**Environmental Economics**

MA Economics, III Semester

(Soft Core Course)

Dr. Sarah Razack,

Assistant Professor of Economics,

Post-Graduate Department of Studies in Economics,

Maharani’s Arts College for Women, Mysore

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**MODULE-1**

**INTRODUCTION TO ENVIRONMENTAL ECONOMICS**

Environment is a quintessential aspect of human existence. Economics is the study of the management of scarce resources. Environmental economics is an integral part of the study of environment in relation to economics. The present module introduces the discipline of Environmental economics, tracing its evolution, explaining its scope and importance, discusses in brief the typical environmental problems and focuses on the relationship between environment and development. The law of thermodynamics in the context of Entropy Law is also explained.

**1.1 Introduction**

Environment is a comprehensive term which refers to our - surroundings and includes all components - living and non-living (lithosphere, atmosphere and hydrosphere) that are present on the earth. Further, environment is sub-divided into natural and social environment. While the natural environment denotes land, water and air (gases) that are the supporting components, social environment refers to man, society and their interaction with the natural environment, the relationship between the two is called *ecology*. In other words, ecology studies relationship between biotic and abiotic means.

A study of interrelationship between living and non-living being – ‘how living beings interact with non-living beings and how non-living beings get impacted with living beings’ - is called *ecosystem*. The study of all components of environment - natural and social - is known as *environmental studies*. It is an interdisciplinary science as it contains various branches of studies like earth sciences, physical sciences, agricultural sciences and social sciences.

The subject matter of environmental sciences includes the study of land, water and air (natural environment) and population settlements, economy, social issues and man-environment relationship (social environment). During the recent past, due to increase in human population and thus high level of economic activities, the natural environment has degraded at a large scale. The environmental and social issues ranging from high level of environmental pollution and exploitation of natural resources and environmental degradation to health hazards manifested a way of regulation of loss for conserving environment. The world communities, governments, administrators, policy institutions, academic and local people are all concentrating on these issues.

**1.2 Definition and Scope of Environmental Economics**

Environmental economics is a nascent sub-discipline of economics. It would therefore be in order if its parent discipline that is economics is defined first. Economics is best defined as social science that deals with the explanation and prediction of economic behaviour of rational individuals, groups of individuals, or other economic decision making entities. Economic behavior is revealed in terms of choices that people, or groups of people make. So, economics is also called a science of making choices. One of the most commonly accepted definitions of economics is given by Lionel Robbins. According to him, ‘Economics is the science which studies human behavior as a relationship between ends and means which have alternative uses (Robbins 1935). This definition implies the fact that human beings have many ends, or wants and that the means available to achieve the ends, or satisfy the wants are scarce and have alternate uses. In a nutshell, it is the multiplicity of ends/wants and the limited availability and existence of alternative uses of means that give rise to the problem of choice, or the need for the economizing. Hence, it is clear that if the means are scarcely relative to ends, there would be no need for making choices or economizing and no need for economics.

Environmental economics deals with the application of the principles of economics to study why and how human beings interact with their environment the way they do, how they use and manage the environmental resources and what are the impacts of human activities on the environment. It draws from all other sub-disciplines of economics such as microeconomics, macroeconomics, and welfare economics as well as from natural sciences including environment science. It attempts to explain the economic aspects of attitude and behaviour of people with regards to the natural environment. It is also concerned with how economic institutions can be changed to bring the environmental impacts of human activities into balance with the human desires and needs of the ecosystems.

Environmental economics seeks to analyze environmental issues, which are complex and multidisciplinary in nature. Consequently, it represents an intersection of several social science and natural science disciplines. In its formative years in the 1960s it encompassed a diversity of economic doctrines and pluralistic view (Pearce and Turner 1990). Many economic concepts and tools such as marginalism, consumer’s surplus, producer’s surplus, the opportunity cost, externalities, subsidies, taxes, social welfare function, Pareto optimality and cost benefit analyses have relevance and applications in analyzing environmental problems.

Environmental economics deals with economic aspects of interdependence and interactions between human beings and the environment. Since many environmental assets, goods, amenities and services have no markets and hence either have no prices, or have prices that are distorted; most environmental problems could be considered as problems of non optional pricing. In the other words environmental problems arise either from nonexistence or failure of markets. Environmental economics deals with non-market goods amenities and services provided by Mother Nature.

The definition of environmental economics as a discipline dealing with the relationship between economic activities and the environment focuses attention on economic development and its effects on environment. Man has been tampering with the ecosphere for very long time presuming that environmental resources and amenities are inexhaustible but now he is forced to recognise that like the other economic goods, environmental goods and services are also scarce and exhaustible. This is where economics enters the scene as it is science of all allocating scarce resources among competing uses’. Economics thus has a vital role to play in finding solutions of environmental problems. As environmental goods and services are scarce, society can have more of them only by giving up significant amounts of other desirable goods and services, that is, there is a trade of between environmental goods and other economic goods.

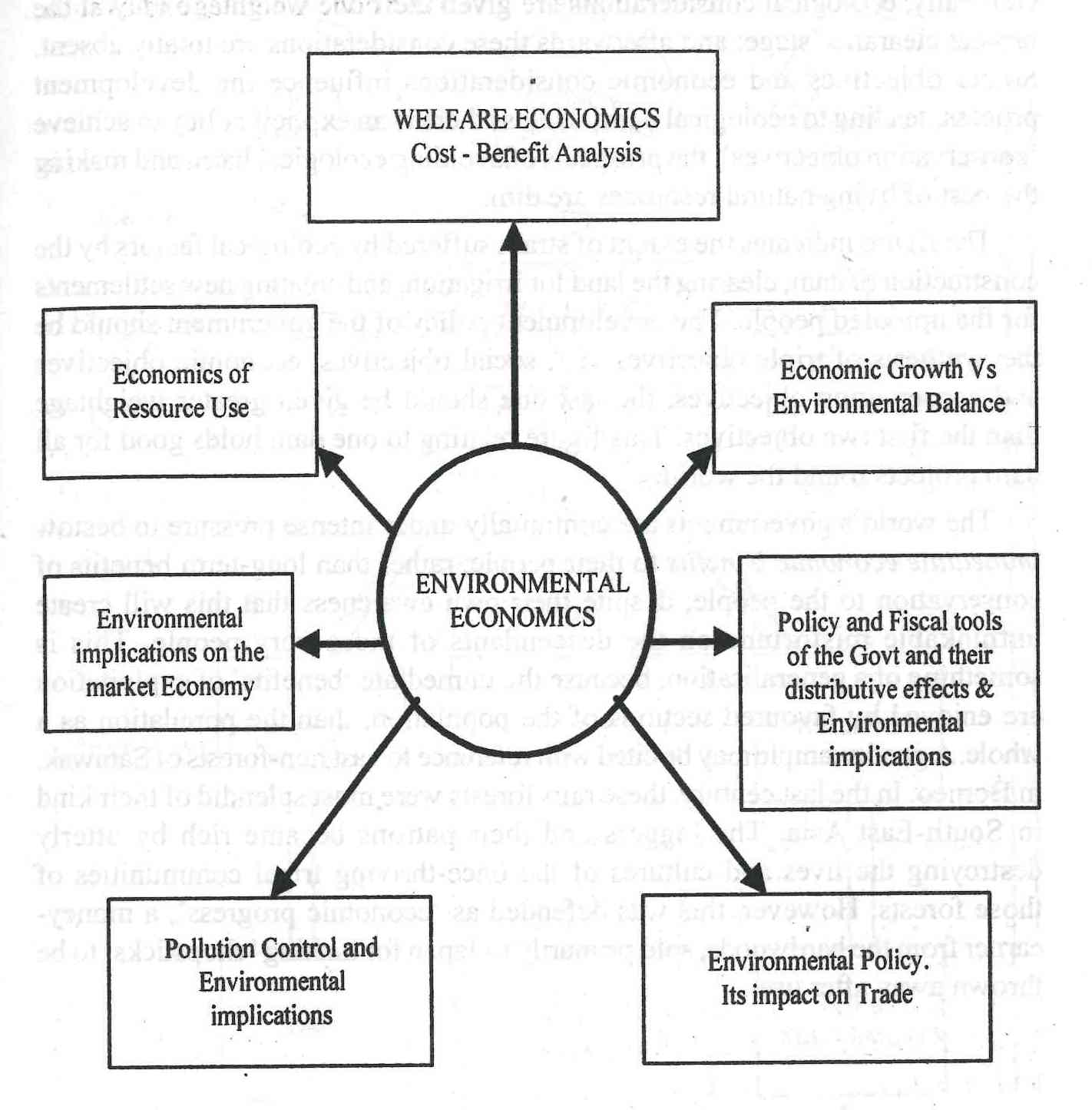
D. W. Pearce defines as, “Environmental Economics brings the discipline of economic analysis to environmental issues such as pollution the rate of use of renewable and non-renewable natural resources, conservation of living species and resources and the choice of policy to achieve environmental ends”.

