartwick showed that, so long as the stock of capital did not decline over time, non-declining consumption was also possible. The stock of capital could be held constant by reinvesting rents from non-renewable resource extraction in man-made capital. Hartwick's rule assumes that man-made capitals and natural capitals are to be perfect substitutes for each other. However, the problem is that man-made capitals and natural capitals are not nearly substitutable as Hartwick suggested.

Coming back to concept of sustainable development, environmentalists try to define the sustainable development based on their own understanding. However, most of the definitions are built upon the view expressed by the Brundtland Commission (1987) in the report, *'Our Common Future'*, which defines sustainable development as "*development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs*." The definition covers three basic ideas-*development, needs* and *future generation*. Development is often confused with growth. On the one hand, growth is an expression for quantitative expansion of economic system. Development, on the other hand, is a qualitative concept incorporating notions of improvement and including cultural, social and economic dimensions.

The use of the concept 'needs' in the definition, is connected to the distribution of natural resources. Elsewhere in the Brundtland report, sustainability is defined as '*meeting the*

basic needs of all and extending to all, the opportunity to satisfy their aspirations for a better life'. Economic growth has converted luxuries to need for some people while for the poor even the basic necessities are not affordable. Meeting the needs of all, therefore involves heavy environmental costs. Need also means redistributing natural and economic resources. Hence it is a moral issue.

The definition concerns for the welfare of the future generation as much as the present generation. The report says, *"In essence, sustainable development is a process of change, in which exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations."* The definition itself provides clues to design the process of development, choice of technology, the kinds of property rights system, institutional structure to manage the resources and the expected social order.

There are three basic components of sustainable development: *Economic, Social and Environmental*. The three components are interdependent. The economic component of sustainability requires that societies pursue growth paths that generate optimal flow of income while maintaining their basic stock of manmade capital (machines, buildings, roads etc.), human capital (stock of knowledge and skills) and natural capital (all renewable and non-renewable resources or any natural assets yielding a flow of ecological services with economic values over time). The economic sustainability also requires internalizing all costs including the environmental costs associated with production and consumption. There are three basic goals of an economic system, viz. (i) increasing production of goods and services, (ii) satisfying basic needs or reducing poverty, (iii) improving equity.

The social dimension of sustainable development is built on the twin principles of justice and equity. For a development path to be sustainable over long period of time, wealth, resources and opportunity should be equitably shared. All citizens should have access to minimum standards of security, human rights, and social benefits such as food, health, education shelter and opportunities of self-development. Social equity implies equal opportunities to all for education and for making productive contribution to society. These have to be ensured to achieve the social goals of (i) cultural diversity, (ii) social justice, (iii) gender equality, and (iv) public participation.

Sustainability is an in-built feature of natural systems provided that human interference is absent or minimized. It relates to the capacity of a system to maintain a continuous flow of whatever each part of that system needs for a healthy existence. Human use of environmental resources and interference with environmental systems disturbs this in-built capacity which can make a system unsustainable. Therefore, the environmental components require sustainable resource use and maintenance of stock of natural capital. That is the environment should be able to perform its three function efficiently and uninterrupted so that ecological stability and resiliencies are not affected.

CHECK YOUR PROGRESS

Q 1: Name the organization that brought into the common use of the terminology 'sustainable development'.

Q 2: What are the three basic ideas that definition of sustainable development covers?

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aesthetic beauty is not easy to put on any scale or indicator, though some of the environment related factors could be viewed in terms of selected physical indicators. For example, air pollution can be viewed in terms of emission of CO_2, SO_2 or NO_x.

In order to capture all aspect of ecological and environmental changes, three types of indicators can be suggested. These are *pressure indicators, impact indicators and sustainable indicators*. *Pressure indicators* refer to flow variable. They show the development over time or amounts or levels of emissions, discharges, depositions, extraction, and interventions originating from a set of economic activities. These indicators express the burden placed on stock of environmental goods and resources. They can be defined by economic activity or sector or with a spatial dimension that is use of environmental goods and services by a district, region, state or country. *Impact indicator*s reflect the impact of environmental pressure on the receptors, usually in a predetermined region. These indicators include imported trans-boundary pressures. Ideally, they show the development over time of the stock and qualities of environmental goods and resources. Both pressure and impact indicators can be transformed into so called *sustainable indicators* by relating pressure or impact with predetermined reference values. These references try to indicate what is considered to be a sustainable level of extractions or a sustainable quality level of an environmental good. The latter refers not only to the quantity, but also to the quality of an environmental resource system, that is, the diversity of species of flora and fauna. In that case, the reference is usually a past or a desirable future state of an ecosystem.

It should be recognized that sustainability indicators contain normative valuation in three respects.

- They picture a distance between current and reference values that should be bridged.
- Although the reference values are based on scientific insights, they are inevitably the outcome of personal and societal assessments and preferences. Alternative operational definitions of sustainable development may be conceived and preferences for environmental quality may differ.
- Another valuation problem creeps in while aggregating sustainability indicators to provide adequate information on an environmental system as a whole. In aggregating, the relative weights of the basic indicators have to be established.

9.4.1: Measurement of Sustainable Development

While a variety of sustainability indicators can be serving the purpose of understanding some of the dimensions of environmental and economy in terms of *pressures, impacts and sustainability*, the need for any aggregated index cannot be underestimated. The measures of sustainable developments are classified as project or program and economic wide levels.

(a) Discounted Present Value Benefits

The Discounted Present Value Benefits is project of program level measure of sustainability. In economic theory, it is well understood that any stream of costs and future benefits from

an economic activity are better understood only when they are aggregated with certain weights so as to arrive at an aggregate index of overall net benefit. The weights are commonly known as 'discount factors'. One such calculation is the Net Present Value Benefit (NPVB) expressed as:

$$NPVB = \sum B_t \delta_t - \sum C_t \delta_t - \sum E_t \delta_t \geq 0$$

where B_t ,C_t, E_t are annual or any time related stream of benefits, costs, environmental costs respectively; δ stands for the discount factor expressed as:

$(1+r)^{xt}$

where r is the discount rate, t stands for time. As long as the present value of benefit is non-negative, it is sustainable.

But, under sustainability conditions, it is appropriate to value environmental costs and benefits over a long period of time (if not over infinite time). In other words, the corresponding discount rates should be much smaller than the usual social discount rate *r*.

There are two problems of this measure of sustainability. First, if the social discount rate is reduced, capital costs which are generally incurred in the initial period of the projects get over-valued, making capital intensive projects go out the list, though in terms of efficiency they may be better. Second, if the discount rate is reduced, it may affect future investments in the economy and have different implications for ecological and natural resources.

(b) The 'Green' GNP

The general definition of sustainable development adopted here is that every future generation must have the option of being as well off as its predecessor. Discounting is compatible with this if the discount rate is less than the rate of technological progress. Maintaining a constant potential for wealth creation means the maintaining a constant means of production. This includes man-made capital, natural resources, technology and the level of learning (i.e. human capital). A sustainable path has the characteristic that along it this overall productive capacity is not reduced. What we need to know at each moment in time is how much of this productive base we can use up. This is given by environmentally adjusted Net National Product (NNP) (It is called ENP). NNP is the total income earned by the economy in any year, less an allowance for the depreciation of man-made capital. When is an environmentally adjusted measure of NNP a good measure of sustainable development? First, when all elements of NNP are correctly valued in terms of current economic situation. Second, when this is true in a forward-looking sense too (prices reflect future scarcity). Third, when all depreciation of natural capital is similarly allowed for as well.

Environmentally adjusted NNP is the annual 'pay-off' from total (natural plus man-made) capital stock. ENP can rise through time if this total capital stock rises, and/or as technology improves. How can the total stock of capital be maintained? By following the Hartwick

rule: each year, reinvest the rents (price minus marginal cost, known as 'Hotelling rents') from an optimal non-renewable resource extraction plan in new natural or man-made capital. So the indicator is: Is ENP rising or falling? If ENP is falling, then society's sustainable level of income is falling too.

Correct Adjustments to GNP

The analysis presented below is adapted from Hartwick and treats each broad class of the natural capital stock separately. NNP clearly fails as a measure of sustainable development owing to many aspects of natural resource depletion being ignored by the system of national accounts (SNA); whilst expenditure on pollution clean-up actually adds to NNP, with any loss in welfare due to the pollution itself being ignored. Hartwick's optimal adjustments to the national accounts can be summarized as follows.

Non-renewable Resource

Each period, it should deduct the 'Hotelling rents' of natural resource extraction from NNP, assuming all inputs/outputs are valued at their correct shadow prices.

Let C = aggregate consumption, K = stock of man-made capital, S = stock of non-renewable resources, R = current extraction from S, L = labour (allowed to grow at some rate n), U= utility, ρ=discount rate.

The economic problem is to maximize discounted utility from consumption,

$$\text{Max} \int U(C)\, e^{-\rho t}$$

Subject to: K = F (K, L, R) – C – f(R, S) and ~ = – R

Here a dot represents a rate of change. F (.) is the aggregate production function, and f(.) is the cost of extracting non-renewable resources. Thus, the first equation [i.e. K = F (K, L, R) – C – f(R, S)] says that the rate of change in the man-made capital stock K depends on production less consumption less the costs of extracting resources. The second equation (e.g. ~ = – R) states that the rate of change in the non-renewable resource stock S is equal to annual production R (since there is no growth and implicitly no new discoveries). Then we find that ENP is given by:

ENP= C+ K – [F_R – f_R] R = NNP – [F_R – f_R] R

Where F_R is the marginal product (= price) of R and f_R is the marginal extraction cost. The expression in square brackets is the 'Hotelling rent' and is the correct way of calculating the amount of deduction from conventional NNP, as Hartwick shows. If published average costs are used instead (marginal costs are typically not recorded), then, given that we expect mining companies to be operating where MC>AC, this overstates the correct deduction and understates ENP. If new discoveries are made, so that –R overstates the actual loss of the non-renewable resource, then this should be netted out before the conversion to ENP is made.

Renewable resources

Renewable resources differ from non-renewable resources in that positive growth can occur, subject to the population size and the rate of harvesting. Hartwick models the introduction of renewable resources into the system by including a term in the utility function to represent fish catch (E), so that we have a utility function, U = U(C, E), where the cost function for fishing (say) is f (E, Z), where Z is the stock of fish. Then,

$K\$=F(K, L) - C - f(E, Z)$ and

$Z\$=g(Z) - E$, where g (Z) is the natural growth function, as constraints in the model. When harvesting exceeds the growth rate, $Z\$$ will be negative; when the reverse is true, $Z\$$ will be positive, while $Z\$$ will be zero if harvesting is equal to the growth rate. Hartwick derives the optimal deduction from NNP to allow for depreciation of the renewable resource (fish) as:

$ENP=NNP - (U_E/U_C - f_E) Z\$$

In other words, the change in the stock Z valued by the term in parentheses: this is the ratio of marginal utilities (= price in a competitive market) minus marginal fishing costs. When the harvest rate is less than the growth rate, this adjustment adds to NNP; when harvesting exceeds the growth rate, the adjustment reduces NNP.

A problem recognized by Hartwick is that all the variables in the above equation are calculated at their socially optimal levels, but with open access to renewable resources, these values will not be optimal (e.g. growth rate varies with population size which in turn depends on costs and prices). In general, we would expect the marginal cost to be too high and the price to be too low, as too much effort will be expended in the fishery, for example, under the open access conditions which describe many of the world's fisheries. If this is the case, we will need to regulate effort levels to their optimal amounts and use the prices/marginal costs that then result; or else calculate these optimal prices/costs and use them to value existing reductions in the stock. Notice that, if fish catches remain within the annual growth rate, no adjustment to NNP is necessary (since $Z\$ = 0$).

Pollution/environmental amenity effects

Pollution (X) is modeled as a stock which exerts negative effects on production.

Production itself adds to this stock:

$X\$= - bX - \gamma F(K, L, X)$

Here pollution dissipates at a natural rate b (this could be set equal to zero if the economy generates pollutants for which no assimilative capacity exists, when making ENP adjustments for such pollutants); and is added to by production according to some constant proportion γ. If the only way to reduce pollution is to cut output (an unlikely case in reality), the correct adjustment to NNP is:

$ENP=NNP - V. X\$$

$$V = \frac{-\frac{\dot{U}c}{Uc} + \rho - Fk}{\gamma Fk}$$

The above expression represents the value of the return on pollution in terms of the return on capital in the economy. As such, it would be difficult to calculate. If in addition we allow for direct pollution abatement activities (represented using a cost function f (b)), we get a

simpler adjustment (since now pollution can be controlled directly). In this case, then, ENP is:

$$ENP=NNP – \delta(f_b)/\delta X \cdot X\$$$

which is the change in the stock of pollution (the amount of pollution abatement) multiplied by the marginal cost of pollution control.

Finally, consider the case of pollution entering directly into the utility function, as well as exerting a depressing effect on production. Hartwick actually models changes in the stock of pollution so that U=U(C, X$). This gives the adjustments:

$$ENP=NNP – [((– U_{\$} /U_c) X\$) – (\delta f/\delta X \tilde{N} X\$)]$$

The first term in square brackets is the ratio of marginal (dis)utilities of changes in the pollution stock and consumption (the price of reducing pollution in terms of the value of forgone consumption), multiplied by the change in the pollution stock. This is equal to willingness to pay for pollution reductions times the amount of pollution reduced. The second term in square brackets is the term found in the earlier equation [i.e. $ENP=NNP – \delta(f_b)/\delta X \cdot X\$$], that is the marginal cost of pollution control times the reduction in the stock. Re-writing above equation makes the nature of the required adjustment clearer:

$$ENP=NNP – [U_{\$} /U_c) + f_b/X] X\$$$

The term in square brackets is positive, but for increases in the stock of pollution (X$ > 0), the 'rent' here is negative (since we make negative the expression in square brackets). Thus an increase in pollution (a bad) is treated exactly the same way as a reduction in the stocks of either nonrenewable or renewable resources (goods). Increases in the stock of pollution should lead us to reduce NNP (which is as expected!). Decreases in environmental amenity for reasons other than pollution should be allowed for in the national accounts in a manner analogous to the treatment of the 'amenity' effect of pollution.

(c) Pearce-Atkinson Measure (PAM) of Sustainability

Pearce and Atkinson have developed a sustainability index or indicator which is known as Pearce-Atkinson Measure (PAM) of sustainability. It is economic wide level indicator of measure of sustainability. Following the growth model approach, the savings rate is normally considered to be a good indicator of health of the economy. Higher saving rate will imply better capability of the economy to grow. But under sustainable conditions, both the depreciations of natural resources and man-made capital are to be deducted to arrive at a corrected measure of a sustainable saving rate. Accordingly, the improved measure is stated as:

$$\text{PAM} = \frac{S}{Y} - \left(\frac{\delta m}{Y}\right) - \left(\frac{\delta n}{Y}\right)$$

Where, S and Y are savings and income, ä stands for change, *m* and *n* are man-made capital and natural capital respectively. Only when this PAM is greater than or equal to zero, the economy is sustainable. i.e. for a sustainable economy,

$$PAM = \frac{S}{Y} - \left(\frac{\delta m}{Y}\right) - \left(\frac{\delta n}{Y}\right) \geq 0$$

Improved PAM Formula

One can marginally improve the PAM by incorporating effects of *productivity changes* (mainly due to technological progress) upon the use of investable resources and *change in population* dynamics. The measure is based on aggregate estimates of rate of changes in technical efficiency, population and depreciation etc. The modified PAM is stated as:

MPAM= s*p-n-d-e

where, s= saving rate, p= productivity of new investments, n=rate of population growth. The rate of depreciation of man-made capital (d) and the rate of depletion or degradation of natural capital (e) are expressed as ratios to income. i.e. the economy is sustainable if,

MPAM= s*p-n-d-e e $\geq$ 0

The model assumes that there is no depreciation of human capital, i.e. δh=0, where, h=human capital.

(d) Genuine Saving and Sustainability

The genuine savings (GS) is an indicator that can be used to assess an economy's sustainability. Genuine savings aim to represent the value of the net change in the whole range of assets that are important for development: produced assets, natural resources, environmental quality, and human resources. Generally, development is considered to be sustainable if and only if the stock of capital (wealth) remains constant or rises over time. Thus, the rate of genuine saving can be used to measure sustainability, in that if the genuine savings index (GSI) is positive we are leaving more for future generations; a negative rate of genuine savings, on the other hand, indicates unsustainability. The calculation of genuine savings involves the itemization of a nation's stock of wealth, and an accounting of changes to that stock. The World Bank researchers have defined genuine savings as follows:

Genuine Savings = Production – Consumption – Depreciation of Produced Assets – Depletion of Natural Assets = Gross Domestic Savings – Consumption of Fixed Capital (Depreciation) + Education Expenditure – Air Pollution Costs – Water Pollution Costs – Depletion of Nonrenewable Natural Resources – CO_2 Damage Costs.

CHECK YOUR PROGRESS

Q 5: What do you mean by indicator?

Q 6: Defining development indicators is quite complicated. Why?

Q 7: In order to capture all aspect of ecological and environmental changes, what are the three types of indicators of sustainable development?

9.5 SIGNIFICANCE AND IMPORTANCE OF S U S T A I N A B L E DEVELOPMENT

The significance and importance of sustainable development are: -

Firstly, sustainable development creates consciousness about environment among the present generations so that the same (greater, if possible) resource can be left for the future generations for their better life. It indicates that sustainable development includes the issue of maintaining equity and justice between present and future generation regarding use of natural resources.

Secondly, sustainable development improves quality of life of human beings and other living beings. Sustainable development includes the issue of resource stock recognition and proper valuation of resources, so that all-round development can be attained within the limited natural resources.

Thirdly, sustainable development tries to balance among economic, social and environmental development. It is some sense of warning to human beings that once imbalance takes place, it will be harmful for all, including human beings, which is known as resiliencies.

Fourthly, sustainable development encourages producers to invent and to use better technology so that output can be produced by using least natural resources. Sustainable development also encourages to producers and consumers to release residuals as least as possible. It indicates efficient use of natural resources.

Fifthly, sustainable development is combined concept of natural sciences and social sciences. It is a multidisciplinary as its contribution is multidimensional to all living beings. Thus, the adverse effects of natural environment are also multidimensional.

Lastly, sustainable development tries to make understand the basic features of natural capital, viz. uniqueness, uncertainty and irreversibility. Sustainable development holds that certain elements of nature are very critical due to their unique contribution to the living beings. Perfect duplication is impossible once such element is damaged or extinct.

CHECK YOUR PROGRESS

Q.8. What kind of consciousness that sustainable development tries to make?

Q.9. What kind of encouragement does sustainable development provide to producers?

Q.10. What are the three basic features of natural capital?

9.6 POLICIES FOR SUSTAINABLE DEVELOPMENT

For sustainable development, it is necessary to set some common policies, such as-

- Setting up tide rules and regulations regarding establishment of industries. Proper implementation of those rules and regulations are necessary for sustainable development, because industrial pollutions are regarded as one of the major sources of environmental pollution.
- Poor people are both agent and victims of environmental degradation. They are agent, because their livelihood directly depends on natural resources and they are victim, because they live in least health and sanitation facilities. Therefore, reducing or eradicating poverty is regarded as one of the important policies for sustainable development.
- Economic incentives should be provided to the industries which use eco-friendly technology in production process. Economic incentives include, imposition of low tax, providing subsidy for the products which are produced by using eco-friendly technology.
- Participation in protection of global environmental efforts is another policy for sustainable development. Greater the participation in protection of global environmental efforts, greater will be the scope of sustainable development.
- It should be provided proper environmental education in schools and colleges so that the mindset of loving and protecting the nature can be created to all levels of people of all the countries in the world.
- Environmental auditing should be made compulsory for all levels of factories/firms including government factories/firms. This will reduce environmental costs of the factories/ firms as well as make factories/firms related people more consciousness on environmental.