According to Charles Kolstad, the best division between environmental economics and resource economics is between static and dynamic issues related to the natural world. “Environmental economics involves questions of excessive production of pollution by the market (or insufficient protection of the natural world due to market failure). Resource economics on the other hand is concerned with the production and use of natural resources, both renewable and exhaustible. Renewable resources would include fisheries and forests. Non-renewable would include minerals and energy as well as natural assets.”

Like its parent discipline, environmental economics also has two branches, namely, positive environmental economics and normative environmental economics. The positive environmental economics draws upon microeconomic theories and macroeconomic theories to describe and explain the ways in which economic factors influence the consumption and production of environmental goods and services. It is largely descriptive and predictive. The normative environmental economics is largely prescriptive that is it attempts to prescribe what ought to be done to protect and conserve the environment. It applies the principles of welfare economics to determine the socially optimum allocation of environmental goods and services currently and over time that maximizes the net social welfare of present as well as future generation.

The multidimensional character of environmental economics can be gauged by the following figure 1.1

**Figure 1.1: Multidimensions of Environmental Economics**



The Figure 1.1 illustrates the multidimensional character of environmental economics and how it encompasses different aspects of theoretical and practical studies of man’s socio-economic cum political life.

**1.3 Evolution and Growth of Environmental Economics**

Classical economists such as Adam Smith (1723-1790) Thomas Malthus (1772-1823), and John Stuart Mill (1806-1873), did not explicitly address the environmental aspects of economic growth but they left a legacy of ideas many of which are relevant to and have been re-introduced into contemporary environmental debates. For example, Ricardo argued that economic growth would dwindle out in the long run because of scarcity of natural resources and diminishing returns to land that would set in as society is forced to bring under cultivation successively less productive land to produce food enough to feed its increasing population.

John Stuart Mill conceived of economic progress in terms of a race of a technical change and diminishing returns in agriculture. Classical theory of political economy highlighted the importance of market as an instrument of stimulating growth and innovation but remained essentially pessimistic about long run economic growth prospects. The growth economy was thought to be merely temporary phase between two stable equilibrium positions, with the final position representing barren subsistence level existence - the stationary state.

Starting around 1870, neoclassical economic thought began to develop within the main stream economics profession. The neoclassical economics introduced a new methodology of marginal analysis, which dealt with the study of relationships between small or incremental changes in inputs and outputs. The rational and egotistic person constituted the hard core of the neoclassical economic theory, which postulated that a rational individual tries to maximize his satisfaction, or utility subject to his income (budget) constraints. According to the mainstream neoclassical system of thought the economic value, marketable commodities unprized environmental goods and services, or sympathy for future generations was determined based on the amount of personal utility yielded.

The experiences of the inter-war-years (1920s and 1930), when mass unemployment became a reality contrary to what the neoclassical economists had presumed, led to the formulation of Keynesian economics with its emphasis on government intervention and deficit spending. Thus during the 1950s, growth of economics as a discipline got back on to both economic and political agenda. Subsequently, during the 1960s, environmental pollution caused mainly by rapid economic growth in developed countries intensified and became wide spread. This led to the emergence of new environmental ideologies and mass awareness about the need and importance of keeping the quality of the environment intact. A number of these new ideologies were basically anti - economic growth.

Since 1970, a number of ‘world views’ have crystallised within environmentalism providing rationale for the emergence of environmental economics as a sub-discipline of economics. The world views can be distinguished, ranging from support for a market and technology driven growth process which is environmentally damaging through a position favoring managed resource conservation and growth to ‘eco preservationist’ positions which explicitly reject the economic growth paradigm.

In many developing countries including India, pollution is still seen as a necessary price for economic growth as a result; some cities such as Mexico city, Sao Paulo, Delhi and Kolkata regularly suffer air pollution levels that are far more severe than those in developed countries. Worst of all, many of the poorest nations seem stuck in an unending cycle of poverty and economic degradation; they are unable to devote the necessary resources to secure tomorrows economic interests because they are too concerned with survival today. These nations do not have the resources to combat major environmental concerns like global climate change.

One reason for the relatively recent emergence of environmental economics is the change in our society’s attitude towards the environment overtime. Before the American Revolution, there was a colonial tradition of social control that provided great deal of environmental protection. Common law at that time imposed a lot of legal restrictions on the ability of land owners to pollute streams used by their neighbors. By about 1820, the whole landscape of common law changed to that of free-market or laissez-faire economic system. Under this only economic development was emphasized upon and no questions were asked, whether trees were felled or mines quarried, rivers dammed as long as it was in the interest of economic growth.

Until the 1960s, a view prevailed that the environment was capable of absorbing all the unwanted by-products of the human pursuits of economic well-being. Economists concentrated on relocation of scarce land and labor and did not consider environment as a scarce resource. Then, there began a widespread shift in values and expectations, which represented a sort of return to the pre-revolutionary colonial tradition of social control. The effects of our economic actions on the environment were noticeable. Air and water had become filthy. Society then started looking for its response towards environmental protection, combining everything from legislation, mandating improvements in air and water quality, to agitation protesting against wasteful and profligate use of the natural resources and the environment. Economists responded by studying the causes of degradation of the environment and seeking alternatives for reserving the quality and integrity of the environment.

With the end of the Cold War and the collapse of the Soviet Union, the world discovered that environmental degradation was not a unique attribute of the 'capitalist' Western world. Quite the contrary, in many formerly communist countries, including Poland, Russia and Czech Republic, pollution existed at levels unimaginable in the West. Decades of heavy industrialization had led to crippling declines in air and water quality. Water pollution levels in some rivers and lakes in Eastern Europe were very high. Unfortunately these environmental problems were compounded by an overarching silence, in the belief that no physical price was too great to pay to seek economic and military parity in the West.

The major landmarks in the growth and development of environmental economics can be summarized as follows;

1. 1972: The Stockholm Conference on Human Environment created formal international awareness of the need for maintaining the quality and integrity of the environment.
2. 1987: Brundtland Commission’s Report titled our Common Future popularised the concept of Sustainable Development.
3. 1992: World Banks World Development Report highlighted the links between development and environment and opportunities for ‘win-win’ policies.
4. 1992: Setting up of the Global Environment Fund (GEF) provided grant funds for activities such as biodiversity protection, reduction of greenhouse gas emissions, and reduction of CFC emissions to protect the ozone layer.
5. 1992: Agenda 21 of the United Nations conference on Environment and Development (Earth Summit) in Rio de Janeiro prompted the United Nations Statistics Division (UNSD) to prepare and publish, in 1993, a Handbook of National Accounting entitled Integrated Environmental and Economic Accounting (IEEA).
6. 1992: Convention on Biological Diversity highlighted the need for biodiversity conservation.
7. 1993: Development of Forest Resource Accounting (FRA) system by the International Institute of Environmentand Development (IIED) and the United Nations Environment Programme-World Conservation and Monitoring Centre (UNEP-WCMC) for the International Tropical Timber Organisation (ITTO).
8. 1990s and beyond: Growth and development of theoretical and applied economic analysis of environmental issues.

The and other related developments led to the setting up of several specialised institutes, department and professional bodies including the IED, Swedish Royal Academy’s Beijar Institute of International Society for Ecological Economics and Indian Society for Ecological Economics. Besides, several professional journals have also been launched and national and international conferences and training courses in environmental economics organised. This trend is continuing and is likely to gain momentum as awareness about the need to protect and conserve the environment grows in developing countries.

**Growth of Environmental Economics in India**

In India, although the field of economics is well established, there had been little focus in the past on the economic aspects of environmental and natural resource management. But interest in these problems is increasing now, as is evident from the initiation of natural resource and environmental economics teaching and research programmes in many universities and research institutes. In most of these institutions, however natural resource and environmental economics programmes are in their infancy. Qualified teachers and teaching materials are scarce, and capability to conduct research is limited. There is only a weak link between the research conducted and the needs of policymakers, managers and research users in solving critical natural resource management problems. An institutional mechanism is needed in India to help develop teaching comma training and research skills and capability in the field of natural resource and environmental economics and management.

Some of the major developments in the field of natural resource and environmental economics in India are summed up below.

1. In 1992, a programme called Indian Natural Resource Economics Programme (INREP) was launched and based in the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Patancheru, Andhra Pradesh. After some time of its existence and operation, it was decided in a meeting held on 6th and 7th August 1992 at hotel quality inn Hyderabad that a new organisation should be created for taking up the activities of INREP. The meeting was convened by the Ford foundation, New Delhi and attended by 10 eminent agricultural and natural resources economists and William R. Bentley from Winrock International and John Ambler from the Ford Foundation, New Delhi.
2. A steering committee was constituted under the chairmanship of Katar Singh, then RBI chair professor, Institute of rural management, anand to guide and facilitate the process of creating the proposed organisation. This meeting also decided to name the new organisation as India Natural Resource Economics and Management Foundation. Subsequently the INREM foundation was registered on 16th April 1994 under the Societies Registration Act, 1860, the Bombay Public Trust Act, 1950.
3. The mission of iron REM foundation is to promote sustainable use and management of natural resources and environment in India. Its main objective is to promote teaching, training and research in natural resources and environmental economics in Indian universities and help improve natural resource policies and programmes. Since its inception in 1994, INREM foundation has undertaken several research products and conducted several training programmes. One of its major contributions is the publication of a textbook, Natural Resources Economics: Theory and Application in India, 1997. This is the most comprehensive and the only textbook of its kind on the subject of natural research economics ever published in India.
4. The Indian Society for Ecological Economics (INSEE) is a professional society registered under the Indian Society’s Act, 1999. It is affiliated to the International Society for Ecological Economics. INSEE aims to further the cause of sustainable development by providing a forum for continuous dialogue between scholars and practitioners and policy analysts working on different aspects of environment and Ecology. It seeks to disseminate the results of research and its policy implications through multiple venues such as conferences workshops and networking and the sponsoring of research and publications.
5. Beginning 2000-2001, the Ministry of Environment and Forests [MOEF], Government of India [GOI] implemented, with World Bank’s assistance, a five year programme called, India: Environmental Management Capacity Building Technical Assistance Project. The Madras School of Economics, Chennai was the executing agency. The specific objective of the project was to enhance environmental management capacity in selected areas of environmental management. An important area of component so identified for such capacity building or enhancement relates to environmental economics. The objective was to increase the capacity for the application of economic principles and tools to environmental management in India across the full range of issues such as priority- setting, cost benefit analysis of alternative policies for pollution control, resource management and biodiversity conservation. Achievement of this objective was sought to be measured in terms of the additional number of students at the undergraduate and postgraduate level trained in environmental economics; the number of officials, industrial managers, NGOs and others are trained in environmental economics; the reach and quality of research in the field of environmental economics; and the integration of the research recommendations into environmental decision making at the various levels of government

The environmental economics programme consisted of:

1. Establishing Environmental Economic Indicators and Project Planning Cell (EEIPPC) in the Ministry of Environment and Forests.
2. Establishment of project units in environmental economics in four core institutions.
3. Support for developing an environmental economics curriculum and for preparing teaching materials, case studies and textbooks combining India specific case studies with examples of ‘best practices' from other countries for diploma and degree programs.
4. A faculty up gradation programme designed to train economic faculty members from across India in basic environmental economics to better equip them to introduce the environmental economics curriculum in their respective colleges and universities this was designed to consist primarily of short courses offered in India but was supplemented by a few fellowships for all prominent economics faculty in other countries.
5. A Ph.D scholar’s workshop programme to provide an opportunity for the scholars to present their results and get feedback from experts in environmental economics and also to provide access to the library, computer and faculty resources in well-established centres in environmental economics.
6. A programme to invite environmental economics faculty from other countries to teach and conduct research on India specific topics.
7. Training programmes for practising economists and non-economists on the application of the principles of environmental economics , mainly to pollution control policy, environmental costs and benefits, environmental assessments, cost effectiveness and trade-offs between environment and economic growth.
8. Short term overseas training programme for Indian Economic Services (IES) candidates.
9. Support to selected University, Institutes and college libraries to expand their collections of important books, journals and databases in environmental economics.
10. Support for applied research, case studies and analysis of best practises in the area of environmental economics. A tentative list of themes included: Economic Analysis of Policies in Natural Resource Management, and environmental pollution, role of institutions in environmental management, valuation methods, international environmental issues, environmental technologies, and clean production technologies.

The implementation of this programme was done through for four institutions- Madras School of Economics, Chennai, Indira Gandhi Institute of Development Research, Mumbai, Institute of Economic Growth, Delhi, and Indian Statistical Institute, Kolkata – as well as through a network of interested institutes. The objectives of the programme were sought to be achieved through a network of four sub-committees that had divided up the work and assigned clear responsibilities, under the overall guidance and supervision of the Expert Committee on Environmental Economics. The programme has contributed significantly to the growth and development of environmental economics in Indian universities and institutes.