9.7 RELATED CONCEPT OF SUSTAINABLE DEVELOPMENT

Some related concepts of sustainable development have been developed in universal level since the last two decades of the last century. The concepts related to sustainable development includes-(i) green growth, (ii) green economy, and (iii) low-carbon development.

9.7.1: Green economy

The concept of 'green economy' is related to ecological economics. The term green economy was first coined in 1989, in the report for the Government of the United Kingdom, prepared by a group of leading environmental economists. It is the economy that aims to achieve sustainable development by including issues like, reducing environmental risks and ecological scarcities. The concept also includes political issues, that the economy should be not only efficient, but also fair. The term was revived in 2008, in the context of discussions on the policy response to multiple global crises. In the context of the financial crisis and concerns of a global recession, the United Nations Development Programme (UNEP) campaigned the idea of 'green stimulus packages' and identified specific areas where large-scale public investment could kick-start a 'green economy'. In the same year, the UNEP launched its Green Economy Initiative to provide analysis and policy support for investment in green sectors and for greening environmentally unfriendly sectors. The United Nations Climate Change Conference held in Copenhagen, in 2009, the UN released an interagency statement supporting the green economy as a transformation to address multiple crises. The statement included the hope that the economic recovery would be the turning point for an ambitious and effective international response to the multiple crises facing humanity based on a global green economy. In 2010, Ministers and Heads of Delegation of the UNEP Global Ministerial Environment Forum in Nusa Dua acknowledged in their declaration that the green economy concept can significantly address current challenges and deliver economic development opportunities and multiple benefits for all nations.

9.7.2: Green growth

The concept of 'Green growth' is associated with the concept of 'Green economy'. It is the concept that aims to harmonize the economic growth with environmental sustainability, while improving the eco-efficiency of economic growth and enhancing the synergies between environment and economy. The concept has its origins in the Asia and Pacific region. At the Fifth Ministerial Conference on Environment and Development (MCED) held in March 2005 in Seoul, 52 Governments and other stakeholders from Asia and the Pacific agreed to move beyond the sustainable development rhetoric and pursue a path of 'green growth'.

9.7.3: Low-carbon development

The concept of low-carbon development was adopted by the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. At present, the concept of low carbon development is generally expressed using the term Low-Emission Development Strategies (LEDS). The concept is generally used to describe forward-looking national economic development plans or strategies that encompass low-emission and/or climate-resilient

economic growth. The LEDS have attracted interest in the climate negotiations as a soft alternative to voluntary or obligatory greenhouse gases (GHG) emission reduction targets in developing countries. The initial proposal to introduce LEDS was put forward by the European Union (EU) in 2008, highlighting how information on planned low-carbon pathways can help to inform the international community about funding needs and priorities and to help gauge the level of global climate change action.

CHECK YOUR PROGRESS

Q 11: Why should tide rules and regulations set for establishment of industries?

Q 12: Give two examples of economic incentive which use eco-friendly technology.

Q 13: Write three concepts that related to sustainable development.

Q 14: Which organization and when the concept of low-carbon development was adopted?

9.8 LET US SUM UP

- Sustainable development is one of the most commonly used terminologies since the last part of the last century throughout the world. Despite a wide acceptance of the concept of sustainable development, there is no single definition which is all accepted. Development, needs and future generation are the three basic contains of the definition of sustainable development given by the Brundtland Commission. Economic, social and ecosystem are the three basic components of sustainable development.

- Defining sustainable development indicators with the framework of economic development itself is quite complicated. In order to capture all aspect of ecological and environmental changes, three types of indicators can be suggested. These are *pressure indicators, impact indicators and sustainable indicators*.

- Sustainable development creates consciousness about environment among the present generations so that the same (greater, if possible) natural resources can be left for the future generations. It improves quality of life of human and other living beings

within the limited capacity of the environment. It tries to maintain the balance among economic, social and environmental problems so that better lives can be provided for all kinds of living beings in the world. It encourages inventing and using better technology so that output can be produced and consumed by using least natural resources. Sustainable development encourages both producers and consumers to release residuals as least as possible. It is a multidisciplinary concept, as it provides multidimensional benefits. It tries to make understand the basic features of natural capital-uniqueness, uncertainty and irreversibility. Sustainable development holds that certain elements of nature are very critical due to their unique contribution to the living beings.

- Setting up of tide rules and regulations regarding establishment of industries and implementation of those are regarded as policy for sustainable development. Besides, reducing poverty, economic incentives for industries that use eco-friendly technology, greater participation in protection of environmental efforts, providing proper environmental education in schools and colleges are regarded some of the basic policies for sustainable development.

- Green economy, Green growth and low-carbon development are some of the related concepts of sustainable development.

9.9 FURTHER READING

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- Important websites: https://sustainabledevelopment.un.org/
  https://www.undp.org/

9.10 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: The name of the organization that brought into common use of the terminology sustainable development is *World Commission on Environment and Development.*

Ans to Q No 2: The three basic ideas that definition of sustainable development covers are: (i) development, (ii) needs, and (iii) future generation.

Ans to Q No 3: The difference between growth and development is that growth is an expression for quantitative expansion of economic system. Development on the other hand, is a qualitative concept incorporating notions of improvement are progress and including cultural, social and economic dimensions.

Ans to Q No 4: The three basic components of sustainable development are (i) economic components, (ii) social component, and (iii) ecosystem component.

Ans to Q N 5: Indicator means the variables that use to measure knowledge which support for policy analysis and decision-making process.

Ans to Q N 6: Defining development indicator is quite complicated, because defining development indicator is too normative. No single indicator can give a perfect and complete picture about the state of welfare. Regarding social issues, it is very difficult to measure social dimensions. Justice and equity are not easy to define. Likewise, the environmental dimensions invite several new indicators for discussion. Only a few of ecological attributes are quantifiable. Ecological status of aesthetic beauty is not easy to put on any scale or indicator, though some of the environment related factors could be viewed in terms of selected physical indicators. For example, air pollution can be viewed in terms of emission of CO_2, SO_2 or NO_x.

Ans to Q No 7: In order to capture all aspect of ecological and environmental changes, the three types of indicators of sustainable development are (a) pressure indicator, (b) impact indicator, and (c) sustainable development indicator.

Ans to Q No 8: Sustainable development try to create consciousness about environment among the present generations so that the same (greater, if possible) resource can be left for the future generations for their better life.

Ans to Q No 9: Sustainable development encourages producers to invent and use better technology so that output can be produced by using least natural resources.

Ans to Q No 10: The three basic features of natural capitals are, (a) uniqueness, (b) uncertainty, and (c) irreversibility.

Ans to Q No 11: Tide rules and regulations should be set regarding establishment of industries, because industrial pollutions are regarded as one of the major sources of environmental pollution.

Ans to Q No 12: The two examples of economic incentive which use eco-friendly technology are (a) imposing low tax rate, (b) providing subsidy.

Ans to Q No 13: The three concepts that related to sustainable development are (b) green economy, (b) green growth, and (c) low-carbon development.

Ans to Q No 14: The concept of low-carbon development was adopted by United Nations Framework Convention on Climate Change (UNFCCC) in 1992.

9.11 MODEL QUESTIONS

Short questions (Answer each question in about 150 words)

Q.1: Discuss the concept sustainable development?

Q.2: Discuss the different indicators of sustainable development?

Q.3: Discuss the significance and importance of sustainable development?

Q.4: What are the different policies, which should be adopted for sustainable development?

Q.5: Discuss the different concepts related to sustainable development?

Long questions (Answer each question in about 500 words)

Q.1: Critically discuss the different measures of sustainability.

Q.2: Discuss the problems related to implementation of policies regarding sustainable development.

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UNIT 10: ENVIRONMENTAL ACCOUNTING

UNIT STRUCTURE

10.1 Learning Objectives

10.2 Introduction

10.3 Environmental Accounting

10.4 Environmental Auditing

10.5 Environmental Impact Assessment (EIA)

10.6 Let Us Sum UP

10.7 Further Reading

10.8 Answer to Check Your Progress

10.9 Model Questions

10.1 LEARNING OBJECTIVES

After going through this unit, you will be able to know -

- the objectives of environmental accounting.
- meaning and objectives of environmental auditing,
- definition and significances of environmental impact assessment, and
- process of environmental impact assessment.

10.2 INTRODUCTION

Natural resources provide energy and materials that are used to produce goods and services to satisfy human needs. Overuse of natural resources create two basic environmental problems simultaneously viz. scarcity of natural resources and huge release of residuals which increase the carrying capacity of the earth. Because of these two basic environmental problems, the concept of environmental accounting, auditing and environmental impact assessment is becoming popular throughout the world. It is made compulsory to do environmental accounting, auditing and environmental impact assessment in most of the countries.

10.3 ENVIRONMENTAL ACCOUNTING

There is no standard definition of environmental accounting. In general, it is a term used to take into account the environment and changes in it, and integrating the results with the systems of national accounts (SNA) so as to provide a valuable information base for planning and making policies for the integrated sustainable development and growth of the nation as a whole. It is also known as natural resource accounting. Environmental accounting is an approach to accounting that includes measures of the environmental impacts and resource use of economic activities as well as financial measures. It is the

publication of information about the level of natural resource use, existing stocks of natural resources and environmental degradation, within a country or a region. Environmental accounting is also called Green *Accounting* which refers to modification of the system of national *accounts* to incorporate the use or depletion of natural resources. *Environmental accounting* is a vital means to assist in the management of *environmental* and operational costs of natural resources. It is the estimation and public reporting of environmental liabilities and environmental costs.

There are some basic objectives of environmental accounting which can be represented as follows:

- Taking the total stock of assets or reserves related to environmental issue and changes therein.
- Estimation of the total expenditure related to protection or enhancement of environment.
- To identify that part of the gross domestic product which reflects the cost necessary to compensate for the negative impact of economic growth i.e. the so-called defensive expenditure to protect environment.
- Assessment of environmental costs and benefits, which includes-

(a) The decrease or depletion in natural resources due to their use in production and final demand, and

(b) The changes in environmental quality resulting from pollution and other impacts of production and consumption and other natural events on one hand, and the expenditure for environmental protection and enhancement of the environment on the other.

- Elaboration and measurement of indicators, relating to environmentally adjusted product and income which are disclosed by Environmentally Adjusted Net Domestic Product (EDP), i.e., Net Domestic Product minus Environmental costs.
- Analysis of EDP, it is to plan the use of resources by squeezing them and reducing waste to attain sustainable development.

A number of countries have carried out the exercise of environmental accounting so far. However, the methodologies adopted by the countries are not same. In India, there is no common method of environmental accounting adopted by corporate or government. In the international level, since the 1970s, the work on the designing of environmental accounts has been going on. In the 1980s, the United Nations Environmental Programme (UNEP), the United Nations Statistical Division (UNSTAT) and the World Bank launched concerned international efforts to build consensus on how the System of National Accounts (SNA) might be modified to include environmental problem. As a consequence, a draft titled 'Handbook for integrated Economic and Environmental Accounting' was published in 1993, encompassing the preliminary methodology to be tested and refined. The approach in this document is often referred to as a system of Integrated Economic and Environment Accounting (SEEA). The SEEA tries to integrate the various methods available for environmental accounting into a single framework. This document offers a series of versions or 'building blocks' for the construction of accounts beginning with physical accounts and disaggregation of data already included in SNA. It also works towards more complex information such as calculation of depletion and estimation of maintenance costs required for sustainable use of resources. None of the versions of SEEA encompasses

the valuation of non-marketed environmental services. UNSTAT, with UNEP and other experts, is preparing a practical manual or Work Book for implementing SEEA. The SEEA is a proposed methodology and does not have official approval of the United Nations.

10.4 ENVIRONMENTAL AUDITING

Auditing is an inspection or systematic examination of a process or activity, often carried out by an independent or external specialist, designed to ensure compliance with requirements. Environmental auditing is a formal independent evaluation of compliance with environmental regulations, standards and policies or an assessment of the management of any impact on the environment. For example, pollution prevention initiatives require an audit to determine where wastes may be reduced or where energy can be conserved. Like general auditing, environmental auditing is also done by independent body or recognized company or agency. Environmental audit determines how well the businessmen comply with environmental laws and regulations. An audit may relate to a strict compliance audit, where facility activities are reviewed against legislative requirements or as part of a company's/firm's management system to ensure environmental best practice. Environmental audits cover a wide range of environmental issues and also focuses on a particular aspect such as air and water permit etc.

Environmental audits are generally performed on a routine or periodic basis. Frequent environmental auditing is appropriated, because, if it is done frequently then the central or state or local government can issue notice more frequently to firms/companies regarding violation of norms.

The objectives of environmental auditing cover three major issues, viz,

- *The financial issue*, the objectives of environmental auditing include- (a) to help in avoiding fines by regulatory agencies, (b) to identify issues of non-compliance sooner versus later allowing for proactive financial planning, and (c) to lower corrective action costs, and to minimize opportunities leading to reduce operating costs.
- *The issue of compliance*, the objectives of environmental auditing include, (a) to reduce agency enforcement actions and penalties, and (b) to increase awareness among the employees regarding environmental standards and responsibilities.
- *The issue of stakeholder relations*, the objectives of environmental auditing include- (a) to improve employees' relations with the employers and increase ethical thoughts on environment, and (b) to improve community image goodwill of the respective company/ firm that they are concerned about sound environmental programmes.

CHECK YOUR PROGRESS

Q 1: What do natural resources provide to producers to produce goods and services?

Q 2: Define environmental accounting.

Q 3: What are the two issues related to assessment of environmental cost and benefits?

Q 4: What is environmental auditing?

Q 5: Why frequent environmental auditing is appreciated?

10.5 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Environmental Impact Assessment (EIA) refers to the evaluation of the effects of a proposed major project on a man-made environment. It is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, basically, the adverse impacts. It is the basic tool for the sound assessment of development proposals.

10.5.1: Significances of EIA

Why do we need EIA? We need EIA, because the EIA helps the decision makers to identify the possible effects at an early stage and to improve the quality of proposed projects. It is a process used to predict the environmental consequences of proposed major development projects, to identify and plan for appropriate measures to reduce the possible adverse impacts. The significances of the EIA can be cited as follows-

- An EIA is a means to a larger end, the protection and improvement of environmental quality.
- It is not just a single technique or method but a procedure that uses many approaches to evaluate environmental impacts.
- It is interdisciplinary, since the impacts of proposed developmental projects are multidimensional.
- In is an integral part of project planning and not just an addition.
- An EIA does not make decision but its findings should be considered in policy and decision making.

10.5.2: Process of the EIA

An EIA attempts to answer the following questions:

- What will happen as a result of the proposed project?
- What will be the extent of the changes, because of the proposed project?
- Do the changes matter?
- What can be done about them?
- How can decision makers be informed of what needs to be done?

Answers to these five questions are given through five steps.

- Identification of impacts.
- Predictions of significance of causes and effects of impacts.
- Evaluation of the predicted adverse impacts to determine whether they are significant enough of warrant mitigation.
- Suggesting a wide range of measures to prevent reduce or remedy those adverse impacts which warrant mitigation.
- Documentation of the process and conclusion.

However, the EIA does not require in all proposed developmental projects. There are three options available before a proposed developmental project, viz. No EIA required, uncertainty and EIA required. When EIA does not require, the available options are: either reject the proposed developmental projects or approved it. In case of uncertainty, a preliminary assessment is done to assist project planning. Preliminary assessment identifies the impact and predicts the magnitude of impacts and evaluates their importance to decision makers and helps to clear the projects of a full EIA. If preliminary assessment calls for full EIA, then only the process of the EIA has been done.

Once the proposed project is recommended for EIA, the first step is *Identification* of the impacts from that proposed project. The identification of the impacts depends on the magnitude of the project, geographical extent, significance of decision makers etc. Once the most important impacts are identified, the second step is *Prediction* of the impacts, which includes quantification of impacts through mathematical models, physical models, socio-cultural models, economic models and experiments. The third step that seeks to answer the question 'do the changes matter?' *evaluates* the predicted adverse impacts by comparing it with laws, regulations, or accepted standards or by reference to pre-set criteria, or on the basis of acceptance to local community or public in general. In fact, evaluation involves consultations with relevant decision makers. The fourth step is ***Mitigation Measures***. If evaluation warrants mitigation for the impacts, it may suggest some mitigation steps to follow, say, (i) change the project site, (ii) change the production process, (iii) change the raw materials, (iv) introduction of pollution control methods, say, wastes treatment, monitoring pollution etc. (v) restoration of damaged resources, compensation to affected community, or persons etc. Then only the fifth step i.e. ***documentation*** is done. After documentation, a draft EIA report is prepared. The report is reviewed by experts. The final EIA report is placed after correction is done. There are two options available once the final EIA report is placed, viz. rejection and approval. The proposed developmental project is implemented, once it is approved.

10.5.3 : EIA in India

When the Department of Science and Technology took up environmental appraisal of river valley projects, EIAs of development projects were first started in 1977-78 in India. Afterward, various other projects were brought under the purview of EIA. However, the EIA was made mandatory in India in 1994, under the Environmental (Protection) Act of 1986. The Ministry of Environment and Forests (MoEF), Government of India has prepared environmental guidelines, to help the project proponents to work out an EIA. Guidelines have been prepared to bring out specific information on the environment required for environmental approval. The agencies which are primarily responsible for the respective sectors are closely involved in preparing the guidelines. Basically, river valley projects, thermal power projects, mining projects and industries, ports and harbours, development of beaches, highway/railway projects are the sectors for which guidelines have already been prepared. These guidelines basically consist of aspects regarding planning and implementation of development projects. As of now, in India, EIA is required for 30 categories of industrial projects.

CHECK YOUR PROGRESS

Q 6: What is Environmental Impact Assessment (EIA)?

Q 7: Why does Environmental Impact Assessment require?

Answer:

Q 8: What are the possible options after preliminary evaluation has been done for a proposed project?

Q 9: According to which act Environmental Impact Assessment is compulsory in India?

10.6 LET US SUM UP

- In general, Enviromental Accounting is a term used to take into account the environment and changes in it, and integrating the results with the systems of national accounts (SNA) so as to provide a valuable information base for planning and making policies for the

integrated sustainable development and growth of the nation as a whole. It is the publication of information about the level of natural resource use, existing stocks of natural resources and environmental degradation, within a country or region.

- There are numbers of objectives of environmental accounting. Some of them are: - eestimation of the total expenditure protection or enhancement of environment, to identify that part of the gross domestic product which reflects the cost necessary to compensate for the negative impact of economic growth i.e. the so-called defensive expenditure to protect environment, assessment of environmental costs and benefits etc.

- A number of countries have carried out the exercise of environmental accounting so far. In India, there is no common style of environmental accounting has been developed. In the international level, since the 1970s, the work on the design of environmental accounts has been underway.

- Environmental auditing is a formal independent evaluation of compliance with environmental regulations, standards and policies or an assessment of the management of any impact on the environment. Environmental audits are generally performed on a routine or periodic basis. Objectives of environmental auditing include three basic issues, viz. financial, compliance and stakeholder relation.

- Environmental Impact Assessment (EIA) refers to the evaluation of the effects of a major project on a man-made natural environment. It is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, basically, adverse impacts.

- The EIA is necessary, because the EIA helps the decision makers to identify the likely effects at an early stage and to improve the quality of project planning and decision making. It is a process used to predict the environmental consequences of proposed major developmental projects, to identify and plan for appropriate measures to reduce adverse impacts.