**1.4 Importance of Environmental Economics**

The importance of Environmental Economics can be gauged from the study of the following issues;

* Sustainable Development

Sustainable development is defined by UNEP as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The concept analyses the role of economic development in supporting sustainable development. The four basic components of sustainable development is growth, environmental protection, social equity and institutional capacity.

* Market Failure

Market failure occurs if the functioning of a perfect market is compromised; hence it is unable to efficiently allocate scarce resources at a given price as conditions for laws of demand and supply are met.

* Externalities

Externalities are inadvertent consequences of economic activity that affect people over and above those directly involved in it. Externalities are also another form of market failure. They can be either negative or positive. A negative externality creates unplanned outcomes that are harmful to the environment or directly to the general public. A positive externality is a benefit to other people not directly involved in its generation.

* Valuation

Valuation is an important aspect of environmental economics, as it helps to evaluate a variety of options in managing challenges with the use of environmental and natural resources. The valuation of ecological resources is a complex process, as it is difficult to assign value to intangible benefits, such as clean air and unpolluted environment.

* Cost-Benefit Analysis

Cost-Benefit Analysis (CBA) involves weighing the benefits arising from a policy against the perceived benefits. Hence, the best policy is one in which there is greatest surplus of benefits over costs. Costs include opportunity costs, internal and external costs and externalities. Benefits include extra income, improves quality of life, clean water and beaches.

**1.5 Some Typical Environmental Issues and Questions**

There are several environmental issues and questions that can be discussed; however the critical ones are as follows;

* **Air Pollution:** Why is air Polluted? How ‘clean’ should the air be? What policy measures could reduce air pollution?
* **Water Pollution:** Why are rivers, lakes and groundwater aquifers polluted How ‘clean’ should rivers be? What policy measures could reduce water pollution? Why do farmers over irrigate their crops from public canals?
* **Land degradation**: Why is land degraded? Which type of land is degraded most and why? Why do farmers not adopt the required conservation measures on their private land? What Policy measures could reduce land degradation? What is the optimum level of soil conservation?
* **Deforestation:** Why are forests degraded? Why do People living in or around forests resort to illicit felling of trees and grazing of animals in the forests? What policy measures could promote afforestation of degraded forest lands?
* **Loss of biodiversity**: What is the value of biodiversity conservation? Why do forest dwellers not appreciate the need for biodiversity conservation? What policy measures could promote biodiversity conservation? How should the biodiversity conservation programmes be financed?
* **Climate Change:** Why are people not concerned about global warming, acid rain, depletion of ozone layer, droughts and floods? What is the right amount of carbon dioxide in the atmosphere? How can the emissions of greenhouse gases be reduced? Why do nations not cooperate and act collectively to reduce the emissions of carbon dioxide and other greenhouse gases? What policy measures at national and international levels are necessary to improve the global Climate?

**1.6 Environment and Development**

The enormous growth in world economy, reflecting both population growth and rising affluence, is taking place on a finite planet. Consequently, the world is on an economic path that is environmentally unsustainable. This is evident from the following indicators

* Falling water tablets;
* Increasing pollution of air and water;
* Increasing degradation of land;
* Food shortages;
* Shrinking/ collapsing fisheries; and
* Increasing incidence of natural calamities such as floods and droughts.

‘Development’ is a subjective and value-loaded concept and hence there cannot be a consensus regarding its meaning. The term is used differently in diverse contexts. But generally speaking, development conceptualized as a set or vector of desirable social objectives or a development index which does not decrease over time. The objectives of economic development are;

* Increase in real per capita income (economic growth).
* Improvement in distribution of income (equity).
* Political and economic freedom; and
* Equitable access to resources , education, health-care, employment opportunities and justice

The basic elements of development include – basic necessities of life, self-respect and freedom.

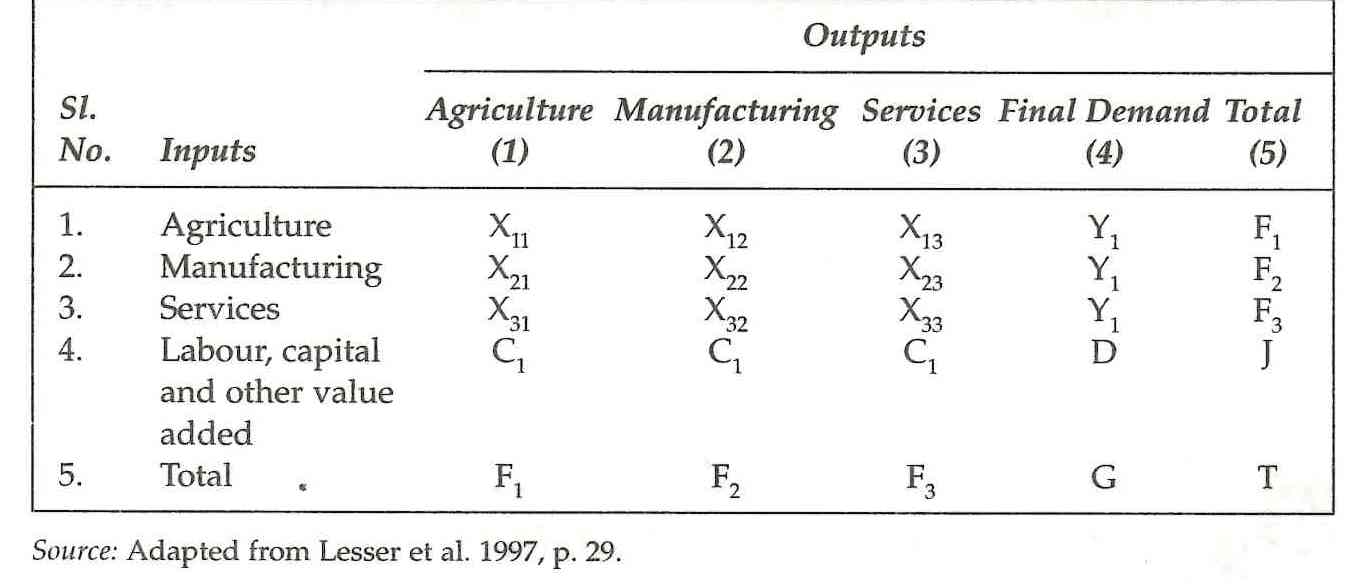
**1.7 Environmental Inputs into the Economy**

Environment provides many inputs for production process and serves as a sink for dumping the wastes produced in the process of production. Many environmental goods and amenities such as air to breathe, water to drink, and wildlife for recreation and hunting are directly consumed. Tracing the flow of environmental inputs into an economy is necessary to determine the ripple effects of different economic and environmental policies and assessing their social desirability.

Input-Output (I/O) table is the most commonly used method of tracing the flow of environmental inputs as also other inputs and outputs into an economic system. A typical I/O table is shown in Table 1.1. It is broken down into different sectors of the economy and shows purchases and sales from one sector to another.

For the sake of simplicity, we assume that there are only three sectors, or industries in the economy, each industry purchases some inputs, valued in rupees, from the other two industries, as well as from itself. The purchases are read down the column as X1i X­2i, X3i, where Xjjj, represents purchases of Industry ‘I’ from Industry ‘j’. Industries also purchase the service of labour and capital to produce goods and services. The total value of the goods and services produced equals the total value of the material inputs, labor, capital, taxes and profit.