- The EIA does not require in all developmental projects. There are three options available before a proposed developmental project, viz. No EIA required, Uncertainty and EIA required. In case of uncertainty, a preliminary assessment is done to assist project planning. Preliminary assessment identifies the impact and predicts the magnitude of impacts and evaluates their importance to decision makers and helps to clear the projects of a full EIA. If preliminary assessment calls for full EIA, then only the process of the EIA has been done.

- When the Department of Science and Technology took up environmental appraisal of river valley projects, EIAs of development projects were first started in 1977-78 in India. Afterward, various other projects were brought under the purview of EIA. However, the EIA was made mandatory in India in 1994, under the Environmental (Protection) Act of 1986.

10.7 FURTHER READING

- Bhattacharya, R. N. (2001). *Environmental Economics: An Indian Perspective*, (edited book), Oxford University Press.
- Karpagam, M. (1999). *Environmental Economics*, Sterling Publishers Private Limited.
- Ulaganathan, S. (2001). *Environmental Economics, Readers in Economics*, Oxford University Press.

10.8 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Natural resources provide energy and materials to producers to produce goods and services.

Ans to Q No 2: Environmental accounting is an approach to accounting that includes measures of the environmental impacts and resource use of economic activities as well as financial measures.

Ans to Q No 3: The two issues related to assessment of environmental costs and benefits are- (a) the decrease or depletion in natural resources due to their use in production and final demand, and (b) the changes in environmental quality resulting from pollution and other impacts of production and consumption and other natural events on one hand, and the expenditure for environmental protection and enhancement of the environment on the other.

Answer to Q.4: Environmental auditing is a formal independent evaluation of compliance with environmental regulations, standards and policies or an assessment of the management of any impact on the environment.

Answer to Q.5: Frequent environmental auditing is appropriated, because, if is done frequently then, the central or state or local government can issue notice more frequently regarding violation of norms.

Answer to Q.6: Environmental Impact Assessment (EIA) refers to the evaluation of the effects of a major project on a man-made natural environment. It is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, basically, adverse impacts.

Answer to Q.7: The EIA requires, because the EIA helps the decision makers to identify the likely effects at an early stage and to improve the quality of project planning and decision making. It is a process used to predict the environmental consequences of proposed major development projects, to identify and plan for appropriate measures to reduce adverse impacts.

Answer to Q.8: The possible options after preliminary evaluation has been done for a proposed project is (a) rejection of the proposed project, (b) approval the proposed project, and (c) EIA requirement of the proposed project.

Answer to Q.9: In India, EIA is statutory according to the Environmental (Protection) Act, 1986.

10.9 MODEL QUESTIONS

Short questions (Answer each question in about 150 words)

Q 1: What are the objectives of environmental accounting?

Q 2: Discuss the objectives of environmental auditing.

Q 3: Discuss the significances of Environmental Impact Assessment.

Long questions (Answer each question in about 500 words)

Q 1: Give an account of Environmental Accounting in international level.

Q 2: Discuss the processes of Environmental Impact Assessment.

Q 3: Give an account of Environmental Impact Assessment adopted in India.

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UNIT 11 : INSTRUMENTS OF ENVIRONMENTAL PROTECTION-I

UNIT STRUCTURE

11.1 Learning Objectives
11.2 Introduction
11.3 Types of Instruments
11.4 Conventional Instruments –Command and Control Measures
11.5 Importance of Conventional Instruments
11.6 Let Us Sum Up
11.7 Further Reading
11.8 Questions to Check Your Progress (Very Short Questions)
11.9 Answers to Check Your Progress
11.10 Model Question

11.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- understand about the emergence and need of environmental protection measures
- discuss the role of various types of environmental protection measures
- explain about different types and need of Command and Control (CAC)measures
- interpret the implications of CAC measures

11.2 INTRODUCTION

The practice of protecting the natural surroundings or environment by individuals, society, institutions, organizations and governments is defined as Environmental protection. The prime objective of environmental protection policies is to conserve natural resources along with the existing natural environment. The econdary objective is, where possible, to repair damage and reverse the trend of environmental degradation. Thus we can say that environmental policy instruments are tools used by governments to implement their environmental policies to preserve the environment as a whole. Governments may use a number of different types of instruments. For example, economic incentives and instruments which are market based such as taxes and tax exemptions, tradable permits, and fees. Market based instruments can be very effective to encourage compliance with environmental policy. Corporate companies who engage in efficient environmental management and are transparent about their environmental data are reporting benefit from improved business performance.

In most of the cases, now a day, several instruments are combined in a policy to combat the environmental problems. Since, environmental issues have many aspects; several policy instruments may be required at a time to adequately address each one. Moreover,

a combination of different policies may give firms greater suppleness in policy compliance and reduce uncertainty about the cost of such compliance. Therefore, government policies must be cautiously formulated so that the individual measures do not demoralize one another. Then only it may be able to create a more flexible and cost-effective framework. Overlapping policies result in unnecessary administrative costs due to the high cost of implementation.

11.3 TYPES OF INSTRUMENTS

There are basically two major kinds of tools available for environmental policy making. On the one side the more reactive command-and-control approaches (CAC) and on the other side preventive market-based instruments creating more economic incentives not only for industries but also for private persons to reduce harm to the environment. Most of the Governments have traditionally employed CAC regulations in the 1970s and 1980s. In India also The Wild Life Protection Act, 1972, The Water (Prevention & Control of Pollution) Act 1974 and many more laws are enacted in this regard. This approach was afterwards reconsidered when economic studies become critical about CAC regulations and points out that these are often cost-ineffective, inflexible, and of limited efficacy. In particular, the private sector lacks an incentive to invest in developing a new and better control technology or strategy when the government dictates flat CAC rules.

However in this chapter, we will look into the CAC instruments as an environment protection tool and its importance in particular.

It has been recognised that command-and-control regulations were highly successful in protecting and cleaning up the US environment back in 1980-90s and beyond that. The Environmental Protection Agency was created to oversee all environmental laws in 1970 in the United States. To address air pollution, in the same year, the Clean Air Act was enacted. Just after two years, Congress passed and the president signed the far-reaching Clean Water Act in 1972. These command-and-control environmental laws, and their amendments and updates, have been largely responsible for cleaner air and water in the United States in recent decades.

Table 1.1 depicts a general taxonomy of climate policy instruments. This section will give a short introduction to each instrument category.

Environmental policy instruments are basically divided into market-based and non-market-based instruments. Although some environmental economists also talk about some other

fixed solutions like Coase theorem, Kaldor – Hicks compensation criteria etc. as some other possible types of solution, we will strictly look at the market based and CAC measures only.

Table 11.1 Types of Environmental Protection Policies

Market Based Instruments	Command and Control Instruments
Emission fees	Emission standard
Marketable pollution permits	Technology standard
Environmental taxes	

Source: With the help of Blackman & Harrington, 1999

Another classification of all the policy instruments with their strength and limitations can be as follows.

Table 11.2: Taxonomy of Climate Policy Instruments

Instruments	What is meant	Example	Strength	Weakness
Prescriptive Regulations (CAC)	The government tells about what to do	Endangered Species Act, Clean Water Act, Clean Air Act	Simple to administrate, predictable results	No incentives , lots of loopholes, inflexible
Property Rights	The government distributes the rights	Fishing rights	Allow markets to work, more flexible	Can be expensive, setting up is difficult
Penalties/tax	The Government taxes 'bad' behaviour	Carbon tax, gas and heavy taxes	Economically efficient, allows markets to work	Taxes are not always preferred
Payments	The government subsidizes 'good' behaviour	Grazing on national land	popular	Someone has to pay for it
Persuasion	The government tries to persuade people	Information on the product like cigarette and its health hazards, product labelling	No coercion	Effects can be small
Provision	The government does it	National Parks, Wild life refuges	Easy to set up and no coercion	Can be expensive, not suitable for all projects

Source: Prepared with the help of Leslie Ruyle, 2018[1]

Command-and-Control regulation sets precise limits for pollution, emissions and/or requires that specific pollution-control technologies that must be used.

Property rights can be also another handy tool to solve some problems. The innovative extension of property rights to ecological resources could help address many

environmental problems. Predominantly in the case of natural resources, property rights are a feasible and demonstrated means of attractive sustainability, particularly when compared to the available political alternatives. Property rights are basically subjective rights. Normally, they belong to somebody. Either a person or legal corporation or government is responsible for the act. Accordingly, they can be the subject of contracts to civil war.[2]

Market-based instruments are indirect regulatory instruments. These instruments influence peoples' behaviour by changing their economic incentive structure. Although, costs from environmental externalities, for example greenhouse gas (GHG) emissions, are usually not visible in consumption or investment decisions but are nonetheless imposed on third parties. Therefore, market based instruments work by reflecting the environmental impact of a certain action by attaching a cost to it. It is a kind of signal that provides an incentive to the polluter to reduce this impact. The idea of environmental taxation was first introduced by Arthur Cecil Pigou; therefore, these taxes are sometimes also referred to as Pigouvian taxes. Environmental taxes adjoin directly to the price of a certain good or service; therefore, they ideally should reflect the environmental externalities caused by production and/or consumption of this good or service. The rise in costs is usually passed through to the end consumer. In theory, the consumer reacts with a reduction of demand, as the price increases. However, consumer reactions are hard to predict and depend on availability of substitutes and perceptibility of the price signal. This type of tax fixes a price and thereby indirectly influences behaviour. It is also crucial to set the price at the right level. For these reasons environmental taxes bear a certain degree of uncertainty regarding their environmental effectiveness.

Persuasion aims to give consumers access to information on the environmental performance of the product. By the way of environmental product labelling it distributes information to consumers to put them into position to include environmental characteristics in their consumption decisions. The labels can contain information on product content, composition, and its origin or production method[3]. In climate policies the energy performance of products plays an important role. Energy efficiency labels can also provide incentives for industries to develop energy efficient products. It can work as a means of marketing products to

[2] linkspringer.com/chapter/10.1007/

[3] Michael Common & Sigrid Stagl, "Ecological Economics", Cambridge University Press,2012

Persuasion aims to give consumers access to information on the environmental performance of the product. By the way of environmental product labelling it distributes information to consumers to put them into position to include environmental characteristics in their consumption decisions. The labels can contain information on product content, composition, and its origin or production method[3]. In climate policies the energy performance of products plays an important role. Energy efficiency labels can also provide incentives for industries to develop energy efficient products. It can work as a means of marketing products to consumers as superior to others (based on a more favourable label). However, a precondition is that labels are updated regularly so that to keep up with efficiency advances and also to incentivise them. The energy consumption labelling

scheme introduced by the Directive on Energy Labels informs consumers on the energy performance of most household appliances, of light bulbs and also cars. Thus, the products' energy efficiency is rated in terms of a set of energy efficiency classes[4].
Provision can be another option if government is in a position to provide them in the form of giving protection. For example, wild life sanctuaries, national parks are good example of protecting the flora and fauna of the region.

CHECK YOUR PROGRESS

Q 1: The practice of protecting the natural surroundings/environment by individuals, society, institutions, organizations and governments is defined as.....

Q 2: Market-based instruments are..... regulatory instruments.
Q 3: Property rights are basically .....rights.
Q 4: The labels can contain information on....., composition, and its origin or production method.
Q 5: .....instruments have a number of political features that encourage their adoption.

11.4 CONVENTIONAL INSTRUMENTS: COMMAND AN CONTROL MEASURES

Command-and-control instruments inflict direct regulatory intervention by means of setting standards, e.g. of pollution output or technology requirements. In climate change policies, these are mainly connected to greenhouse gas (GHG) emissions or energy efficiency. In the case of nonconformity of standards are usually combined with legal enforcement. They are a very straight-forward way of policy intervention with relative certainty over the environmental effectiveness (Stagl, 2012). Forms of command-and-control instruments mainly comprise framework, performance and technology standards, as well as prohibition of certain products and practices. Command-and-control (CAC) approaches indicate regulatory instruments that speak about abatement decisions. CAC measures fall in two broad categories: i) technology standards, which impose on emitters the use of specific abatement technologies; and, ii) performance standards, which set specific environmental targets to be met (e.g. a certain amount of emissions per unit of output) without mandating particular technologies. By forcing all firms to undertake specific emission reduction efforts regardless of their individual abatement costs, CAC instruments do not, in general, achieve marginal abatement cost equalisation and, thus, do not minimise overall abatement costs (Russell, 1985). Again, technology standards are usually more costly than performance standards. But the latter give firms greater flexibility in selecting the abatement option that is most adapted to their individual situation. For a CAC instrument to be as cost-effective as a market-based incentive, firms' marginal abatement costs should be similar, or the supervisory body should have full information about individual cost structures and then set regulation accordingly. These conditions are improbable to be met in practice. Also,

principles can be subject to “regulatory capture” by lobbies that gradually undermines economic efficiency. Finally, unlike price-based instruments, standards do not yield any “double dividend” since they do not raise fiscal revenues. However, if cautiously designed, CAC instruments can add to deal with a number of market imperfections that are left unaddressed by market-based incentives: In number of conditions like when emissions cannot be perfectly observed. For example, fugitive emissions from pipelines, methane from agriculture etc can be monitored by effective CAC tools. Market-based incentives are unable to minimise abatement costs as they do not address the monitoring issue. In principle, cost-effectiveness can then be enhanced through the use of technology standards. Another fact is that performance standards are useless in this context since their implementation also requires adequate emissions monitoring. When the emissions observation imperfection is large and abatement costs are relatively homogenous across agents, such standards have been shown to be more cost-effective than market-based incentives (Montero, 2005). Their performance can be further enhanced by combining them with market incentives whose effects can be measured, when these are available. In situations where asymmetric information between two contracting parties with opposite goals creates adverse selection and/or moral hazard problems, well-designed CAC instruments may also perform better than market incentives. Examples of such market failures have been identified especially in energy service markets (Sorrell et al. 2007). For example, in the housing market, landlords have better information than tenants but have little motivation to install the most energy-efficient equipments because they do not pay the energy bill. Similarly, asymmetric information between buyers and sellers may also prevent house prices from fully reflecting the discounted value of efficiency investments. The invisibility of energy-efficiency performance of electrical appliances and light bulbs may also prevent households from optimising energy consumption. In such cases, policy should as much as possible address directly the market failure involved through information instruments, such as public disclosure requirements or eco-labelling. However, when information instruments are costly or insufficient, standards can be justified, and they have been found to yield sizeable welfare gains. It has also been argued that CAC instruments should be preferred to market-based incentives in situations where agents do not respond to price signals. For instance, lack of institutional – including monitoring – capability may impede the proper functioning of market-based incentives in lower-income countries, while technology standards may be comparatively easier to implement and track. Standards may help raise emissions abatement in state enterprises with market power closer to levels that would be undertaken if such firms operated under private governance in competitive markets.

11.5 IMPORTANCE OF CONVENTIONAL INSTRUMENTS-COMMAND AND CONTROL

The hypothetical case for CAC instruments should, on the other hand, be qualified on three grounds:

1. Policymakers should make sure that the use of standards addresses genuine market failures, rather than merely high transaction costs. Hidden transaction costs may explain why apparently efficient investment decisions – e.g. in energy efficient equipments – are rationally not taken up by optimising households and firms. For example, transaction costs, rather than market imperfections, may partly explain why landlords and tenants do not in practice sign the type of shared-savings contracts that would seem to benefit both parties a priori.

2. CAC instruments have a number of political features that encourage their adoption. They already represent the most common form of environmental regulation. CACs can be easily enforced through existing national institutions, and unlike price instruments their costs are not immediately visible to voters. Some economists have also argued that international negotiations to set technology standards for key emitting industries could succeed in bringing large emitters from developing countries on board, if accompanied by technology transfers. Nevertheless CAC instruments offer little scope for addressing the "free-rider" problem affecting international climate policy negotiations. As a result, if large reductions in worldwide GHGs were to be secured through standards, adoption incentives could be weak.

3. Unlike with permits, burden-sharing rules cannot be built in CAC instruments and would, therefore, have to be negotiated separately. Information problems would affect such negotiations, reflecting the difficulty to assess the costs of implementing standards.

Finally, going through the existing literature it can be said that the idea of getting same international standards is unclear and whether it would actually be desirable. Another important point is that while expanding the international coverage of price instruments at all times reduces the overall cost of achieving a given worldwide reduction in GHG emissions, mandating uniform standards across all countries may not.

However, economists have pointed out four difficulties with command-and-control environmental regulation.

First, command-and-control regulation offers no inducement to improve the quality of the environment beyond the standard set by a particular law. Once the command-and-control regulation has been satisfied, polluters have zero incentive to do better.

Second, command-and-control regulation is stiff or not flexible. It typically requires the same standard for all polluters, and often the same pollution-control technology as well. This means that command-and-control regulation do not recognise the distinctions between firms that would find it easy and inexpensive to meet the pollution standard or/ and to reduce pollution even further; and firms that might find it difficult and costly to meet the standard. Generally, firms have no reason to rethink their production methods in fundamental ways that might reduce pollution even more and at lower cost.

Third, command-and-control regulations are written by legislators and the Environmental Protection Agency. Therefore, they are subject to compromises in the political process. Existing firms often argue and lobby so that stricter environmental standards should not be applied on them. They insist on the fact that the rules should fall upon new firms that wish to start production. Consequently, real-world environmental laws are full of fine print, loopholes, and exceptions.

Fourth, CAC are rarely effective in comparison to other instruments like tax and permits. Again, government may not have enough information to order the least cost method. Critics of command-and-control regulation appreciate the goal of reducing pollution, but they question whether this type of regulation is the finest way to design policy tools for accomplishing that goal. But in most of the developing countries, CAC measures are great in use in combinations of other available instruments.

CHECK YOUR PROGRESS

Q 6:State true or false

a) Market-based incentives are unable to minimise abatement costs as they do not address the monitoring issue. (true/false)

b) Command-and-control regulation is flexible. (true/false)

c) Forms of command-and-control instruments mainly comprise framework, performance and technology standards, as well as prohibition of certain products and practices. (true/false)

d) Provision aims to give consumers access to information on the environmental performance of the product. (true/false)

e) CAC instruments should be preferred to market-based incentives in situations where agents respond to price signals. (true/false)

11.6 LET US SUM UP

- Environmental protection is the practice of protecting the natural surroundings/ environment by individuals, society, institutions, organizations and governments.
- There are two types of environmental protection policies basically- market based and non-market based instruments.
- Market-based instruments are indirect regulatory instruments.
- Command-and-control instruments inflict direct regulatory intervention by means of setting standards, e.g. of pollution output or technology requirements.
- CAC instruments can add to deal with a number of market imperfections that are left unaddressed by market-based incentives.
- CAC can be the best possible solution when the problem is well known and success requires very strong compliance.
- CAC instruments should be preferred to market-based incentives in situations where agents do not respond to price signals.

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11.8ANSWERS TO CHECK YOUR PROGRESS

A. a) Environmental protection b) indirect c) subjective d) product content e) CAC

B. a) Market-based incentives are unable to minimise abatement costs as they do not address the monitoring issue. (True)

b) Command-and-control regulation is flexible. (False)

c) Forms of command-and-control instruments mainly comprise framework, performance and technology standards, as well as prohibition of certain products and practices. (True)

d) Provision aims to give consumers access to information on the environmental performance of the product. (False)

e) CAC instruments should be preferred to market-based incentives in situations where agents respond to price signals. (False)

11.9MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q 1: How command and Control measures of environmental regulation help in protection of environment.

Q 2: What are the markets based instruments of regulation of environment?

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

Q 1: What are the types of environmental protection instruments? State in brief (within 500 hundred words)

Q 2: Discuss the advantages and disadvantages of command and control measures. (Within 650 words)

Q 3: Write a short note for each of the following (each within 150 words)
a) Property right b) Penalty c) Persuasion

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UNIT 12: INSTRUMENTS OF ENVIRONMENTAL PROTECTION- II ECONOMIC INCENTIVE MEASURES

UNIT STRUCTURE

12.1 Learning Objectives
12.2 Introduction
12.3 Pollution Fees/Tax
12.4 Tradable Pollution Permit
12.5 Liability Rules
12.5.1 Non-Compliance Fees
12.5.2 Deposit Refund System
12.5.3 Performance Bonds
12.6 Let us Sum up
12.7 Further Reading
12.8 Answers to Check Your Progress
12.9 Model Questions

12.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- describe pollution tax method of pollution control
- explain about tradable pollution permit method
- discuss different liability rules such as deposit refund system, non-compliance fees and performance bonds

12.2 INTRODUCTION

Government policies to control pollution can be broadly classified into two categories, that is, command and control policies and economic incentives. As the name indicates, command and control policies are implemented by orders of the regulator (i.e. government). Under command and control policies, the polluter has no option to choose any particular method to control pollution. However, under economic incentive method Government policies to control pollution can be broadly classified into two categories, that is, command and control policies and economic incentives. As the name indicates, command and control policies are implemented by orders of the regulator (i.e. government). Under command and control policies, the polluter has no option to choose any particular method to control pollution. However, under economic incentive method (which are non-conventional in nature), the profit or cost of production is linked to the level of pollution caused by a particular producer. This system raises the cost of environmental degradation, while allowing the producer the flexibility to find the least cost pollution control method. Under this method, there is an incentive to reduce pollution, as lower level of

pollution reduces cost of production or increases profit. This is why economic incentives are also known as incentive based measures. The economic incentive measures are of three types:

(a) Pollution Tax (or subsidy)

(b) Tradable Pollution Permits and

(c) Liability Rules.

12.3 POLLUTION TAX/ FEES

One of the criteria of pollution control policy is efficiency. Efficiency of a policy indicates that targeted reduction in pollution is to be achieved through minimum cost. Empirical studies state that "pollution tax" or "polluter pays" is the most efficient method of pollution control. The pollution tax method may take different forms such as taxes on polluting inputs, taxes on emissions, product tax and subsidies on pollution reduction.

Externality exists when one economic agent's (consumer or producer) action (consumption or production) affects another agent's welfare directly rather than through market price or quantity. In other words, one person's consumption (or one firm's production) imposes cost or benefits on another consumer or producer. Externality may be positive (benefit) or negative (cost). Pollution is nothing but negative externality, as pollution generated by an industry (producer) or a smoker (consumer) affects the welfare of all other individuals in the society. Under pollution tax (fees) method, the polluter has to pay the cost made by his action (pollution).

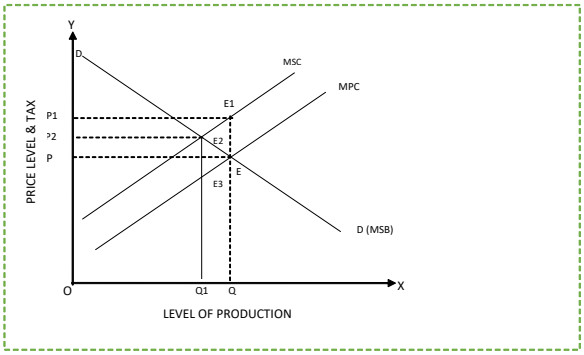
An individual economic agent is in equilibrium; when Marginal Private Cost = Marginal Private Benefit However, the society's welfare is maximised or the society is in equilibrium, when

Marginal Social Cost = Marginal Social Benefit

Or, Marginal Private Cost + Marginal External Cost = Marginal Private Benefit + Marginal External Benefit

The system of pollution tax to reduce pollution can be explained with the help of Fig. 12.1

Fig. 12.1: Pollution Tax to Control Pollution



]In Fig. 12.1, the downward sloping demand curve (D) indicates the marginal social benefit (MSB). MPC and MSC indicate the marginal private cost of an individual polluter and marginal social cost respectively. The difference between MPC and MSC is the marginal external cost. In other words, marginal external cost (negative externality) is not a part of the private cost of the producer, but it costs to the society. Without any intervention from the regulator (or government), the equilibrium level of price and output are OP and OQ respectively, corresponding to the point of interaction between D and MPC. However, due to the existence of marginal external cost (negative externality), OQ level of output is not socially desirable. So the regulator has decided to impose tax equal to EE1 per unit of output. After imposition of tax, the marginal private cost (MPC) becomes equal to marginal social cost (MSC) and the market is in equilibrium at point E2. Accordingly, equilibrium level of price and output are OP2 and OQ1 respectively. Thus, pollution tax controls pollution through higher price level and reduction in equilibrium output. It also generates revenue for the government, which can be used for cleaning up the environment.

Notably, the extent of pollution tax may be less than equal to EE1. In other words, pollution tax may cover negative externality partly or fully. If the rate of pollution tax is equal to the marginal external cost (negative externality), it is called Pigouvian tax. In case of pigouvian tax, total amount of tax revenue is equal to the volume of negative externality.

On the other hand, if the production of a commodity generates positive externality, socially desirable level of output is higher than which is produced by the market. In this case, the government may provide subsidy to the producer to produce higher level of output.

CHECK YOUR PROGRESS

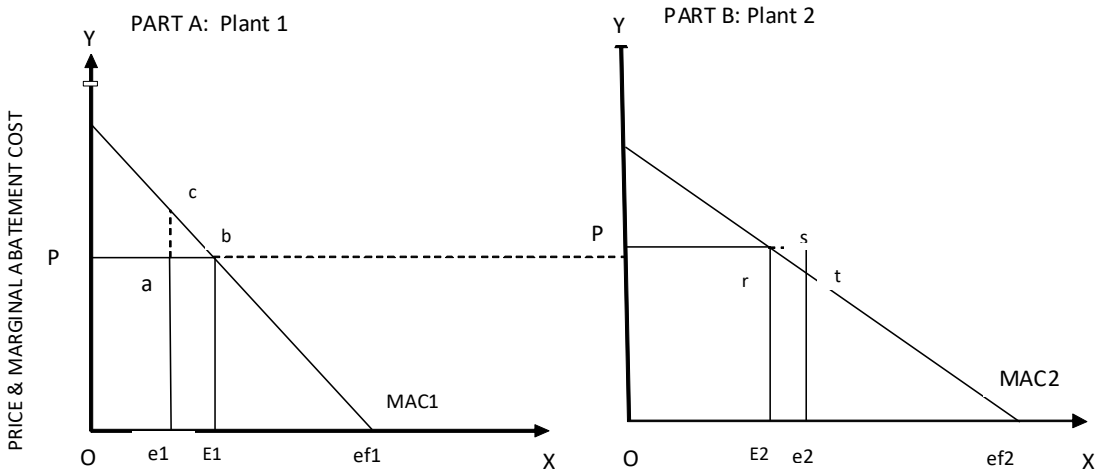
Q 1: What is Pigouvian Tax? (within 30 words)

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equal to the total permissible emissions are distributed among the potential polluters. The potential polluters are mainly the producers. The permits are tradable among the producers. Moreover, permits may also be traded among different plants of the same producer. If a producer is able to keep its pollution level below its allotted permit level, he or she can sell or lease rest of the permits to other producers.

The basic feature of tradable pollution permit is that it is beneficial for the polluters to adopt appropriate method of production to reduce pollution, if the cost of reducing the level of pollution is less than the price of the permits. Thus, the design and locations of pollution control strategies are shifted from the regulators to the potential polluters. If the potential producers are similar, the trading of permits will lead to equality in marginal abatement cost across the polluters.

The method of tradable pollution permit can be explained with the help of a simple example of two uniformly mixed pollutants. Let there be two thermal power plants in a particular location, which discharge carbon dioxide. Now, the regulator wants to fix a maximum limit on the carbon dioxide emissions in that region and has decided to give permits to the two power plants. The functioning of the system can be explained with the help of the figure 12.2.



In the figure above, level of emissions made by the plants and the number of permits allotted to them are measured on X axis. The price of permits and marginal abatement costs are measured on Y axis. In the absence of any regulation, the level of emissions made by plant1 is Oef1 and that of Plant 2 is Oef2. MAC1 represents the marginal abatement cost (MAC) of Plant 1 and MCA2 indicates that of plant 2. The price of permits supplied by the government is OP. The price of permit is determined by demand for and supply of permits. Supply of permits is fixed (E) and is determined by the regulatory authority. Demand for permits of a plant is indicated by its MAC curve. The summation of MAC of all the plants indicates market demand for permits. Thus, the price of permits OP is determined at the level, where

$$E = \sum MAC_i \text{ , where, } i = 1 \text{and } 2$$

Let the regulator assign Oe1 units of permit to Plant 1 and that of Oe2 units to Plant 2. However, given OP is the unit price of the permits distributed by the regulator, the desired level of permits of Plant 1 and Plant 2 are OE1 and OE2 respectively where the price is equal to their MAC of emission control. In this situation, it is profitable for plant 2 to sale E2e2 units of permits to Plant1. Because it can reduce this much of pollution by incurring the amount of cost rE2e2t, which is less than the total cost on permit i.e. rE2e2s. In other words, Plant 2 may earn rts amount of profit, if it sells E2e2 units of permits to Plant1. Similarly, it is beneficial for Plant 1 to purchase e1E1 (or E2e2) units of permits from Plant 2. Because if Plant 1 has to reduce emission by e1E1, its MAC would be cae1E1b. However, it has to pay only ae1E1b for e1E1 units of permits. Thus, both Plant 1 and Plant 2 are benefited by trading permits.

The marketable permit system must satisfy certain criteria to work efficiently.

(a) Only a limited number of permits are to be issued and it is to be given to some definite owner.
(b) Restrictions on trading the permits should be limited.
(c) Permits must be storable for certain time period.
(d) The transaction cost of permits should be limited.
(e) The penalty imposed on the polluter (without permits or beyond the permissible level) should be greater than the price of the permit.
(f) The regulator should take the permit back from the potential polluter only in some exceptional cases to maintain stability in the market.
(g) The sellers of permit should be allowed to enjoy the profit which they earn from trading of permits.

Thus, the tradable permit system has evolved as a less costly alternative to pollution tax. However, if there are multiple polluters than this policy design demands greater care.

CHECK YOUR PROGRESS

Q 4: How is the demand curve for tradable pollution permit derived? (50 words)

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12.5.1 Non-Compliance Fees

This method is a combination of subsidies and random fines. If the level of pollution in a particular area exceeds the targeted standard, the regulating authority selects at least one polluter randomly and charges fine. The regulator then redistributes a portion of this fine minus the damages to society from non-compliance back to the other producers. Thus, the polluting units have to pay fine and non-polluting units get rewards. The random penalty mechanism increases the expected cost of pollution. If this method is designed properly, it will induce the target control level without actually having to monitor the actions of the polluters. The greatest advantage of this method is that its implementation requires less information than the pollution tax. The non-compliance fees method needs information on the total amount of pollution in a particular location, information on pollution made by the individual producer is not required. However, pollution tax requires information on pollution made by each and every individual producer which is costly both in terms of time and money. However, this method works only when the producers are risk averse.

12.5.2 Deposit Refund System

Under this system the buyers of a potential polluter have to make some additional payment, which is refunded to them when they return the product or its container to an approved centre for proper disposal or recycling. For example, while climbing the Mount Everest the climbers leave empty oxygen cylinders on the summit. As per the rule of the government of Nepal, if anyone can collect and return such empty cylinders to the authority they are paid some dollars. Similarly, over the years this method has been applied all over the world to control the disposal of beverage containers. In such case someone may throw such containers on the road. However, someone else may be interested to depositing it to the appropriate authority and get back the refund. Thus, this method awards people with good environmental behaviour and impose cost on those people with bad environmental behaviours.

12.5.3 Performance Bonds

Under the system of performance bonds, the producer posts a bond before operation begins, forfeiting the bond if his activities cause environmental harm or the level of pollution caused by his activities is more than the acceptable levels. The bond increases the cost of pollution, which ultimately discourages polluting activities. This method can be applied when the damages to the environment is clear cut. This method may be applied to surface mining. One of the benefits of the performance bonds is that the potential damages to the environment is to be registered before starting production. The potential damages are open to public debate and scrutiny. Thus the burden of potential pollution is shifted to the producer from the society.

The value of the bond is determined by the potential impact of the producer on environment. The value of the bonds can be reduced if the producer can prove that the damages of his

activity are less than the cost of the posted bond. Therefore, the producer has the incentive to invest more on research and development to discover new method of production which is less polluting or to discover the true value of the environmental damages.

However, performance bonds are rarely used in reality to control pollution because of its certain limitations. The limitations of this method are:

(a) There may be the problem of moral hazard, if the action of the regulator is not observable. Suppose the regulator is interested in maximising his own private profit than the social welfare. In such situation the regulator (government) may label the producer as a polluter and thereby not refund the value of the bond. So, there should be some third party (court) to judge in this situation.

(b) The second limitation of this method is that there may be liquidity constraints. As the producer has to post the bond before starting the business, the producer may not have sufficient fund for it.

(c) Imperfect contact enforcement may affect the performance of the bond.

CHECK YOUR PROGRESS

Q 7: What is the assumption regarding the attitude of the producer towards risk in Non-Compliance Fees method? (20 words)

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12.8 ANSWERS TO CHECK YOUR PRGRESS

Ans to Q No. 1: If the rate of pollution tax is equal to the marginal external cost (negative externality), it is called Pigouvian tax.

Ans to Q No. 2: Externality exists when one economic agent's (consumer or producer) action (consumption or production) affects another agent's welfare directly rather than through market price or quantity.

Ans to Q No. 3: Marginal external cost is the difference between marginal private cost and marginal social cost

Ans to Q No. 4: The marginal abatement cost (MAC) curve of an individual polluter indicates its demand for permits. The summation of MAC of all the polluters indicates market demand for permits.

Ans to Q No. 5: The number of permits given to the polluters in an economy is determined by the regulatory authority.

Ans to Q No. 6: If the marginal abatement cost of reducing pollution is less than the price of the permits, it is profitable for the polluters to sell their permits.

Ans to Q No. 7: Under non-compliance fees method the potential polluters (producers) are assumed to be risk averse.

Ans to Q No. 8: Deposit refund system is commonly used to control the disposal of beverages containers.

Ans to Q No. 9: The limitations of the performance bond method are:

- There may be the problem of moral hazard. If the regulator is interested in maximising his own private profit than the social welfare, it may label the producer as a polluter and thereby not refunding the value of the bond.
- As the producer has to post the bond before starting the business, the producer may not have sufficient fund for it.
- Imperfect contact enforcement may affect the performance of the bond.

12.9 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q.1: Discuss the system of deposit refund.

Q.2: Explain how performance bonds are used to control pollution.

Q.3: What is the difference between command and control policy and economic incentive measures to control pollution?

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

Q.1: Explain pollution tax measure to control pollution.

Q.2: Discuss tradable pollution permit method to control environmental pollution.

Q.3: Discuss different liability rules to control pollution.

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UNIT 13: ENVIRONMENTAL PROTECTION AND ECONOMIC DEVELOPMENT: INDIAN EXPERIENCE

UNIT STRUCTURE

13.1 Learning Objectives
13.2 Introduction
13.3 Structure of Indian Environmental Regulatory Policies
13.4 National Policies for Environmental Management
13.5 Structure of Enforcement Institutions
13.6 Legal Frameworks
13.7 Monitoring and Enforcement
13.8 Let Us Sum Up
13.9 Further Reading
13.10 Answers to Check Your Progress
13.11 Model Questions

13.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- clearly define and explain the environmental regulation.
- discuss various environmental policies and laws in India.
- explain the structure of environmental policies, its enforcement and monitoring.
- describe the structure of environmental regulation enforcement institutions in India.

13.2 INTRODUCTION

The basic life support system in our surrounding is the environment. It consists of both natural and human made phenomenon. As discussed in earlier chapters, natural environment refers to both living and non-living organism whereas human environment is the things created by human beings. The natural environment has been modified by human being with their activities over the years which have endangered the very existing of natural environment. As per Environmental (Protection) Act, 1986, environment includes all the physical and biological surroundings of an organism along with their interaction. Thus, environment is defined as 'the sum total of water, air and land and interrelationship that exists among them and with the human beings, other living organism and materials.' Economy and environment are closely interrelated. Environment supplies energy, raw materials and amenity to the economy and it acts as a receptor of the waste products. Environment has the absorption capacity of waste. The problem arises when it cross the threshold limit. Regulatory policies are required to prevent environmental degradation and preservation of the natural eco system. Due to mechanization of agriculture and

rapid industrialization in India over the years, there is an urgent need for environmental regulation in terms of environmental policies. Various acts have been passed by the country before and after independence to create a proper regulatory mechanism for preservation of the quality of environment.

13.3 STRUCTURE OF INDIAN ENVIRONMENTAL REGULATORY POLICIES

Prior to Independence, various acts have been passed in India to protect the environment and human beings from pollution. Some of the Acts passed before the independence are:

- The Shore Nuisance (Bombay and Kolava) Act 1853
- The Oriental Gas Company Act of 1857
- Indian Penal Code of 1860
- The Indian Easement Act of 1882
- The Bengal Smoke Nuisance Act of 1905
- The Indian Motor Vehicle Act
- The Factories Act,
- The Mines and Minerals (Regulation and Development) Act
- The Industries (Development and Regulation) Act
- The Forest (Conservation) Act,
- The Merchant Shipping Act.

All these acts were enacted to control environmental pollution which endangered life. These Acts were implemented in the form of imprisonment, penalties, tax levied and compensation.

After Independence, India became the first country to include an amendment of safeguarding the environment into its constitution. The constitution permitted the states and empowered them to frame policies and rules to implement the pollution control measures in their respective jurisdiction. Accordingly, Uttar Pradesh, Tamil Nadu, West Bengal, Maharashtra, Orissa, Punjab, Jammu & Kashmir and Mysore have passed various Acts in their respective states which suit their situation during the time period 1950 to 1960.

The Environmental measures adopted in 1950s and 1960s were mostly dealt with the issues like sewage disposal, public health, and sanitation. Such measures were implemented by various ministries. In order to coordinate uniformly, a National Committee on Environmental Planning and Coordination (NCEPC) was set up under the Department of Science and Technology in February 1972. In 1981, NCEPC was set-up as National Committee on Environmental Planning (NCEP). It was the highest advisory body that looks after the matter related to environment protection and improvement related issues. In Januaruy1980, Tiwari Committee was set-up to strengthen the administrative measures and to recommend more such measures. In compliance with the recommendation of Tiwari Committee, the Department of Environment (DoE) was established in 1980 to work in environmental related matters of the central government. The Department of

Environment took steps such as monitoring of air and water quality, establishment of environmental information system, promotion of environmental research and the coordination between federal, state and local governments. However, due to some limitations of DoE, the ministry of Environment and Forest (MoEF) was created in 1985 under the regime of Rajiv Gandhi Government. The ministry, which was more comprehensive and institutionalized compared to the previous department, consists of a union ministers and ministers of states. The department was functioned with the same works as the previous department along in addition to the promotional works on environment.

In view of continuous decline in the quality of environment, the central government enacted, adopted and expanded stronger policies and reorganized the administrative agencies. The government has adopted the National Conservation Strategy (NCS) and policy statement on Environment and Development. The policy of 'Sustainable Development' was adopted under this strategy and with this, the government declared to re-orient the policies and action in accordance with the environment perspective. Usually, development leads to the degradation of environment, especially industrial development and related matter, and the initiatives taken for the development of the country may bring the environment related problem. Thus, the ministry of Environment and Forest completed the environmental action plan to integrate environmental considerations into developmental strategies at the time of entering into the era of liberalization, privatization and globalization in 1990. The ministry has issued various standards and incentives to follow the cleaner and environment friendly technologies for the protection of environment along with the economic development.