**Table 1.1 Input-Output Framework of a Hypothetical Three-Sector Economy**



The goods and services produced by each industry are purchased directly by consumers and are also sold to other industries which use them as inputs to produce their own set of goods and services. In the above hypothetical economy for example, Industry 1 is agriculture, Industry 2 is manufacturing and Industry 3 is services. Reading down column 1 it is seen that Industry 2 and X31 from Industry 3. Besides, it also purchases labour capital and other value added inputs worth C1 , F1, which is the sum of X11 X­21, X33 C1, equals the total value of production of Industry 1.

Sales of Industry 1’s output are read across each row of the matrix. It sells output to itself, to the other two industries, and directly to final consumers.

Thus, the total sales of Industry 1 are X11 to itself, X2 to Industry 2, X13 to Industry 3, and Y1 to the final consumers.

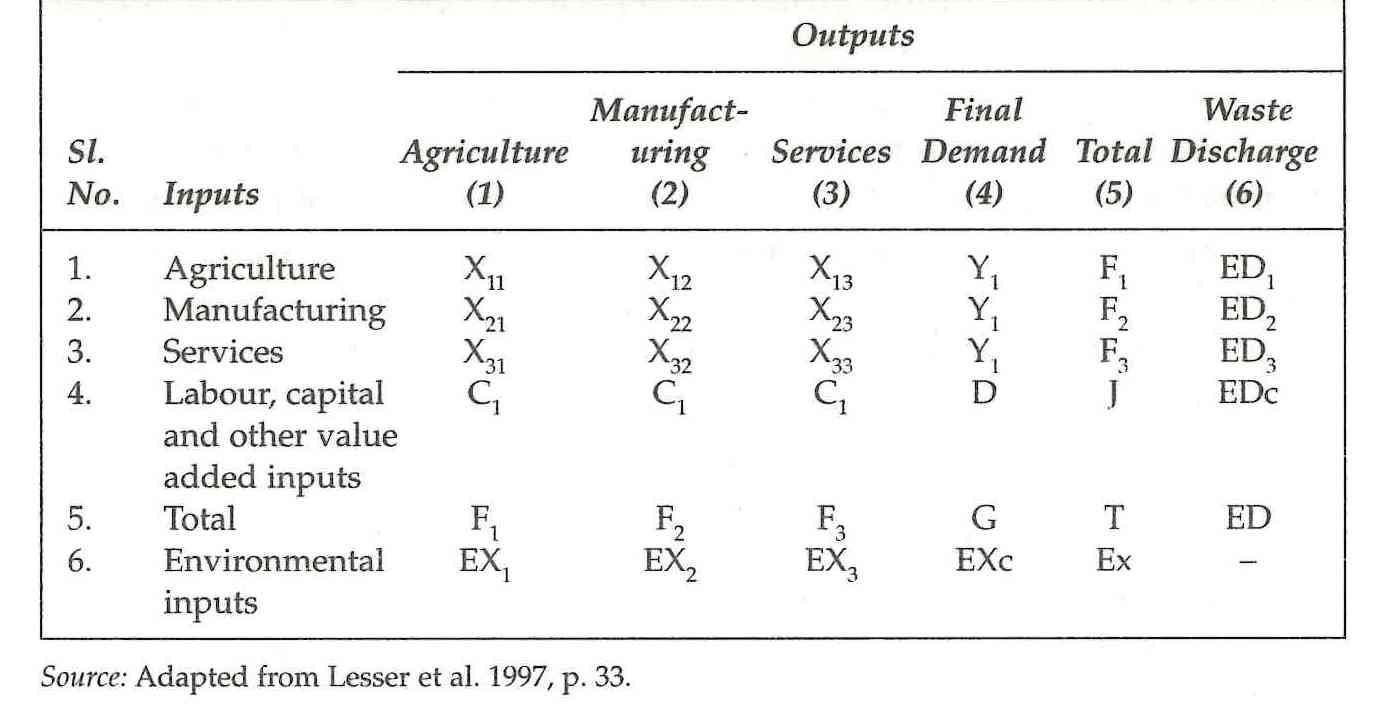
The total value of the output sold is by definition, identical to the total value of production. Thus ƸX11 +Y1 = ƸX11 + C1.

By adding up the values from all three industries, as well as all final demands, the total value of output produced in the entire economy is arrived at, which is in Table 1.2 and it equals T.

The environment and the policies that affect its quality into the input-output framework as the environment is used both as a source of inputs and a sink for waste outputs is fitted. Environmental policies and laws such as the Water (preservation and Control of Pollution) Act 1974, as amended in 1978 and 1988, also have economy-wide-ripple effects.

Using an input- output framework, the economic and Environmental effects of use of Environmental resources and environmental policies in an economy can be traced, and predict their ultimate impact on the demand for all goods and services produced, including environmental ones.

**Table1.2: Input-output Framework of a Three-Sector Economy incorporating Environmental Goods and Services**



To trace the impact of use environmental inputs and disposal of wastes into the environment, standard input-output table as show in Table 1.1 is used, by adding environment to it as a sector, as shown in Table 1.2 in which an additional column waste discharge is added, and an additional row, environmental inputs too is added. Environmental inputs include such natural resources as land, water, air and minerals. Wastes discharged into the environment are outputs/ externalities of all the industries/sectors.

In Table 1.2 EX1 , EX2, EX2 and EX3  represent the quantities of environmental inputs used to produce goods and services by each of the three industries comprising our hypothetical economy. ED1, ED2 and ED3 represent the quantities of waste products discharged into the environment by each of the three industries.

EXcrepresents the environmental inputs used by consumer such as water, land and fresh air. Similarly, the waste discharged by consumers into the environment is denoted by ED, which includes things such as litter, waste water and pollutants from automobiles. EXc represents the total of all environmental inputs, and EDc the total discharge of waste products. The environmental inputs and outputs are expressed in physical terms. Such inputs and outputs could be valued using appropriate techniques. The input-output framework can also be used to determine the environmental impacts of development policies on various groups/ sections of society.

**1.8 Environmentally Sustainable Development**

The concept of sustainable development is related to the notion of sustainability which now has become a buzzword globally. The World Commission on Environment and Development (WCED, 1987) defined sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’.

This definition emphasises the need for the present generation to safeguard the interest of future generations through maintaining the natural resources capital of this Planet Earth. Thus, the challenge before the present generation is to maintain over time the capacity of economic, environmental and social systems to ensure human well-being in perpetuity.

A working definition of sustainable development is as follows:

It involves maximizing the net benefits of economic development, subject to maintaining the quality, functions, and services of natural resources and the environment over time.

Maintaining the functions, services and quality of the stock of natural resources over time implies, as far as is practicable, acceptance of the following rules:

* Utilise renewable resources at rates less than or equal to the natural rate at which they can regenerate; and
* Optimise the efficiency with which non-renewable resources are used, subject to substitutability between resources and technological progress.