Environmental concern has been an important part for the world community from the very earlier period but the international conference at Stockholm in 1972 has influenced many countries in the world. Influenced by this concern, India has inserted specific provision for the protection of environment in the 42nd Constitutional amendment Act 1976 under Article 48A of the Directive Principles of State Policy and Article 51A (g) of the Fundamental Duties. It is enshrined in the Constitution that every citizen of India has to protect and improve the natural environment. The enforcement and monitoring of these legislations is vested to the Supreme Court and High Courts of the country.

CHECK YOUR PROGRESS

Q 1: Define Environment (Answer in about 20 words)

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and well-being of all human community. The policy brings the public agencies, local communities, academicians, investment community and all other international and national stakeholders in one forum to involve in the management of environmental resources.

13.5 STRUCTURE OF ENFORCEMENT INSTITUTIONS

In India, the responsibilities to manage, plan, promote and coordinate the environmental related activities throughout the country are with the Ministry of Environment and Forest. It formulates the national policies, standards and regulations with the objective to protect and conserve its flora and fauna, wildlife and protect the environment from pollution. The ministry is a political branch of country's environmental organization and has the authority to create autonomous bodies to enforce the environmental laws throughout the country. The ministry has established a board called Central Pollution Control Board (CPCB). The board has oversight power over state boards under the Ministry of Environment and Forest. It was established in 1974 under the Water(Prevention and Control of Pollution) Act. The board has the responsibilities to advice the central government to prevent and control water and air pollution in the country. It develops plans and programs to prevent the environment and coordinate with State Pollution Control Boards (SPCBs) in resolving these issues. The board consists of full time chairman, member secretary appointed by MoEF and representatives from central, state boards, private sector and government corporations. The CPCB serves as the national environmental agency and its central office is located at Delhi. The board has six zonal offices at Bengaluru, kolkata, Bhopal, Vadodara, Kanpur, Lucknow, Shillong and a project office at Agra.

The primary focus of the board was to develop national strategies to address environmental problems and to assist technical guidance and compile information about environment compliance for public as well as for government use. They impart training to staffs and sometimes organize mass media awareness on environmental related activities. The zonal offices of CPCB are the main implementing agencies. They implement the environmental policies of the government through conducting the inspection, providing technical assistance to the regulated communities. They develop recommendations and also respond to CPCB and court issued directions.

In state level, SPCBs were established by the states in their respective jurisdiction following the national level structure. The state level boards were basically established to adopt the water Act 1974 and Air Act 1981. In the state, the environmental regulations are divided between the State ministers of environment and SPCBs. SPCBs in most states are attached to the department of environment and forest and with the department of wildlife. The state ministers appoint the state board and manage the environmental policies in the state. On the other, SPCBs have the responsibilities to manage routine environment management programs. Akin to the CPCB, the SPCBs have the responsibilities to advice the government on pollution related matters. It grants consent to establish and operate under water and air acts. The board has authorized to implement and enforce the national programs and look after the hazardous disposal under EP Acts. It also plans state level pollution control, prevention and abatement under its jurisdiction. The SPCBs have the

chairman and member secretary that look after the regulations and develops the state guidance to maintain the regulations. In some large states, the sub- regional offices are also established to reduce the response time and to resolve the complaints.

CHECK YOUR PROGRESS

Q 6: What is the role of Judiciary in Environment related policies? (Answer in about 20 words)

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the right to make rules to assign duties to the people for the protection and development of forest. Section 29, 30, 32 and 33 of the act deals with the declaration of protected area, regulating the rights and privileges for the use of protected forest and penalizing in case of violating through the collection, changing and using of these resources without license.

- **The Forest (Conservation) Act of 1980:** The ecological imbalances posed by rapid deforestation leads to the introduction of new and stronger act which came to be known as Forest (Conservation) Act of 1980. This act was enacted everywhere in the country except in Jammu and Kashmir. It sets restriction on deforestation and use of land for non-forest purpose. Under this act, no state or authority has the right to approve for the clearance of forest or give any resources to any private person or any other agencies without the approval of the central government. Any contravention of provisions of the act by any people including head of the government departments, organizations, corporate and other stakeholders are to be penalized on the basis of the offence made by them. Under section 3-A of this act, individuals that contravene will be punished and this punishment ranges from a simple imprisonment period which may also extend to a period of fifteen days imprisonment.
- **The Wildlife (Protection) Act of 1972:** This act was passed by the parliament under the article 252 of the constitution on the request of eleven states of the country. This act provides the comprehensive national legal framework for wildlife conservation. The main objective was to protect the wild animals, birds and plants. The act was amended in the year 2002 which was named the wildlife (protection) amendment act 2002. It gives the central government to declare areas as sanctuary and national parks. The central government appoints wildlife warden and other officer and employees for the compliance of the act. The state governments also appoint the forest warden for the similar functions. The act also empowers the central government to constitute the National Wildlife Board to consider the proper measures to promote, protection and development of wildlife. The state governments also constitute similar kind of boards in their respective states for the protection of forest.
- **The Biological Diversity Act of 2002:** The act was basically developed to conserve the biological diversity. Along with the conservation, the act also aims sustainable and equitable share of benefits that originates from the biological resources. For instance, biological resources, knowledge and all the resources connected to the biological diversity. The act prohibits the person to take any biodiversity related activities without the approval and prohibits the person to transfer any biological resources to other foreigners or any other agencies. Prior permission is required to seek for the application of intellectual property right and for obtaining resources for commercial utilization. National Biodiversity Authority was constituted under this act and the board has been setting rules regarding the matter related to the conservation of biodiversity. State governments and the local level governments have the power to set up the rules for the management of biodiversity in their respective jurisdictions.

These are the legal provisions made by the authority to conserve the rich biodiversity of the country. It has been seen from the very early period that the environmental resources

are degrading which further affects the biodiversity of the earth. Thus, these acts and policy frameworks are a milestone in an attempt to preserve these resources of the earth. In addition to the forest and biodiversity acts, various other provisions also made to address the environment related issues. Even after the implementation of many regulations and policies, the environmental issues were not given priority.

The international conference held at Stockholm has made an impact among the world communities about the environmental related issues. In India too, a serious consideration has been made for the environmental related matter in the form of many legal frameworks. These are Water (Prevention and Control Pollution) Act 1974, Water Cess Act of 1977, Air

(Prevention and Control Pollution) Act of 1981, Environmental (Protection) Act of 1986 and Public Liability Insurance Act (PLIA) of 1991.

- **The Water (Prevention and Control Pollution) Act:** It has been enacted in 1974 and amended in 1988. The SPCBs are the primary agencies to establish and enforce the act. They are authorized to set to the standard effluent facilities for discharging pollutants in water bodies. CPCB are authorized to enforce the same in Union Territories. Both the CPCB and SPCBs have the right to establish domestic and industrial discharge policies through the consents to establish (CTE) and consents to operate (CTO).
- **Water Cess Act of 1977:** Under this act, cesses on water are collected for the consumption of water by the persons carrying certain industrial activities or by some local authorities. The imposition of levy and collection of cess are made under this act. This act complements the Water (Prevention and Control Pollution) Act of 1974 by providing required resources to the CPCB and SPCBs for the management of their assigned responsibilities.
- **Air (Prevention and Control Pollution) Act of 1981:** The development of Air (Prevention and Control Pollution) Act in 1981 was the result of initiating stronger policies to monitor the environmental issues in the country. It provides framework for the prevention, control and abatement of air pollution. The implementation of this act is similar with the water act. Both the CPCB and SPCBs were assigned to do the same responsibilities as in case of water act.
- **The Environmental (Protection) Act of 1986:** The Environmental (Protection) Act of 1986 provides the policy for environmental protection considering water, air and land. The central government is advised to set and establish the procedures for managing hazardous substance and regulate industrial pollution. The government is assigned to establish laboratories to collect pollution samples and also to investigate and research the pollution issues and disseminate the same information. Initially, the SPCBs were the primary enforcement authority of water and air acts in India. CPCB was authorized to enforce against the violators in Union Territories. CPCB was vested the authority of Environmental Protection Act in the country. Later on, CPCB were kept as the back-up enforcement responsibilities and provided the authority to conduct special enforcement responsibilities.
- **Public Liability Insurance Act (PLIA) of 1991:** Under Public Liability Insurance Act (PLIA) of 1991, the business owners operating hazardous substances are mandatory

to take out insurance policies covering the accidents associated with such hazardous things.

In view of continue environmental degradation and the occurrence of Bhopal gas Tragedy necessitated the introduction of more stringent policies which results in the introduction of these acts in the country.

Additionally, various other regulations such as, sub-ordinate, criminal and appellate courts are also engaged and exercising power under various sections of Indian penal code dealing with offences related to environment. Criminal courts deals with the offences created under section 41-50 of Water Act, section 37-47 of Air Act and section 15-17 of EP Act. All the powers are exercised in their respective territorial jurisdiction. Appellate authority act of 1997 constituted to deal with the appeals on area restrictions where the industrial operations are or will be carried out. These kinds of deals are governed by various departments of government and the respective officers. Some states have also constituted the green bench to hear the environmental issues. Despite of these provisions, priority on environmental issues are comparatively less. Hence, specialized environment courts are also provided to deal with the environmental cases. Through these courts, it is expected to resolve the environmental cases immediately and it also allows the courts to advice on environmental matter.

13.7 MONITORING AND ENFORCEMENT

The employees appointed in the central office, zonal offices of different regions and states are responsible for implementation and enforcement of environmental regulations in the country. The headquarter staffs are responsible for preparing various strategies, preparing reports on activities and successes, developing technical assistance, reviewing zonal recommendations, resolving environmental violations, advising member secretaries for proper enforcement, attending public complaints, implementing and monitoring court issued order and providing administrative support to the enforcement agencies.

The implementation of the environmental regulations is done through following ways by the employees:

i. Conduct surprise inspection in the polluting industries.
ii. Conduct performance evaluation of pollution control measures
iii. Conduct surveillance of water and air quality.
iv. Address public complaints, make problem area action plans and maintain court directives.
v. Conduct pollution assessment other than industries.
vi. Update pollution sources.
vii. Review solid waste management practices etc.

The CPCB office conducts formal enforcement actions through inspections. As a commitment under annual action plan, the CPCB conducts inspection in the request of zonal offices and state boards and sometime CPCB themselves conduct unplanned inspection or follow new court directives. Usually, the zonal office determines the extent

of violation by collecting sample and inspects the facility. The office writes reports and upon identifying the violations they also makes recommendations. The CPCB reviews the recommendations and sometime forwarded to head of the zonal office and gives the final decision in resolving the matter. Chairman and member secretary can refer the case to SPCBs for needful action.

Thus, the main compliance monitoring instruments are permit, inspection, self-monitoring and reporting. Under the permit instrument, all the polluting facilities have to legally acquire the permission from respective SPCBs to establish or operate the industrial activities. As per the MoEF, all those interested, to start any industrial project, required to collect environmental clearance of category A from CPCB or category B from SPCBs based on environmental impact assessment. Establishment permit is generally given after the evaluation of potential environmental impact of the project and after the installation of pollution control measures. The operation permit is issued after the verification of compliance conditions and the necessary inspection on the emission and effluent limits based on industrial sector specific standards. Industries those involved in handling hazardous, bio-medical waste and municipal wastes are also required to obtain authorization from the compliance agencies.

The frequencies of inspection are decided through the identification of potential pollution. The potential pollution is categorized into red, orange and green and through the size of capital investment. The areas which contain less pollution are visited lesser compared to the high potential pollution areas. Sometimes, SPCBs also do the site visit on receiving the complaints from the public and sometimes as a renewal process for the consents. Inspections are usually done covering air, water and land waste altogether and generally unannounced. After the inspection, the inspection team prepares reports and prioritizes the areas or projects that needed more environmental measures.

Self-monitoring and reporting is another compliance method required to present by each polluting facilities and it is a mandatory compliance method put forwarded by the environmental protection rules of 1986. The reporting facilities have to submit the self-monitoring reports to the authority at the end of each financial year. The report should include the raw materials used, air and water pollution discharge, solid waste generation, recycling and disposal of waste and other pollution measures. Other area based measures were also initiated so that it can focus on speedy compliance monitoring of regulations.

Administrative response is done through the measures like cut off of power or water supply of various polluting industrial facilities that violates the regulations. Thus, along with the Administrative and Legislative set up, India has also made judicial provision for protection of environmental regulations. Both Supreme Court and high courts have the concurrent rights to monitor the regulations. A court can impose criminal penalties on violating the environmental regulations. The imprisonment of 18 months to

6 years along with fines is also applicable to the violating individuals or agencies. On violation of mandatory regulations, the government can seek damage compensation. The citizen of the country has also entitled the fundamental rights to clean environment and has the duties too to protect the environment. Thus, these courts are provided to

exercise the power of securing fundamental rights of citizen under article 32 and 226 of the constitution and have the responsibilities to check the expected violations by the citizen of the country.

For the compliance of the environmental laws in the country various assistance have been provided such as training and technical assistance, compliance assistance information, charter on corporate responsibilities for environmental protection, awareness campaign and data management etc.

CHECK YOUR PROGRESS

Q 11: Potential pollution is categorized into how many categories? (Answer in about 20 words)

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13.10ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Environment is defined as the sum total of water, air and land and inter-relationship that exists among human beings, other living organism and materials

Ans to Q No 2: Under the command and control measure, regulator has to specify the steps individual polluters must undertake to solve a pollution problem.

Ans to Q No 3: Environmental regulation is a special and relatively recent example of economic regulation which aims to protect the environment. Pollution fee is a payment charged on per unit of pollution generated.

Ans to Q No 4: The main purpose of enacting various environmental regulations is to control environmental pollution which endangered life. These regulations are implemented in the form of imprisonment, penalties, tax levied and compensation etc.

Ans to Q No 5: The International Conference at Stockholm in 1972 has influenced India to insert special provision for the protection of environment in the Constitution of India.

Ans to Q No 6: The Judiciary can guide the Central and state governments in implementing environmental policies.

Ans to Q No 7: The full form of CPCB is Central Pollution Control Board and SPCB is State Pollution Control Board

Ans to Q No 8: The economic instruments used to control the pollution are prevention of pollution at source, adoption of best technologies, polluters pay system and involvement of public environmental related decision making.

Ans to Q No 9: The CPCB was established in 1974 under the water Act and it serves as the national environmental agency and its central office is located at Delhi.

Ans to Q No 10: The main objective of National Environmental Policy 2006 was to conserve environmental resources which are in critical condition, generation wise equity in resource use, inter- generational equity and security livelihood, integration of social and economic development and enhancement of resource use efficiency.

Ans to Q No 11: The potential pollution is categorized into red, orange and green and through the size of capital investment.

Ans to Q No 12: The Indian Forest Act of 1927 is the result of the replacement of previous Forest Act of 1865 introduced by the British colonial as a claim on Indian forest.

13.11 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q.1: What is Environmental Kuznets's Curve (EKC)? Explain

Q.2: Environmental Measures adopted in 1950's and 1960's mainly deals with which issues?

Q.3: List the main instruments for the compliance of environmental laws in the country?

Q.4: Discuss the role of Ministry of Environment and Forest?

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

Q.1: What is 'Sustainable Development'? Why it is necessary to consider Sustainable Development while framing economic development policies?

Q.2: How do the employees of the Environment department implement the environmental regulations in India?

Q.3: Define the basic features of

a) Indian Forest Act of 1927
b) The Forest (Conservation) Act of 1980
c) The Wildlife (Protection) Act of 1972
d) The Biological Diversity Act of 2002
e) The Environmental (Protection) Act of 1986

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UNIT 14: GLOBAL CONVENTIONS FOR ENVIRONMENTAL ONSERVATION; CONCEPT OF 'COMMON BUT DIFFERENTIATED RESPONSIBILITIES'; CAUSE OF NON-COOPERATIVE BEHAVIOUR AMONG NORTH AND SOUTH

UNIT STRUCTURE

14.1 Learning objectives
14. 2 Introduction
14.2 Global conventions for Environmental conservation
14.3 Concept of 'Common but Differentiated Responsibilities'
14.4 Cause of Non-Cooperative Behaviour among North and South
14.5 Let Us Sum Up
14.6 Further Reading
14.7 Answers to Check Your Progress
14.8 Model Questions

14.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- know about important environmental conventions and protocols held for environmental protection
- know and describe the importance and significance of these conventions and protocols for preservation and protection of environment
- learn the concept of common but differentiated responsibility (CBDR)
- describe the implications of CBDR
- discuss the causes of non-cooperative behaviour among North and South group of countries regarding environmental problems

14.2 INTRODUCTION

As pollution and environmental degradation is a negative externality and it spread over the frontier of a nation, it is necessary to global convention for environmental protection.

14.3 GLOBAL CONVENTIONS FOR ENVIRONMENTAL CONSERVATION

During 1970s, when environmental problems spread over beyond the frontiers of a nation, international efforts were seen to combat these issues. After the Second World War, almost all countries of the world have witnessed tremendous growth process not only in home production but also in international trade. It enhanced the scope of trans frontier pollution. As a result, international efforts were seen to mitigate the issues of

environmental conservation. In the following we will discuss the global conventions and protocols.

- **Stockholm Conference on Human Environment (1972) June 5-16, 1972:**

This conference was the first to be held in seventies in a series of major UN conferences which made an in depth study of the environmental problems and the consequences connected there with and also the need for doing something substantial with the cooperation of the nations of the world. At later phase, it covered problems of pollution, food, women's rights, desertification, human settlements, Science and technology and other similar topics. The Stockholm conference created enthusiasm and hope among all the countries. In order to generate political will to sort out the issues, this conference created the United Nations Environment Programme (UNEP). This conference agreed upon a Declaration containing 26 principles concerning environment and development. Some important principles are-

1. Natural resources must be safeguarded, 2. Non-renewable resources must be shared and not exhausted, 3. Pollution must not exceed the environment's capacity to clean itself, 4. Development is needed to improve the environment, 5. Rational planning should resolve conflicts between environment and development, 6. International organisations should help to improve the environment, etc. Stockholm conference recognised alleviation of poverty for protection of environment and also motivated countries around the world to monitor environmental conditions as well as to create environmental ministries and agencies.

- **Ramsar Convention (1971):**

Wetlands are among the most diverse and productive ecosystems. They provide essential services and supply all our fresh water. However they continue to be degraded and converted to other uses. The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". Under the Convention, the Contracting Parties commit to:

- Work towards the wise use of all their wetlands;

- Designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management;

- Cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

- **Vienna Convention (1985):**

It is a multilateral environmental agreement signed in 1985 for the protection of the ozone layer. Signed in Vienna conference, it provided frameworks for international reductions in the production of chlorofluorocarbons (CFCs) due to their contribution to the destruction of the ozone layer. It is one of the most successful treaties of all time and it provides scope for sharing of climate and atmospheric research to promote knowledge of the effects on the ozone layer. The treaty calls for the adoption of international agencies to assess the harmful effects of depleted ozone and also the promotion of policies that regulate the production of harmful substances that influence the ozone layer.

- **The Montreal Protocol (1987):**

The Montreal Protocol is an international treaty designed to protect the ozone layer from depletion by phasing out the production of numerous substances like Chlorofluorocarbons (CFCs) and other halogens. According to Montreal protocol, the USA, along with other 24 industrial nations agreed to freeze their emissions of nitrogen oxides which are thought to be responsible for acid rain. Further, the Montreal protocol pledged to reduce the release of CFCs by 20 percent by 1994, and further by 30 percent by the end of 20th century; and also phase out productions of halogens. Montreal protocol is considered to be historic in spite of its shortcomings. This was the first international effect to recognise pollution as a global threat, and the need for concerted effort by all countries of the world.

- **Basel Convention (1989):**

The European Economic Community and Thirty Five nations of the world met at Basel in Switzerland in March 1989 to limit and control international transport and also disposal of hazardous waste. The report of Basel convention contains 29 articles and some important ones are-

1. Signatory states are prohibited from transporting hazardous waste to another state which had banned the import of it.

2. Every country has the right to refuse acceptance of a shipment of hazardous waste.

This treaty declared traffic in hazardous wastes as criminal offence.

- **United Nations Conference on Environment and Development (UNCED) at Rio De Janerio, (June, 1992) (Agenda 21):**

In June, 1992, 178 nations of the World participated in the historic “Earth Summit” held at Rio De Janerio. From a legal and institutional standpoint, the Earth Summit produced three important agreements. These were: (i) the Climate convention, (ii) the Biodiversity convention, and (iii) Agenda 21. In addition, the participants at UNCED agreed to a statement of principles known as the Rio Declaration. Each of these instruments established important precedents and underlined the continuing relationship between issues of

economic development and environmental protection. Taken together, they set the agenda on global environmental issues for the next several decades.

i) The Climate Convention:

The United Nations framework Convention on Climate Change (UNFCCC) came into effect from 21 March 1994. The aim of this agreement is to stabilize atmospheric concentrations of greenhouse gases at level that will prevent human activities from interfering dangerously with the global climate system. In ratifying the Convention, Governments agreed to reduce emissions of the warming greenhouse gases to "earlier" (of 1990) levels by the end of the year 2000. States are required to report periodically on their level of emissions and efforts to slow climate change. The target of reducing carbon dioxide emissions to 1990 levels by the end of the year 2000 - which was advocated by the European Community, Japan and most other countries but opposed by the United States - is stated as a goal to be met voluntarily. To enable developing countries to meet their obligations under the convention, developed countries agree to provide 'new and additional' financial assistance. Such assistance is, for the time being, to be channeled through the Global Environment Facility, a fund administered jointly by the World Bank, the UN Development Programme and the UN Environment Programme.

ii) United Nations Convention on Biological Diversity (CBD):

Negotiated under the auspices of UN Environment Programme (UNEP), this convention was aimed at preserving global biological diversity through the protection of species and ecosystems. Since most of the threats were being experienced in developing countries, and most biotechnology was based in developed countries, discussions were again based around attempts to reach a compromise between the needs of the two sides. The four main goals of the convention are:

1. Conservation of biological diversity
2. Sustainable use of its components
3. Sharing the benefits of genetic resources fairly and equitably
4. Compensation to developing countries for extraction of their genetic materials.

The two protocols related to CBD are: (a) Cartagena Protocol on Biosafety, 2000 (b) Nagoya Protocol (Biodiversity Accord), 2010.

iii) Agenda 21:

Agenda 21 was intended to be a set of guidelines on environment and development issues for states to follow in the twenty-first century: a sort of guiding principles of

sustainable development. It has 40 chapters which are covered in 4 sections. The Agenda covers in great length and details about 'sustainable development' on the planet. It gives importance to poverty which has complex multidimensional aspects. Its proposals cover population policies, health care, education, women, youth, indigenous people and their rights to achieve sustainable livelihood. Food security, clean water, sanitation are also given utmost importance. The protection of fresh water resources, oceans, safe use of toxic chemicals, management of hazardous and radioactive wastes, are discussed in details in the proposal of Agenda 21. Other subjects covered by the Agenda are: controlling spread of deserts, conservation and rational use of forests, environment friendly technologies, creation of environmental awareness and the promotion of international legal instruments etc. its overall provisions find expression in the Rio Declaration.

- **Rio Declaration:**

The Rio Declaration on Environment and Development consisted of 27 principles guiding action on environment and development, and building on the Stockholm Declaration of 1972. The Declaration stated that human beings were at the centre of concerns for sustainable development and set the goal of establishing "a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people". The right to development must be fulfilled but at the same time use of environmental resources should be such that needs of future generation should not be compromised. So, it advocated strongly the path of sustainable development. The Declaration states that States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries. It also stressed for strengthening indigenous capacity building for sustainable development by improved scientific understanding through exchange and transfer of technologies. In summary, this Declaration elaborately explains the role to be played by both developed and developing nations to achieve the goals as explained in Agenda 21. The Rio Declaration set the stage for international agreements which would respect the interest of all and protect the integrity of the global environmental and development system.

- **Kyoto Protocol (1997):**

The Kyoto Protocol was adopted in Kyoto in Japan on11 December, 1997 and came into force in 2005. It is an international treaty under UNFCCC that commits state parties to reduce greenhouse gases (GHGs) emission. The emission target includes all 6 major GHGs namely: (a) Carbon Dioxide (CO2), (b) Methane (CH4), (c) Nitrous Oxide (NO2), (d) Sulphur Hexafluoride (SF6), (e) Hydrofluorocarbons (HFCs) and (f) Perfluorocarbons (PFCs). This protocol developed three mechanisms to control emission namely: a) Clean development mechanism, b) Emission trading and c) Joint implementation. Three categories of signatory countries are there in the protocol- a) Annex I countries: industrialized countries and economies in transition, b) Annex II countries: developed countries which pay for costs of developing countries, c) Non-Annex I countries:

Developing countries. India is included in the last category. The commitment periods for emission reduction was agreed upon- first period is from 2008 to 2012; second period known as the Doha Amendment to the protocol, is from 2012 to 2020. One important feature of the protocol is that it agrees upon 'common but differentiated responsibility' among countries as it acknowledges that individual countries have different capabilities in combating climate change, owing to economic development. It places the obligation on developed countries to reduce current emissions on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.

- **Rotterdam Convention (1998):**

It is a multilateral treaty to promote open exchange of information and ask exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the import of chemicals listed in the treaty, and exporting countries are obliged to make sure that producers within their jurisdiction comply with the norms. There were 72 signatory countries and 161 parties to the treaty.

- **Stockholm Convention:**

It is an international environmental treaty signed in 2001 and effective from May 2004, that aims to eliminate or restrict the production and use of persistent organic pollutants (POPs). Salient features of the Convention include-a) the requirement that developed countries provide new and additional financial resources and measures to eliminate production and use of intentionally produced POPs, b) eliminate unintentionally produced POPs where feasible, and c) manage and dispose of POPs wastes in an environmentally sound manner. Precaution is exercised throughout the Stockholm Convention, with specific references in the preamble, the objective, and the provision on identifying new POPs. There were 152 signatories in the convention including both developed and developing nations.

- **United Nations Conference on Sustainable Development, Rio+20:**

It took place in Rio de Janeiro, Brazil on 20-22 June 2012. It resulted in a focused political outcome document which contains clear and practical measures for implementing sustainable development. In Rio, Member States decided to launch a process to develop a set of Sustainable Development Goals (SDGs) which will build upon the Millennium Development Goals and converge with the post 2015 development agenda. The Conference also adopted ground-breaking guidelines on green economy policies.

14.4 CONCEPT OF 'COMMON BUT DIFFERENTIATED RESPONSIBILITIES' (CBDR)

- **Definition towards Common but Differentiated Responsibilities:**

The principle of 'common but differentiated responsibility' came from the notion of 'common heritage of mankind' and is a manifestation of general principles of equity in international law. The principle recognises differences in the contributions of developed and developing nations to global environmental problems on historical background, and also differences in their respective economic and technical capacity to tackle these problems. Though each nation is responsible for environmental problems, it is the developed countries which have contributed more to the problem. So, every State has 'common' responsibility of protecting the environment. Despite their common responsibilities, important differences exist between the stated responsibilities of developed and developing nations on historical ground and capabilities of nations. The Rio Declaration states- "In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command." Similarly UNFCCC states that parties should act to protect the climate system "on the basis of equality and in accordance with their common but differentiated responsibilities and respective capabilities." The principle of CBDR has two fundamental elements. The first one emphasises the common responsibility of States for the protection of the environment, or parts of it, at the national, regional and global levels. The second one recognises the need to take into account the different circumstances, particularly each State's contribution to the evolution of a particular problem and its ability to prevent, reduce and control the problem.

- **Implications of the Principle of CBDR:**

The principle of CBDR has two important consequences. Firstly, it entitles all concerned nations to participate in international response measures aimed at addressing environmental problems. Secondly, it helps nations to set environmental standards that accordingly impose differing obligations on nations.

Common responsibility explains the shared responsibility of two or more nations towards the protection of a particular environmental resource. Common responsibility is likely to be applicable where the resource is shared, or under the control of no State or under the sovereign control of a State. But the resource should be subject to a common legal interest (such as biodiversity – termed as a common concern of mankind).

Differentiated responsibility of States is widely accepted in various treaties and other State practices for the protection of the environment. Differentiated responsibility is based on factors like- historic contributions to the creation of an environmental problem, future economic development of countries, special needs and circumstances of the concerned nations. The Stockholm Declaration clearly emphasises the need to consider the applicability of standards which are valid for the advanced nations but which may not be appropriate for the developing nations. Similarly in Rio Declaration, States agreed on

the facts that environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. They also agreed that least developed and developing countries should be given special priority as they are most environmentally vulnerable these countries should be given responsibilities less than the developed countries. So, differentiated responsibility aims to promote substantive equality between developing and developed nations. The aim is to ensure that developing countries can comply with particular legal rules over time. Differentiated responsibilities are generally put to the nations in the technical form of 'grace period', 'delayed implementation' and 'less stringent commitments'. Another salient feature of CBDR principle is international assistance, including financial aid and technology transfer. Since developed countries have played the greatest role in creating most of the global environmental problems, and at the same time have superior ability to address them, they are expected to take the lead on environmental problems. In addition, developed countries are expected to provide financial, technological, and other assistance to help developing countries to fulfil their sustainable development responsibilities while maintaining their own developmental path. In Agenda 21, developed countries reaffirmed their previous commitments to reach the accepted UN target of contributing 0.7% of their annual gross national product to official development assistance. In sum and substance, Countries have common responsibilities to protect the environment and promote sustainability, but due to different social, economic, and ecological situations, countries must shoulder different responsibilities. The principle therefore provides for asymmetrical rights (different rights for different group) and obligations regarding environmental standards, and aims to induce broad acceptance by the nations of treaty obligations. The CBDR principle also reflects the elements of equity, as it has placed more responsibility on wealthier countries and to those countries more, which are responsible for causing specific global problems. Perhaps more importantly, the principle also presents a conceptual framework for compromise and co-operation in effectively meeting environmental challenges.

14.5 CAUSE OF NON-COOPERATIVE BEHAVIOUR AMONG NORTH AND SOUTH

By the term North (global North) and South (global South) a distinction is drawn between developed and developing countries irrespective of geographical location. The North is mostly comprised of the Western world (previously called "First World") and much of the "Second World", while the South mostly comprised of the developing countries (previously called "Third World") and Eastern world. The global north consists of Australia, Canada, and most Western European countries, Israel, Japan, New Zealand, Singapore, South Korea, Taiwan and the United States. The Global South includes Africa, Latin America and the Caribbean, Pacific Islands, and the developing countries in Asia, including the Middle East. Brazil, India and China are part of it, which along with Indonesia and Mexico, are the largest Southern states in terms of population and land mass. The two groups are generally distinguished in terms of levels of wealth,

economic development, income inequality, and political and economic freedom as defined by freedom indices. Countries in the North group are wealthier, developed, and less unequal with more democratic values. They are hub of much advanced technological know-hows, who export technologically advanced manufactured products. On the other hand, Southern states are generally poorer developing countries burdened with poverty, unemployment, poor infrastructure. They are heavily dependent on primary sector exports and most of them were under colonial rule by the Northern states.

Non-cooperative behaviour or popularly known as the 'North-South divide' among the North and South group of countries started in the late 20th century and earlier part of 21st century. Causes of non -cooperative behaviour among these two groups on environmental issues can be drawn from historical legacy, developmental aspiration in economic and political front, social structure, technological divide, world trade regime, globalisation etc.

Economic growth and environmental degradation go together. But economic progress is very essential to combat problems like poverty, unemployment and many other socio-economic issues in developing countries. Rapid industrialisation, urbanisation have posed serious challenges to the developing nations to contain environmental degradation. Developed nations have already well equipped themselves to combat most of the environmental issues with the aid of superior technology and larger command over world resources. Though it is universally acknowledged that protection of environment is a global problem and should be solved globally but in practice it hardly happened due to growing conflicts among North and South groups. We explain some basic causes below:

- **Historical Legacy:**

Developed countries started their growth journey from the period of industrial revolution already causing huge environmental damage during the last two centuries. The developing nations have started mostly after the second world war their endeavour to attain higher economic growth with rapid destruction of environmental resources causing higher level of pollution, hazards ever before, with a view to solving nation's inherent problems as explained earlier. Developmental activities increase carbon emissions and GHGs emission level in the atmosphere. To reduce these emissions, global consensus was necessary and so Conventions and Protocols were initiated. But unfortunately, disagreement occurred between the North and South over responsibility for environmental damage. Whether to measure emissions on an annual basis or on a historical or cumulative basis became point of heated debate. It is to be noted that if calculated on an annual basis, carbon emission level in proportion to GDP would be higher in developing nations as they are in rapid phase of economic growth and it would create a hindrance to developmental activities while curbing emissions. If calculated on historical or cumulative basis, developed nations would get enough burden to reduce emissions. Eventually, North group wanted emission reduction on current annual basis and South group wanted it on

cumulative or historical basis. Again, Developing countries strongly argue that carbon reduction is an impediment to the development goal of poverty reduction and thus raising issues of how to balance eliminating poverty versus mitigating climate change. To negotiate between North and South, the principle of 'common but differentiated responsibilities' was initiated which to some extent favoured the developing nations as envisaged by many conventions and protocols. Obviously, the global North could not agree upon and hence the divide between North and South group of nations emerged.

- **New trade order post globalisation:**

Developing nations are lack of financial capital and other important resources which compel them to look forward to developed nations. Thus they are highly dependent on globalised world and under the threat of 'neo-colonialism'. Most of the Sothern states were under colonial rule when the North created the legal architecture for contemporary globalisation. World Bank, IMF, WTO and many more international institutions were created for free flow of natural resources, goods, services, capital across national borders and thus capturing the national sovereignty of those states. Due to their national developmental priorities, the southern nations have to abide by the rules and regulations set by these institutions and thus exploited by the Northern states. Most of the developing nations are primary exporter of their raw materials to the developed nations, thereby causing huge environmental damage to their own. Southern nations face huge trade barriers from the North as their bargaining strength is less in the world trade. This created non cooperative behaviour among the two groups as the South is facing larger environmental degradation due to these new trade orders. The debt crisis of 1980s compelled the southern nations to take various structural adjustment policies dictated by IMF and World Bank as conditions of debt relief. It included privatisation, trade liberalisation, reduction or elimination of social safety nets, and expansion of export oriented production to service foreign trade. Thereby, debt ridden southern countries flooded the world market with minerals, timber and agricultural resources at cheaper prices and fulfilling the needs of developed countries.

One very important point to note that under provisions of WTO, developed nations in the name of environmental protection, impose ban on exports on various products exported by developing nations. We cite here the famous 'shrimp case' here. US imposed ban on import of shrimp from India on very controversial ground that if shrimps are caught in the vessels without turtle excluder device. The South group argue that Developed nations are imposing their 'values' on them in the name of protecting biodiversity, which is a form of 'eco-imperialism' and 'moral militancy'. The South group feel that developed countries have no right to do that as they have already done most of the environmental damage and these trade sanctions hamper their export earnings in the world market.

The developed countries are exporting their industrial waste to the poor southern countries where environmental regulations are not stringent. Instead of recycling or reprocessing them at home they prefer to dump it in those poor countries. This amounts to no co-

operation among North and South. Though conventions like Basel imposed ban on such export of hazardous wastes; in the name of trade developed nations are exporting it to South, hampering their environment. India has become a major dumping ground of such toxic wastes.

- **Technological Front**

The southern countries are abundant in biodiversity and environmental resources while the Northern countries are equipped with Hi-fi technology and advanced bio-tech. The rise of patents and other intellectual property rights have immensely benefitted the North though they hardly possess the resources. Commercialisation of those genetic and other resources through patents and property rights by developed nations, have made the resources of the southern nations at stake. Apart from that the developing nations are deprived of bio tech advancements due to restricted access created by patents and rights though they are affluent in bio resources.

Another fact is that the developing nations have been always deprived of technological advancement and they receive technologies already abandoned by the developed one. In other words, the developed nations dump their redundant technology in these poorer nations, thereby causing environmental damage and hazards. Though various conventions and protocols insisted transfer of green and clean technology to the developing nations, developed nations overlook it in the name of non-abiding clause. So the north south divide becomes stronger.

14.6 LETS US SUM UP

- Due to rapid economic growth, environment suffers a lot as economic growth and environmental degradation go hand in hand. During 1970s, when environmental problem spread across the globe, nations started to ponder seriously and global effort started through various conventions and protocols.

- Stockholm conference on human environment was the first to be held in seventies in a series of major UN conferences. It made an in depth study of the environmental problems and the dangers connected there with and also the need for doing something substantial with the cooperation of the nations of the world. The Stockholm conference created enthusiasm and hope to all the countries. In order to generate political will to sort out the issues, this conference created the United Nations Environment Programme (UNEP).

- The Montreal Protocol is an international treaty designed to protect the ozone layer from depletion by phasing out the production of numerous substances like Chlorofluorocarbons (CFCs) and other halogens.

- Kyoto Protocol is an international treaty under UNFCCC that commits state parties to reduce greenhouse gases (GHGs) emission. The emission target includes all 6 major

GHGs namely: (a) Carbon Dioxide (CO2), (b) Methane (CH4), (c) Nitrous Oxide (NO2), (d) Sulphur Hexafluoride (SF6), (e) Hydrofluorocarbons (HFCs) and (f) Perfluorocarbons (PFCs). This protocol developed three mechanisms to control emission namely: a) Clean development mechanism, b) Emission trading and c) Joint implementation.

- The Earth summit was one of the greatest endeavour of the world nations as from legal and institutional standpoint, the Earth Summit produced three important agreements. These were: (i) the Climate convention, (ii) the Biodiversity convention, and (iii) Agenda 21. In addition, the participants at UNCED agreed to a statement of principles known as the Rio Declaration. Each of these instruments established important precedents and underlined the continuing relationship between issues of economic development and environmental protection. Taken together, they set the agenda on global environmental issues for the next several decades.

- United Nations framework Convention on Climate Change (UNFCCC) is the most potential agreement to stabilize atmospheric concentrations of greenhouse gases at level that will prevent human activities from interfering dangerously with the global climate system.Many treaties and protocols are signed under UNFCCC.

- Agenda 21 was intended to be a set of guidelines on environment and development issues for states to follow in the twenty-first century: a sort of guiding principles of sustainable development. It has 40 chapters which are covered in 4 sections. The Agenda covers in great length and details about 'sustainable development' on the planet. It gives importance to poverty which has complex multidimensional aspects.Rio Declaration elaborately explains the role to be played by both developed and developing nations to achieve the goals as explained in Agenda 21. The Rio Declaration set the stage for international agreements which would respect the interest of all and protect the integrity of the global environmental and development system.

- United Nations Conference on Sustainable Development, Rio+20decided to launch a process to develop a set of Sustainable Development Goals (SDGs) which will build upon the Millennium Development Goals and converge with the post 2015 development agenda. The Conference also adopted ground-breaking guidelines on green economy policies.