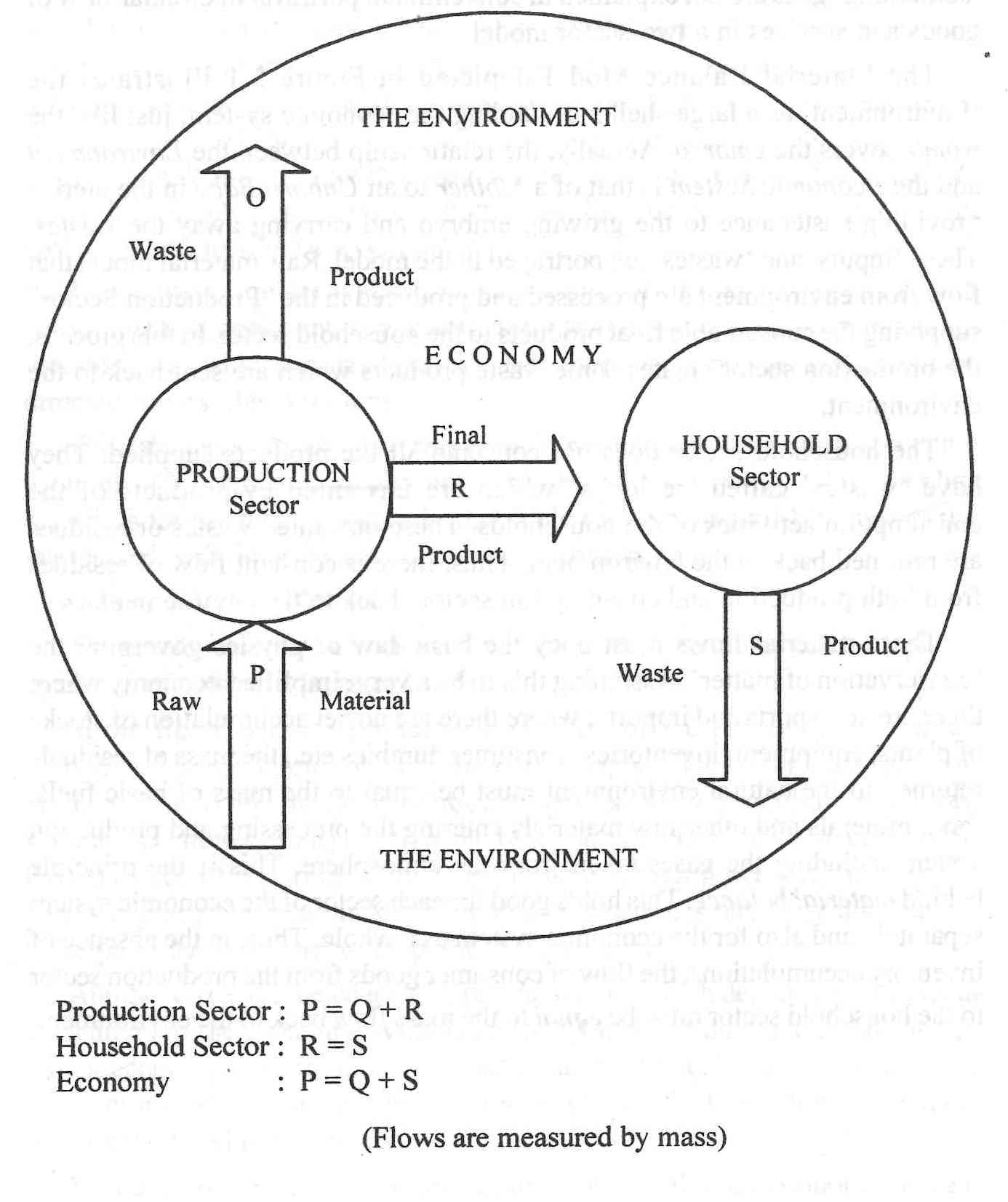
Another operational definition of sustainable development that takes explicit account of economic, ecological and other non-economic standards and targets is given by Bartelmus (1997) as ‘a set of development programmers that meets the targets of human needs satisfaction without violating long-term natural resource capacities and standard of environmental quality and social equity’.

In this definition, the emphasis is on the means, that is, programmes and activities that lead to sustainable development and not on the end result. This definition is considered more practicable and useful to policy makers and practitioners who are concerned with the ‘what to do’ aspect of sustainable development. But it is important in this context to distinguish between the means (programmes) and the end (sustainable development).

**1.9 Environment Interaction – The Material Balance Model**

The relationship between the environment and the economy can be depicted by means of “Material Balance Model”.

**Figure 1.2: Relationship between Environment and Economy- Material Balance**



In the figure 1.2, the production activities of the economic system are represented by the circle called ‘Production Sector’. This circle represent all productive activities in the economic system, such as agriculture, factories, warehouses, mines, transportation and other public utilities that are engaged in the extraction of materials from the environment; their processing, refinement and rearrangement into marketable goods and services and their distribution throughout the economy to the point of ultimate use.

The other circle is labelled as ‘Household Sector’ which depicts the individual consumers in the economy. What is produced in the production sector of this model economy goes to individuals acting as consumers. This is a simplified two-sector model of the economic system to show the relationship between the environment and the economy.

The conventional portrayal of the economic system showing circular flow of money and deposit flow of goods and services between production sector and consumption sector is dispensed. In the conventional analysis, the household sector provides factor inputs for money income; and the production sector provides goods and services in return for money payments, making the circular flow completing two opposite directions.

This conventional circular flow of money and goods fails to explain the material flows and the basic laws of physics governing them and assumes that goods and services are produced out of something. From where that something comes and where to that something goes are not explained in conventional portrayal of circular flow of goods and services in a two- sector model.

The material balance model depicted in figure 1.2 illustrates the environment as the large shell surrounding the economic system, just like the womb covers the embryo. Actually, the relationship between the environment and the economic system is that of mother to an unborn baby in the uterus; providing sustenance to the growing embryo and carrying away the wastes. These inputs and wastes are portrayed in the model. Raw material inputs that flow from environment and processed and produced in the production sector supplying the consumable final product to the household sector. In this process, the production sector creates some waste products which are sent back to the environment.

The household sector does not consume all the products supplied. They have waste called residues which are unwanted by-products of the consumption activities of the households. These unwanted wastes or residues are returned back to the environment. Thus, there is constant flow of residues from both production and consumption sectors back to the environment.

These material flows must obey the basic law physics governing the conservation of matter. Assuming this to be a very simplified economy where there are no exports and imports; Where there are no net accumulation of stocks of plants, equipment, inventories, consumer durables etc., the mass of residuals returned to the natural environment must be equal to the mass of basic fuels, food, minerals and other raw materials entering the processing and production system including the gas is taken from the atmosphere. This is the principle behind material balance. This holds good for each sector of the economic system separately and also for the economic system as a whole. Thus, in the absence of inventory accumulations, the flow of consumer goods from the production sector to the household sector must be equal to the massive flow back to the environment.

**1.10 Entropy Law**

The Law of Thermodynamics forms an integral part of the discussion on environmental economics.

The first law states that whenever energy is converted in form, its total quantity remains unchanged. In other words, energy (or matter) can be neither created nor destroyed.

A common example of coal-fired electricity generating plant, the coal is heated which produces electricity. A by-product of this process is waste heat that is transported away as cooling water or gases. In addition, various waste gases are emitted into the atmosphere, which cause pollution, such as acid rain.