- Common but differentiated responsibility principle recognises differences in the contributions of developed and developing nations to global environmental problems on historical background, and also differences in their respective economic and technical capacity to tackle these problems. Though each nation is responsible for environmental problems, it is the developed countries which have contributed more to the problem. So, every State has 'common' responsibility of protecting the environment. Despite their common responsibilities, important differences exist between the stated responsibilities of developed and developing nations on historical ground and capabilities of nations.

- The principle of CBDR has two important consequences. Firstly, it entitles all concerned nations to participate in international response measures aimed at addressing environmental problems. Secondly, it helps nations to set environmental standards that accordingly impose differing obligations on nations.

- The global North and global South groups are generally distinguished in terms of levels of wealth, economic development, income inequality, and political and economic freedom as defined by freedom indices. Countries in the North group are wealthier, developed, and less unequal with more democratic values. They are hub of much advanced technological know-hows, who export technologically advanced manufactured products. On the other hand, Southern states are generally poorer developing countries burdened with poverty, unemployment, poor infrastructure. They are heavily dependent on primary sector exports and most of them were under colonial rule by the Northern states.

- Non-cooperative behaviour or popularly known as the 'North-South divide' among the North and South group of countries started in the late 20th century and earlier part of 21st century. Causes of non-cooperative behaviour among these two groups on environmental issues can be drawn from historical legacy, developmental aspiration in economic and political front, social structure, technological divide, world trade regime, globalisation etc.

CHECK YOUR PROGRESS

Q 1: Write three important principles of Stockholm conference. (Answer in about 30 words)

Q 2: What was the objective of Montreal Protocol? (Answer in about 20 words)

Q 3: Write the full form of UNCED.

Q 4: Write the full form of UNFCCC.

Q 5: Write the objective of the Climate Convention. (Answer in about 50 words)

Q 6: What was the focal theme of Agenda 21? (Answer in about 30 words)

Q 7: What is the significance of Kyoto Protocol? (Answer in about 40 words)

Q 8: Explain briefly the concept of common but differentiated responsibilities. (Answer in about 50 words)

Q 9: What is 'common responsibility'? (Answer in about 40 words)

Q 10: What is meant by 'differentiated responsibility'? (Answer in about 40 words)

Q 11: What is meant by the term 'North-South divide'? (Answer in about 30 words)

Q 12: Mention three important causes of non- cooperation among North and South regarding environmental issues. (Answer in about 20 words)

Q 13: Explain briefly the historical ground of non -cooperation among North and South. (Answer in about 50 words)

14.6 FURTHER READING

- Eugine, T. (2006). *Environmental Economics*: New Delhi, Vrinda Publications (P) Ltd.

- Stone, S.D. (2004). 'Common but Differentiated Responsibilities in International Law', *The American Journal of International Law*, Vol. 98, No. 2 (Apr., 2004), pp. 276-301.
- Mathur, A. (2009). 'Fractured Globalization: North South Divide over Human Rights and Environment', *The Indian Journal of Political Science,* Vol.70, No.1 (Jan. - Mar., 2009), pp. 9-20.

14.7 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Three important principles are: 1. Natural resources must be safeguarded, 2. Non-renewable resources must be shared and not exhausted, 3. Pollution must not exceed the environment's capacity to clean itself.

Ans to Q No 2: To protect the ozone layer from depletion by phasing out the production of substances like Chlorofluorocarbons (CFCs) and other halogens.

Ans to Q No 3: United Nations Conference on Environment and Development

Ans to Q No 4: United Nations framework Convention on Climate Change

Ans to Q No 5: The objective of this agreement is to stabilize atmospheric concentrations of greenhouse gases at level that will prevent human activities from interfering dangerously with the global climate system. In ratifying the Convention, nations were expected to reduce emissions of the greenhouse gases to "earlier" (i.e. 1990) levels by the year 2000.

Ans to Q No 6: Agenda 21 set guidelines on environment and development issues for states to follow in the twenty-first century: a sort of guiding principles of sustainable development.

Ans to Q No 7: It is an international treaty under UNFCCC that commits state parties to reduce greenhouse gases (GHGs) emission.This protocol developed three mechanisms to control emission namely: a) Clean development mechanism, b) Emission trading and c) Joint implementation.

Ans to Q No 8: The principle recognises differences in the contributions of developed and developing nations to global environmental problems on historical background, and also differences in their responsibilities towards environment based on respective economic and technical capacity to tackle these problems.It held developed nations the most responsible for environmental degradation.

Ans to Q No 9: Common responsibility explains the shared responsibility of two or more nations towards the protection of a particular environmental resource. Common responsibility is applicable where the resource is shared, or under the sovereign control of a State.

Ans to Q No 10: Differentiated responsibility of developed and developing nations on environmental protection are based on factors like- historic contributions to the creation

of an environmental problem, future economic development of countries, special needs and circumstances of the concerned nations.

Ans to Q No 11: The North and the South are distinguished in terms of levels of wealth, economic development, income inequality, and political and economic freedom as defined by freedom indices. North group are wealthier, developed, and less unequal with more democratic values but Southern states are poorer developing countries burdened with poverty, unemployment, poor infrastructure.

Ans to Q No 12: 1. Historical legacy, 2. New trade order post globalization, and 3. Technological front.

Ans to Q No 13: Historical legacy: Since developed countries exploited environmental resources much earlier than developing nations, the responsibilities should be more on them and burden should be divided on historical cumulative basis as demanded by developing nations instead of annual current basis as demanded by developed nations.

14.8 MODEL QUESTIONS

Short Questions (Answer each question in about 150 words)

Q.1: Write short notes on a) Kyoto Protocol, b) UNFCCC and c) Agenda 21.

Q.2: Discuss briefly on the followings:

a) Montreal Protocol, b) Basel Convention and c) Vienna Convention.

Q.3: How the new trade order post globalization has created North South divide?

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

Q.1: Explain the importance and outcomes of the 'Earth Summit' or United Nations Conference on Environment and Development.

Q.2: What is the principle of common but differentiated responsibilities? Explain the implications of the principle of common but differentiated responsibilities.

Q.3: Discuss the causes of non-cooperation among North and South on environmental issues.

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UNIT 15: GLOBAL INITIATIVE TOWARDS ENVIRONMENTAL ISSUES -II

UNIT STRUCTURE

15.1 Learning Objectives

15.2 Introduction

15.3 Global Environmental Issues

15.3.1 Climate Change Reflected in Global Warming and Ozone Depletion

15.3.2 Energy Crisis

15.3.3 Exploitation of Natural Resources

15.3.4 Pollution and Wastes Disposal

15.3.5 Biodiversity Loss

15.3.6 Sustainability of Development

15.4 International Trade and Environment

15.5 Let Us Sum Up

15.6 Further Reading

15.7 Answers to Check Your Progress

15.8 Model Questions

15.1 LEARNING OBJECTIVES

After going through this unit, you will be able to

- explain environmental issues of global concern
- differentiate between local/regional and global environmental problems
- establish the link between local and global environmental problems
- describe the sources of global warming and ozone depletion
- explain the natural resource taxonomy and the state and implication of energy crisis as global environmental crisis
- describe pollution and the nature of pollutants damaging the environment
- analyse the danger of loss of biodiversity
- discuss sustainable development as global environmental issue

- show the link between international trade and environment.

15.2 INTRODUCTION

It is needless to repeat that along with technological advancement the world has also witnessed considerable environmental damage. In pursuit of economic development and advancement of human well-being, the natural resources are being used in a manner that has led to over-exploitation of natural resources in one hand and accumulation of wastes or increase in level of pollution on the other hand, together leading to rapid depletion of the environment. As a result of human pursuance of economic progress, the stock of non-renewable natural resources is depleting fast and the rate at which the renewable natural resources are being used happens to be higher than the natural rate of replenishment. This presents a serious conflict between economic progress, production and consumption on the one hand and environment on the other. In a broader sense, environmental degradation is the continuous deterioration of natural resource base (energy and materials resources) over time resulting in many major life threatening situations like global warming, ozone layer depletion, loss of biodiversity, etc.

Environmental problem has two dimensions: local and global. In fact, there is two-way traffic of local environmental problem causing global effects and global trends causing local effects. There are clear instances in which poor natural resource management in some countries not only cause environmental damages in the countries themselves but also affects other countries and pose a threat to vulnerable ecosystem of the planet. For example, overgrazing and deforestation in many countries result in soil erosion, sedimentation, flooding and salinization, all of which affect the atmosphere and endanger wildlife in general. This is mainly due to the fact that many local environmental problems or negative environmental externalities have transitional nature. This aspect of environmental issues gained worldwide recognition since mid 1980s prior to which it was believed that environmental problems are predominantly of regional character and restricted to individual countries. When the countries started acknowledging global dimensions of environmental problems the need for joint international effort to curb environmental problems has become a deliberate policy issue of the world as a whole. It is thus clear that global dimensions emanated from two major sources: (a) the mobility of adverse environmental qualities across borders of countries and (b) contribution of production, trade, trade policies in environment intensive goods, factors and services to environmental damages. In the next section, we shall discuss some of the global

environmental issues keeping in mind the transnational nature of local pollutants of environmental problems.

LET US KNOW

Externalities take place when action of one economic agent affects another that is not directly involved in the activities of the former. It can be both positive and negative. While presence of positive externalities benefits others, the presence of negative externalities harms others.

Transnational externalities: Adverse or negative externalities crossing national boundaries are termed as transnational externalities. For example, (a) industrial wastes and agricultural run-off from West Bengal to river Churni or Ichhamati have presumably been killing fish and other aquatic lives in Bangladesh and affecting the water and mangrove forests of the Indo-Bangladesh watershed commons, (b) carbon dioxide emission from US thermal power plants have been observed to be crossing over to Canada along the regional air currents and have allegedly caused acid rain in Canada (Chakraborty, 2019).

15.3 GLOBAL ENVIRONMENTAL ISSUES

It is clear from the previous discussion that environmental problems have both local or regional and global dimensions and these are interlinked. The interlink between regional and global environmental issues is presented in the following flow chart.

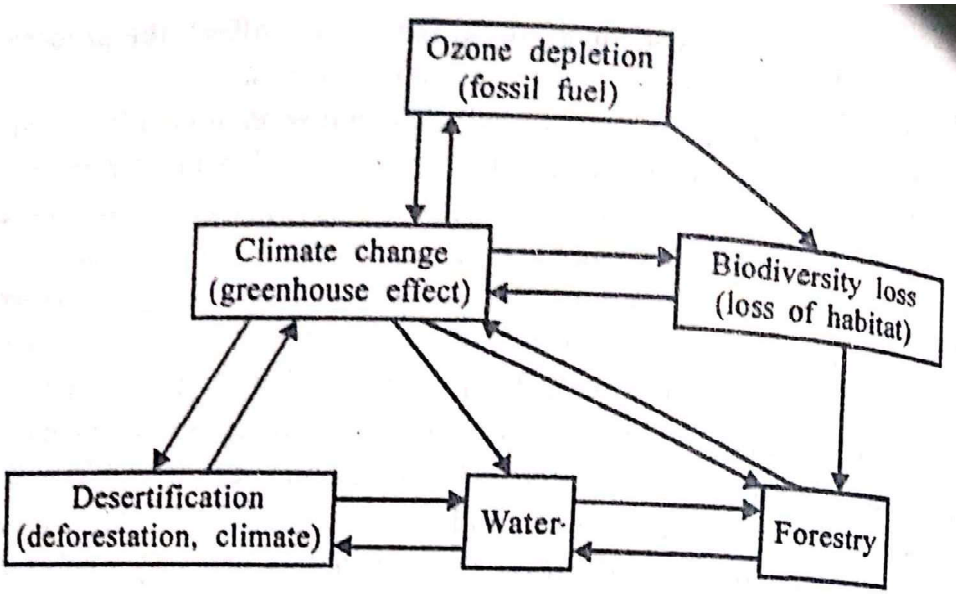


Figure 7.2 Linkages among Environmental Issues.

Source: World Bank (1997).

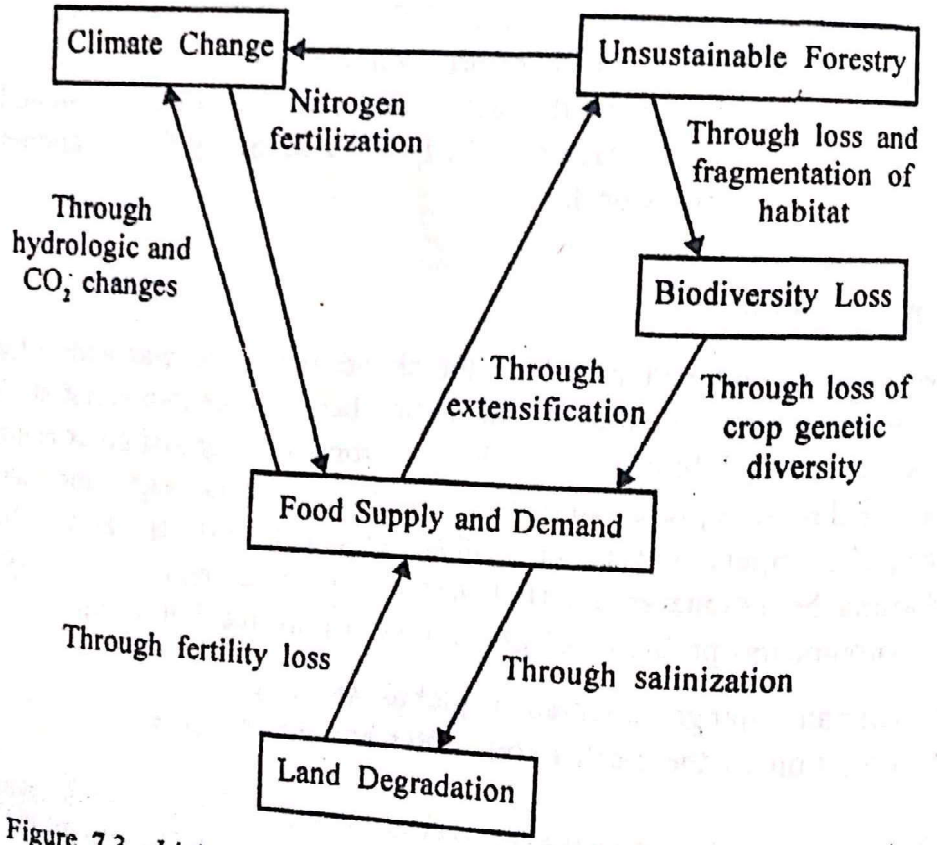


Figure 7.3 Linkages of Food Production (Threatened Sustainability).

Source: World Bank (1997).

Scanned with

Environmental problems of global concern refer to comprehensive environmental issues presently threatening our global environment. Air and water pollution do not recognise borders. Poor soil condition in one country may reduce another country's food supply. At the same time different regions face different problems. The environmental problems faced by developed countries are largely result of their economic strength and higher standard of living. Over-consumption is cited by many observers as a cause of resource depletion in the developed world resulting in adverse consequences for human population. Examples of environmental problems of global concern are as follows:

- Climate change as reflected in global warming and ozone depletion
- Energy crisis
- Pollution (that includes earth's soil, water and air)
- Overexploitation of renewable resources
- Depletion of exhaustible or non-renewable resources
- Loss of biodiversity
- Disposal of solid waste
- Sustainability of development

Let us discuss some of these issues in details for better understanding of the problems and enlarging our vision.

15.3.1 Climate Change Reflected in Global Warming and Ozone Depletion

Climate change is a clear ramification of environmental degradation. Climate is the long-term average of weather, typically averaged over a period of 30 years. Some of the meteorological variables that are commonly measured are temperature, humidity, atmospheric pressure, wind, and precipitation. Changes in the key elements in climate system clearly show changes over time posing some unavoidable threat to the mankind. Since all indicators of climate change cannot be covered here, let us discuss global warming and ozone layer depletion as indicators of climate change. Global warming is the persistence rise in surface temperature of the earth and related changes in the geographical distribution and chemical quality of rainfall. It is the result of rising concentration and accumulation of green house gasses (GHGs). Major components of GHGs are carbon dioxide, methane, chlorofluorocarbons (CFCs), nitrous oxide, ozone and water vapour. The most recent assessment reports by the Intergovernmental Panel

of Climate Change (IPCC) concluded that the global average surface temperature has increased by about 0.6 degree Celsius during the twentieth century. Additionally, in most mid and high latitudes of the Northern Hemisphere continents precipitation has increased by 0.5 to 1.0 percent per decade in the twentieth century. Emission of greenhouse gases, mainly carbon dioxide, continue to increase. The most recent estimate is that atmospheric concentration of the green house gases mainly carbon dioxide will get doubled or increase threefold pre-industrial levels by the end of this century. As a result, global surface temperature is expected to increase by 1.4 to 5.8 degree Celsius from 1999 to 2100.

The adverse effects of global warming are reflected in the decrease in forest biomass, decrease in agricultural production, damages caused by coastal inundation and sea water ingression due to rise in sea level. The present rise in temperature will lead to further rise in the sea level between 30 to 100 centimetres leading to acute aggravation of an already jeopardised common asset of the world that is our atmosphere and environment. This level of change in climate can create frequency and intensity of natural disasters from flooding to draughts to torrential rains, ice storms, tornadoes and hurricanes. Higher temperature, heavier rainfall and changes in climate would encourage vectors of some infectious diseases to multiply and expand to newer geographical regions. There are also numerous health effects both in terms of disease and injury associated with extreme weather events such as heat waves, storms and floods. This is interesting to note that these adverse effects will fall on almost all countries in the world equally. Thus, it is easy to comprehend international dimension of global warming as a serious environmental issue.

Another related hazard to climate change is the destruction of ozone layer– a region of Earth's stratosphere that absorbs most of Sun's ultraviolet radiation. Ozone layer contains a very high concentration of ozone (O_3) in relation to other parts of the atmosphere. Over the years there is continuous depletion of ozone layers resulting mainly from manufactured chemicals such as halocarbon refrigerants, solvents, propellants and foam-blowing agents (chlorofluorocarbons (CFCs), HDFCs, halons) referred to as ozone-depleting substances (ODS). Ozone layer depletion and ozone hole have generated worldwide concern over increase in cancer risks and other numerous negative effects. Ozone layer contains less than 10 parts per million of ozone while the average ozone concentration in Earth's atmosphere as a whole is about 0.3 parts per million. Ozone layer is mainly found in the lower portion of the stratosphere from approximately 15 to 35 kilometres above Earth and

its thickness varies seasonally and geographically.Ozone hole: There are two related events of ozone depletion which have been observed since the later 1970s. Ozone layer depletion is the steady lowering of about four percent in the total amount of ozone in Earth's atmosphere and Ozone hole is the much larger springtime decrease in the stratospheric ozone around Earth's polar regions. The health effects of climate change and ozone depletion is summarised in table 15.1 based on the World Development Report 1992.

Events	Potential direct effects	Potential indirect effects
Ozone depletion **UV radiation**	Skin cancer, cataracts (may be due to depression of immune system)	Impairment of photosynthesis leading to compromised food production (may exacerbate problems of groups with already compromised immune systems
Climate change		
Thermal stress	Death, illness, injury Habitat altercation: infectious diseases, epidemics Food production: malnutrition, Water quantity and quality: diarrheal diseases Aggravation of air pollution, aggravation of existing illness	
Storms	Drowning and injury	Loss of housing; Mental/physical stress of displaced persons
Floods	Same as storms	Same as storms Desertification, droughts; Malnutrition, stress
Brush/forest fires	Injury and death	Same as storms but to a lesser extent. Rise in sea level, susceptibility to storms, Water pollution, salt water intrusion Vector-borne diseases; Malnutrition, Social/demographic dislocations; Loss of infrastructure; Mental/physical stress of displaced persons.

15.3.2 Energy Crisis

When we identify global warming and ozone depletion as serious environmental problems with global concern, it is apparent to question the genesis of the problem. The genesis lies in the paramount increase in worldwide rise in energy demand requirement in the modern century. There has been unprecedented rise in consumption of fossil fuels (coal, oil and natural gas) resulting in more emissions of carbon dioxide and fast depletion of exhaustible resources such as coal, hydrocarbons and natural gas in order to meet the rising demand for energy. Our life style and technology is entirely energy driven and we are dependent upon fossil fuels to meet our energy requirement. In technical term, this situation is described as carbon lock-in. This has led to energy crisis- a condition where the world's demand on the limited natural resources that are used to power industrial society are diminishing as the demand rises. It is a matter of deep concern in the sense that these natural resources have limited supply and while they do occur naturally, it can take hundreds of thousands of years to replenish the stores. A plethora of factors contribute to global energy crisis which include over consumption, overpopulation, unexplored renewable energy sources, wastages of energy, major accidents (like pipe line bursts), natural calamities, etc. What concerns us more is the fact that there is limited exploration of alternative energy sources. A few renewable energy sources have been identified but none of them have been promising enough when it comes to replacement of fossil fuels as the major source of energy for human being.

15.3.3 Exploitation of Natural Resources

Most of our human activities including agriculture, fishing, mining, etc. which have resulted in degradation of natural resources. While mining and extensive agriculture have resulted in large scale deforestation, over fishing has resulted in the reduction in population of marine creatures of the planet. If this exploitation tends to continue then crisis will prevail as these natural resources will get exhausted on which the mankind is dependent.

15.3.4 Pollution and Wastes Disposal

Pollution is environmental bads and the by-product of production and consumption activities. Along with the advancement of human civilisation with more reliance on technology the level of pollution at all levels i.e. air, water and land is increasing so rapidly

that it is matter of great concern for the mankind. Transport sector and combustion of fossil fuels results in generation of local pollutants such as sulphur dioxide, particulate matter, benzene, carbon monoxide, carbon dioxide which are responsible for air pollution. These are also significant net contributors to emission of greenhouse gases leading to global warming and ozone depletion (the ill effects of these are discussed in section 15.3.1). Recent estimates show that transportation such as cars, buses, trucks, railways, etc. account for nearly twenty-nine percent of GHG emissions in the world. The major advance countries like USA, European countries, UK and China together emit over fifty percent of the world's GHGs. Equally serious environmental issue that has global concern is the degradation of land resources. It is known that land is a unique resource for it is perfectly inelastic in supply (that is it is available to us in fixed quantity). So degradation of land resources (converting land for the construction of buildings and roads, soil erosion, desertification, deforestation) pose serious threats to mankind in terms of environmental costs such as reduction in landscape quality (for natural vegetation, forestation: the two main important ingredient of human survival on earth), loss of wildlife habitat (threat to biodiversity), islanding effects whereby movements of corridors for wildlife are disrupted (example is the increased man-animal conflict in many parts of the country) and loss of cultural heritages sites. Similar to air and land, the most serious environmental issue having global concern is the water pollution. The level of water pollution is so high that there is apprehension that the whole world will suffer from pure drinking water crisis. Regarding water pollution main concern is the non-point pollution where emissions are very hard to measure as they are not traceable to single point of entry like point source pollution. Point source pollution is defined as an emission which enters water bodies from an easy to identify single source such as pipe from a factory or the outfall from a sewage works. The serious concern regarding water pollution is due to the unavoidable sources from where it originates, for example,

- Industry in the form of point source discharges of heavy metals, organic wastes and other pollutants;
- Municipal sewage treatment works or direct sewage outfalls
- As acidic drainage water from old mines
- As leachate from landfill sits
- As pathogens washing off from fields in which cattle are kept

- As run-off of oils and solvents from city streets and
- As run-off of fertilizers, pesticides and soil erosion from farmland and forests.

The increasing reliance on groundwater for domestic, agricultural and industrial purposes pose another challenge to the mankind worldwide leading to acute water crisis.

15.3.5: Biodiversity Loss

Biodiversity or diversity in biological life forms is a crucial life support system for human life on the earth. Biodiversity is the variety and variability of life on Earth. It is a measure of variation at the genetic, species and ecosystem level. Biodiversity include three types: diversity within species (genetic diversity), between species (species diversity) and between ecosystems (ecosystem diversity) As UNEP, 1993 defines, biodiversity is the variability among living organisms from all sources, including inter alia, terrestrial, marine and other aquatic ecosystem and the ecological complexes of which there are a part: this includes diversity within species between species and of ecosystems. However, due to environmental damage that includes loss of forest cover, more and more use of land for agriculture and other use there is loss of habitats that support biodiversity. As result of which many species on Earth are endangered and facing extinction or near to extinction. The increased loss of biodiversity and consequent loss of a species is a cause of concern for the mankind at least for three reasons: (a) the species lost may have a direct value in terms of genetic material for food crops or as a source of medicines, (b) a species may play a critical role in maintaining ecosystem and providing humanity with a range of ecosystem services such nutrient cycling and water catchment regulation, and (c) a species may have aesthetic and non-use benefits for instance people like to see charismatic species such as birds and butterflies in the wild (Hanely et al. 2004). It is important to note here that there exists a food web relationship among species that qualifies the maintenance of ecosystem so that reduction in any one may become fatal for an entire ecosystem. Similarly, the changes in air quality or quality of water or wetlands through chemical changes in the environment species become endangered and vulnerable, thus in turn threatening the biodiversity on the planet. This way environmental damage becomes a serious threat to habitats and biodiversity.

At the global level, accumulated depletion of natural resources and habitats over time has resulted in threatening the biodiversity. Deforestation, pollution, climate change, ocean

warming, desertification, loss of wetlands to human settlement have been contributing to destruction of biodiversity and near collapse. Overhunting, overgrazing, over population (under population in case of endangered species) have been causes of global concern because of their threat to the total web of life system on the planet (Chakraborty, 2019).

15.3.6 Sustainability of Development

We have discussed above that the resources on the earth are finite and they are depleting fast. This has posed a big question on the sustainability of present state of development in near future. Immediately after the publication of the Brundtland Committee Report (WCED 1987), sustainable development has become one of the widely discussed global environmental concern. According to the Brundtland report, "sustainable development is the development that meets the needs of the present generation without comprising the ability of the future generation to meet their own needs". In a simplified term sustainable development requires natural capital to remain intact over the generation. But it raises concern because the present state of indiscriminate use of natural resources and consequent stress on the environment due to large scale eco-harmful economics activities of mankind has little ability to retain natural capital intact in future.

CHECK YOUR PROGRESS

Q.1: What is meant by environmental goods and services?

Q.2: What is environmental bad?

Q.3: There is a two-way traffic between local and global environmental problems. True/False

Q.4: What is externality? Give an example of negative externality.

Q.5: Pollution is a negative externality. True/False.

Q.6: State the difference between point and non-point pollution?

Q.7: What is global warming?

Q.8: State two implications of land degradation.

Q. 9: What is biodiversity?

Q.10: What is sustainable development?

Q.11: What is natural replenishment rate of any renewable resources?

15.4 INTERNATIONAL TRADE AND ENVIRONMENT

The discussion on global environmental issues is not complete without discussing the link between international trade and environment in details. The relationship between international trade and the environment has been a matter of serious deliberation in the field of Economics or Environmental Economics in the recent years. Economists are primarily interested in exploring how environmental factors/resources influence the gains from international trade, while environmentalists are primarily concerned about how the expansion in international trade impacts global environmental conditions. To be very specific, there are two-way linkages between international trade and the environment and in the recent years the former is treated as one of the responsible factors for many environmental ills/damages. As international trade is related to a country's trade, it has an inextricable linkage with the environment. The link between trade and environment protection, consisting of both the impact of environmental policies on trade, as well as the impact of trade on the environment, was recognised as early as 1970. In the early 1970s,

there was growing international concern regarding the impact of economic growth on social development and the environment. Trade and environment emerged as an issue of academic and public concern in the 1980s and gained prominence in national policy making and international conferences since the 1990s, in particular since the 1992 Rio Earth Summit. Since then, more attention has been given to the role of trade and trade policies in promoting or hindering moves to protect our natural environment.

International trade facilitates exchange of goods and services across borders of countries. International trade largely changes production and consumption pattern of a country involved in trade and this change in the spatial distribution of production and consumption affects the environment nationally and globally.

In international trade, transactions are facilitated by international financial payments, in which the private banking system and the central banks of the trading nations play important roles. Free international trade has various positive effects on countries. In the eighteenth century in France, Physiocrats demanded liberty of production and trade. In England, the economist Adam Smith demonstrated the advantages of removing trade restrictions in his book *"The Wealth of Nations"* This doctrine of free trade was also advocated by economist David Ricardo (1817) and the followers of comparative advantage principles of trade have largely believed that countries benefit by an increase in welfare from free trade and hence trade restrictions through tariffs and quotas must be reduced to expand gains from international trade. These principles have also been pursued through the General Agreement on Tariffs and Trade (GATT) and World Trade Organisation (WTO) which succeeded GATT in 1995. As a result of this, the world has witnessed a considerable expansion in trade volume of a country engaged in international transactions and the global production and consumption has increased manifold.

International trade drives changes in national patterns of production of goods and services, which in turn entails impact on the domestic environment. This impact is further influenced by domestic environmental regulations. As an engine of growth, trade can also provide the necessary resources for environmental conservation. Further, trade may lead to a reallocation of production to countries which are better able to deal with the environmental side-effects of production. Conversely, the environment and environmental concerns impact trade. The natural environment is the basis of production for many exported products, particularly from developing countries, and an important input to their long-term sustainable development. Growing environmental concerns as enshrined in the

international level in multilateral environmental agreements (MEC) and at the national and local level in environmental regulations and standards, as well as consumer preferences for "greener" products, increasingly influence trade patterns.

International trade has both positive and negative effects on the environment which makes it one of the key issues of a country. It has a direct impact on the environment by increasing pollution or degrading natural resources. Trade also makes possible the over exploitation of species to the point of extinction. A major concern is that the increasing competition between companies induced by further trade liberalisations causes a "race to bottom" in environmental standards, because countries might weaken their environmental policy in order to shelter their industry from international competition. Increased pollution haven in some developing countries as a result of trade liberalisation lured by employment and income generation is another adverse consequence of international trade.

However, increased trade can in turn, by supporting economic growth, development and social welfare, contribute to a greater capacity to manage the environment more effectively. More importantly, open markets can improve access to new technologies that make local production processes more efficient by diminishing the use of inputs such as energy, water and other environmentally harmful substances. Similarly, trade and investment liberalisation can provide firms with incentives to adopt more stringent environmental standards. As a country becomes more integrated within the world economy, its export sector becomes more exposed to environmental requirements imposed by the leading importers. Changes needed to meet these requirements, in turn flow backwards along the supply chain, stimulating the use of cleaner production processes and technologies. Similarly, the increased income due to international trade may lead to consumers demanding higher environmental standards as delineated by the Environmental Kuznets Curve (EKC). However, there is little empirical evidence of this pro-environment effect of international trade when a country adopts stringent environmental regulations. Tobey (1990) in a multi-country cross section study taking into consideration five pollution-intensive industries viz. mining, paper, chemicals, steel and non-ferrous metals, has concluded that stringent environmental control measures caused export pattern deviate from patterns predicted by the resource endowments of the countries. Akin to other studies, this study concludes that pollution abatement costs are a relatively small proportion of the total costs of production.

Hence to keep a balance between the positive and negative impacts of trade on the environment, effective environmental policies and institutional frameworks are needed at

the local, regional, national and international levels. Countries have undertaken a number of environment related efforts under the World Trade Organisation (WTO) framework including negotiating tariff reductions in environmental goods and services, seeking more clarity on the relationship between existing WTO rules and specific trade obligations in multilateral environmental agreements. WTO which has an important role to play in the field of trade and environment mainly focused on sustainable development. Its members recognised that the WTO is not an environmental protection agency and that it does not aspire to become one. Its competence in the field of trade and environment is limited to trade policies and to the trade related aspects of environmental policies, which have a significant effect on trade. In addressing the link between trade and environment, WTO members do not operate on the assumption that the WTO itself has the answer to environmental problems. However, they believe that trade and environmental policies can complement each other. Environmental protection preserves the natural resource base on which economic growth is premised, and trade liberalisation leads to the economic growth needed for adequate environment protection. To address this, the role of WTO is to continue to liberalise trade, as well as to ensure that environmental policies do not act as obstacles to trade, and that trade rules do not stand in the way of adequate domestic environmental protection.

15.5 LET US SUM UP

- Environmental problem has two dimensions: local and global. In fact, there is two-way traffic of local environmental problem causing global effects and global trends causing local effects. Poor natural resource management in some countries threatens the physical basis of the countries themselves and harms the fragile ecosystem of the planet.
- Some of the environmental problems of global concern are climate change as reflected in global warming and ozone depletion, energy crisis, pollution (that includes earth's soil, water and air), overexploitation of renewable resources, depletion of exhaustible or non-renewable resources, loss of biodiversity, disposal of solid waste and sustainability of development.
- Climate change is one of the major global concerns of environmental problems getting reflected in global warming and ozone depletion. Global warming is the persistence rise in surface temperature of the earth and related changes in the geographical distribution and chemical quality of rainfall. It is the result of rising concentration and accumulation of

greenhouse gasses (GHGs). Major components of GHGs are carbon dioxide, methane, chlorofluorocarbons (CFCs), nitrous oxide, ozone and water vapour. The most recent assessment report by the Intergovernmental Panel of Climate Change (IPCC) concludes that the global average surface temperature has increased by about 0.6 degree Celsius during the twentieth century.

- Death, illness, injury, habitat altercation: infectious diseases, epidemics; food production: malnutrition; water quantity and quality: diarrheal diseases; aggravation of air pollution; aggravation of existing illness are some of the serious effects of climate change.
- The damages caused to the environment, which is by and large used as the dump for wastes of economic activities, in the form of pollution of air and water and destruction of plants and biological species are significant costs to the society.
- At the global level, accumulated depletion of natural resources and habitats over time has resulted in threat to biodiversity. Deforestation, pollution, climate change, ocean warming, desertification, loss of wetlands to human settlement have been contributing to destruction of biodiversity and near collapse. Overhunting, overgrazing, over population (under population in case of endangered species) have been causes of global concern because of their threat to the total web of life system on the planet.
- International trade has both positive and negative effects on the environment. It has a direct impact on the environment by increasing pollution or degrading natural resources. Trade also makes possible the over exploitation of species to the point of extinction. A major concern is that the increasing competition between companies induced by further trade liberalisations causes a “race to bottom” in environmental standards, because countries might weaken their environmental policy in order to shelter their industry from international competition.

15.6 FURTHER READING

Chakraborty, P. (2019), “Global Environmental Issues and Initiatives”, in R. N. Bhattacharya (2019) ed., *Environmental Economics: An Indian Perspectivs,* Oxford University Press, New Delhi.

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15.7 ANSWERS TO CHECK YOUR PROGRESS

Ans to Q No 1: Environmental goods are subcategory of public goods which include clean air, landscape, green transport infrastructure, flora and fauna, etc. and environmental service is nature's capacity to provide quality life and comfort i.e. to ensure that life as exists in quality form. Example- pure air, fertile soils, forest rich in biodiversity, nutritious and abundant foods and so on.

Ans to Q No 2: Bads in general refers to those things consumption of which decreases our utility/or adds to disutility. Environmental bads refers a broad category of events or things which endanger or affect the natural environment or environmental ecosystem.

Ans to Q No 3: True

Ans to Q No 4: An externality is defined as an action by one individual agent that provides benefits or costs affecting other individual agents. Externality is negative when action has negative effects on the agents. Examples: 1. If neighbour plays loud music at 4 a.m. in the morning, 2. Riding on a noisy motor cycle, 3. Smoking in a public place. Pollution is a very good example of negative externality.

Ans to Q No 5: *True.*

Ans to Q No 6: According to United States Environmental Protection Agency (EPA), point source pollution is any contaminant that enters the environment from an easily identified and confined place. Example include discharge pipe of an industrial plant, drainage ditches. Nonpoint-source pollution is the opposite of point source pollution with pollutant released in a wide area hence the source cannot be identified. For example, run off i.e. rain water which flows and washed away drops of oil that leaked from car engines, particles of the rubber, wastes, trash, etc.

Ans to Q No 7: The rise in mean or average surface temperature of earth due to the effect of greenhouse gases such as carbon dioxide emission from burning fossil fuels

(oil, coal and natural gases) or from deforestation which trap heat which would otherwise escape from the earth is a type of greenhouse effect.

Ans to Q No 8: First reduction in landscape quality (for natural vegetation, forestation: the two main important ingredient of human survival on earth) and secondly, loss of wildlife habitat (threat to biodiversity), islanding effects whereby movements of corridors for wildlife are disrupted (example is the increased man-animal conflict in many parts of the country)

Ans to Q No 9: Biodiversity is the variety and variability of life on Earth. It is a measure of variation at the genetic, species and ecosystem level. Biodiversity include three types: diversity within species (genetic diversity), between species (species diversity) and between ecosystems (ecosystem diversity)

Ans to Q No 10: According to Brundtland Commission Report "Sustainable development is the development that meets the needs of the present without compromising the ability of the future generations to meet their own needs". This is the most widely accepted comprehensive definition of sustainable development.

Ans to Q No 11: The natural replenishment rate of any renewable resources is that it is the rate at which all natural resources can regenerate themselves. If natural rate replenishment is lower that the extraction rate then degeneration of environmental resources takes place. The magnitude of environmental resources gets degenerated.

15.8 MODEL QUESTIONS

A. Very short questions:

Q.1: What is environment?

Q.2: What is local environmental problem?

Q.3: What is global warming?

Q.4: What is ozone layer depletion?

Q.5: State the pollutants that deplete the ozone layer.

Q.6: What is the main source of energy demand?

Q.7: Pollution is environmental bad. True/False

Q.8: What is the difference between point and non-point pollution sources?

Q.9: Define biodiversity.

Q.10: Give a suitable definition of sustainable development.

Q.11: What is autkary?

Q.12: How does free trade help in environmental conservation?

Q.13: What is pollution haven?

Q.14: Expand, WTO, GATT, UNDP, UNEP

B. Short Questions:

Q.1: Describe the link between local and global environmental problems.

Q.2: Explain two serious implications of global warming.

Q.3: State three adverse effects of ozone layer depletion.

Q.4: Explain the mismatch between energy demand and available energy sources.

Q.5: What is carbon lock in? Suggest two ways to do away with carbon lock in.

Q.6: Identify five sources of water pollution.

Q.7: State three adverse implications of land degradation that has global concerns.

Q.8: What is biodiversity? How does it lead to environmental damages?

Q.9: Is the present state of development sustainable? Give arguments in support of your answer.

Q.10: Discuss the beneficial effects of international trade on the environment.

Q.11: Discuss in brief the adverse effects of international trade on the environment.

Q.12: State the link between trade liberalisation and pollution haven.

C. Long Questions:

Q.1: Discuss in detail the inter-linkage between environmental problems which has global environmental implications.

Q.2: What is global warming? What are the sources of global warming? Discuss the effects of global warming on the environment and mankind in details.

Q.3: What is pollution? Discuss the sources of air, land and water pollution.

Q.4: What is biodiversity? How does loss of biodiversity impose threat to the mankind? Explain.

Q.5: Discuss environmental problems which have global concerns.

Q.6: Explain the link between international trade and environment.

Q.7: Does international trade lead to environmental damage? Suggest policies to address the threat caused by international trade to global environment.

Q.8: Discuss the role of international trade in environmental conservation of a country.

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