The second law of thermodynamics is also known as the Entropy Law, There are a great many ways of stating the law. In a closed system, the use of matter – energy causes a one-way flow from low entropy resources to high entropy resources: from order to disorder.

As energy resource, for example, is used, the amount of work that energy can do is diminished.

The entropy law can also be stated as ‘no process is possible where the sole result is the transfer of energy from a cooler to a hotter body’ (Kalil, 1990) the alternative suggests what happens to energy when it is used, consider a piece of coal, when the coal is burnt, the energy in it is released. It is known from the first law that energy cannot be destroyed. Some of the energy in a heat-exchanger can be captured, for this is where the energy ‘goes’: it dissipates as heat. This is due to the tendency towards equilibrium in thermodynamic systems. And thus a tendency for temperature differences, in our example, to be equalized.

The major implication of the second law is that energy cannot be recycled in such a way that we get back all the capacity of the original energy source to do useful work, since the act of using the original low-entropy resource will result in some of its energy being lost as heat. If the earth is a closed system, with a limited stock of low entropy energy resources (fossil fuels), then that system is unsustainable, since economic activity inevitably degrades the energy resource so that, eventually, no capacity for useful work could remain.

The entropy law has an important implication for the recycling of matter, since production and consumption of matter can lead to its dissipation, and scarce matter or energy must be used up to recycle it.

Biological and ecological systems are also constrained by the entropy law, particularly in terms of the proportion of energy which is passed between trophic layers. The earth is not, however, a closed system; we obtain energy directly from the sun, which we have a limited capacity to utilise. Thus, whilst the entropy law is very useful in understanding the limits of matter and energy recycling, it is not necessarily the ultimate thing. Some economists (Kalil, 1990) have disputed its applicability to the economic system whilst others have pointed to the possibility of technological progress off-setting the entropy process for material resources. Finally, it is noted that it seems more likely that the first law of thermodynamics, with its implications of increased residuals output, will be more likely to set a limit to growth (given the earth’s limited capacity to assimilate these residuals) before the entropy constraint becomes binding and the world runs out of useful energy.

The above discussion systematically puts forth the meaning, nature, scope and importance of environmental economics. The global and national evolution of the discipline is also explained. Environment and development are complimentary to each other but one must remember that development must be sustainable enough to meet the resource/environmental needs of the future generations too. The material balance model clearly explains the relationship between environment and the economy. The transformation of material and energy in an irreversible transformation of materials into wastes is explained through the entropy law.

**MODULE-2**

**THEORY OF EXTERNALITY, PUBLIC GOODS AND TECHNIQUES OF EVALUATION**

**2.1 Concepts of Pollution and Externalities**

Environmental economics mainly builds its theoretical foundation on welfare economics. The use of environmental functions for the production and consumption of economic goods imposes a significant cost on the society. Environmental economics analyses rules for the efficient use of the environment.

The four economic functions of the environment are inter-related and efficient use

1. The environment supplies us with resources both renewable resources and non-renewable resources.
2. The environment assimilates wastes.
3. The environment provides life support services such as the maintenance of genetic diversity and stabilisation of the ecosystem.
4. The environment provides us with various environmental services like providing space for recreation and scenery and wildlife for aesthetic enjoyment.

These four economic functions of the environment are inter-related and efficient use of the first two functions is a fundamental requirement for the environment to perform its third function, misuse of the past two functions results in environmental crisis.

Environmental functions have both a qualitative and quantitative dimension. The adverse effects of our actions on the quality of environment are explained by economics of pollution. The effects of our actions and the quantity of environmental resources available for future use are explained by economics of resource use or resources economics. The theoretical issues relating to pollution are as follows;

1. Pollution as an externality
2. Second best theorem.
3. Environmental Quality as a public good.

Economists consider pollution to be an externality. Externalities result when firms and households do not appropriate the full costs or benefits of their productive or consumptive activities.

Externality may be defined as the cost or Benefit imposed by the consumption and production activities of the individuals and the rest of the society towards which no payment is made the definition makes it clear that externalities are arise from both production and consumption activities and that their impact could be beneficial (positive) or adverse (negative).

The concept of externality can be traced back to Alfred Marshall’s ideas on external economies. Marshall introduced the concept of external economies, which by no exaggeration contains the key to the economic analysis of production.

Marshall defined external economies to include only the benefits enjoyed by producers without the additional costs caused by factors outside the market. In 1920, A. C. Pigou pointed out that externalities involved both benefits and costs. He explained negative externalities through his classic illustration of woodlands damaged by sparks from railway engines –thus leading the discussions that considered pollution as an externality. In 1950, K. W. Kapp presented the first substantial discussion of externalities and social costs in his book “The social cost of Private Enterprise” in which he analyses all external costs arising from production processes in the form of air and water pollution.

While many economists consider externality as market failure, there are few economists like William J Baumol and Wallace E Oates who support the views of Buchanan and Stubblebine that considers externalities simply as forces violating the conditions of optimum allocations of resources.

**2.2 Types of Externalities**

Externalities can be classified as;

1. Positive or beneficial consumption externality (e.g. Vaccinatior against an infectious disease)
2. Positive or beneficial production externality (e.g. Pollination of blossom in an orchard arising from proximity to beehives)
3. Negative or adverse consumption externalities (e.g. Noise pollution from a loud music system)
4. Negative or adverse production externalities (e.g. Effluents and emissions from factories)

Externalities have also been classified as pecuniary externalities and real or technological externalities. Technological externalities alter the production function (utility function) of a third party not involved in the production (consumption) process that generates the externality.

Pollution of air and water are examples of real or technological externalities, pecuniary externalities, on the other hand, are reflected in market prices. They arise due to changes in the price of some input or output in the economy. Pecuniary externalities do not cause distortions in the efficient allocation of resources while real or technological economics require efficiency conditions to be redefined.

Pollution is a negative externality. Most environmental problems come under the category of negative externalities. They represent the costs of production and consumption decisions which are not borne by the agents involved in the transactions.

The discharge of effluents made of organic and inorganic material into a river by a firm will lower the quality of water. The DO-Dissolved content of water in the river will be lowered, thus making the water unfit for drinking purposes. Besides, the reduced oxygen content will even bring down the number of fish in the river, affecting the income of the fishing industry. The factory discharging the untreated effluent into the river does not compensate the people affected by the deterioration in the quality of water. They are hence external cost to the firm that causes the pollution.

The firm will price its products on the basis of the cost it bears in making them; wages, rent, material inputs and so on. These private costs will not include the cost of releasing the effluent, since this is not paid by the firm. Pollution is thus an externality cost falling on the third parties.

The firm actually has an economic incentive to pollute. It is cheaper to pollute the river than it is to treat the effluent before discharging it into the river. So long as the firm is not legally prevented from doing so, a rational firm will pollute and not treat its effluent/emissions.

**Methods of abatement of externalities**

Assessing and mitigating negative impacts of development projects is important, project level actions are not sufficient to reduce all environmental problems. The underlying causes of many environmental problems are not directly related to the specific projects, but rather stem from policy and market failures. In these cases government action is required to correct these failures through interventions, which may include changes in property rights and other institutions governing resource use, policy instruments such as tax/subsidies, market incentives and regulatory measures and direct public investments.

However, there are two alternative approaches to abatement of externalities, namely

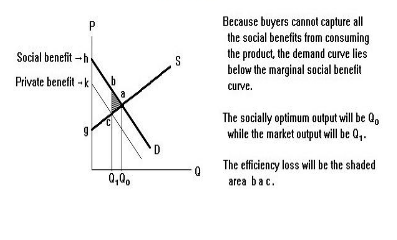
1. Pigouvian Tax-Subsidy Approach;

2. Coasean Property Rights Approach.

**2.3 Divergence between Social Cost and Private Cost**

Externalities can also take the form of a divergence between the private and social benefits from consuming a good. The classic example is police protection. Suppose that there is no government operated police force and a person therefore hires a private police force to protect her property and, in the course of doing their work, those police arrest and jail some criminals. Since these criminals are no longer able to commit crimes, the property of others who did not hire the police force also receives protection. One therefore obtains benefits from hiring police protection that are less than the true social benefits. An externality on the demand side is illustrated in the figure 2.1 below.

**Figure 2.1:Divergence between Social Cost and Private Cost**



The social marginal cost and benefit curves drawn as thick lines and the private marginal benefit is given by the thin line. The private and social cost curves are identical, but the private demand curve is below the social demand curve by the amount of the external benefit. Private demanders will thus purchase the quantity Q1 when the socially efficient quantity is Q0. A portion of the potential rents to consumers and producers from having the product, given by the area b a c, is lost.

**2.4 Market Failure**

It is assumed that well-functioning or perfectly competitive markets will normally provide efficient mechanisms for allocating resources among users and overtime in such a way that society attends the maximum possible social welfare. The market functions efficiently when the following fundamental conditions are fulfilled

* Property rights are clear and secure.
* All scare resources must enter active markets that price them accordingly to supply and demand.
* There are no significant externalities.
* Competition prevails.
* Public goods are minor exceptions.
* Issues of myopia, uncertainty and irreversibility do not arise.

As these conditions are not met in case of most environmental goods and services, free market fails to allocate environmental resources and goods efficiently among users and over time it wastes too many resources today and leaves too little for tomorrow.

For instance, for historical and socio cultural reasons, property rights over irrigation systems and water resources in India are ill defined and insecure.

The state [government] makes a deliberate policy decision to provide farmers with irrigation water at a nominal price/fee. In this case, it is not only water, scarce natural resource of positive opportunity cost which is left unpriced (or zero priced), it is also scarce capital invested in the irrigation systems that is left unpriced. The consequences are many and far reaching.

* Water is inefficiently and wastefully used without any attempt to conserve it in even when scarcities obvious to the user.
* The state is unable to recover the capital and operation and maintenance costs with the result that watersheds remain unprotected and the irrigation systems are poorly maintained.
* Serious environmental problems such as sedimentation, soil salinization and water logging result from watershed degradation and from over irrigation, while other potentially irrigable areas receive inadequate water to grow dry season crops.
* Better-off farmers near the irrigation canals or water sources are indirectly subsidised by worse off farmers who pay taxes but have little access to irrigation water.

**2.5 Pigouvian Solution**

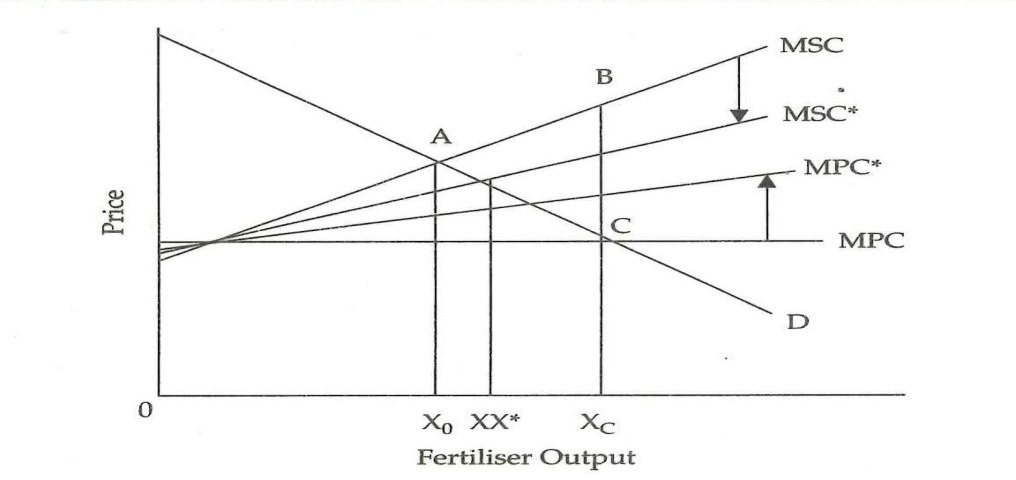
The traditional economic approach to modifying externalities can be ascribed to A.C. Pigou (1962), who has argued that taxes and subsidies could be used to encourage economic agents to internalize externalities. In the case of the negative externalities, Pigou’s solution is that the producer must compensate parties who are affected by negative externalities or be taxed to the extent that the marginal private cost, including the tax, is equal to marginal social cost including the negative externality.

The tax should be fixed at exactly the level of marginal external cost. This either induces the one who imposes the externality to: (a) eliminate or reduce the externality to acceptable limits (depending on how and to what extent the tax is imposed); or (b) compensate the parties adversely affected through the tax proceeds.

Conversely, a payment, such as a subsidy, could be made to compensate producers who cause beneficial externalities. The subsidy should be precisely equal to the marginal external benefit so as to reduce the cost of production sufficiently to increase the output to a socially efficient level.

The tax-subsidy solution is commonly used in both developing and developed countries of the world. The tax solution of a negative externality (air pollution) is shown in Figure 2.2.

**Figure 2.2: Effect of a Negative Externality on Private Production**



Suppose a chemical fertilizer (for example, urea) producing factory is polluting the air in nearby areas. There are no restrictions on the use of the atmosphere as a sink for discharging the pollutants and on the production of fertilizer.

The only way to reduce the pollution is by curtailing the fertilizer production. In Figure 2.2, demand for fertilizer is given by the curve D. The marginal private cost and the marginal social cost of fertilizer production are given by the curves MPC and MSC, respectively. Without any restrictions on production, the most profitable level of output of fertilizer is Xc. But if the fertilizer producing firm is forced to internalize the externality, that is, the external cost of using the atmosphere as a sink by imposing a tax equal to the amount of external cost, the MPC would shift upward and become MSC. In that case, the most profitable level of fertilizer production will be Xo which is less than Xc.

This means that society will be better off producing less fertilizer than what a private firm will produce. The gain to society is shown by the shaded triangle ABC, which is the amount by which the social cost of producing the excess quantity of fertilizer area (Xc-Xo) exceeds the willingness to pay for that quantity of fertilizer.

The question now will be is curtailing of fertilizer production the socially optimum way of reducing pollution? The answer is: perhaps not. Air pollution could be reduced by outfitting the fertilizer plant with special precipitators.

In that case, the firm will have to incur additional cost to install the precipitators and consequently the MPC will increase and will become MPC\*, which is less than MSC.

However, the new marginal social cost for production of fertilizer, MSC\*, will be less than MSC. Now, the socially optimum level of fertilizer production will be X\*, which is more than Xo.

Thus, society will be better-off if the fertilizer firm reduces the level of air pollution by installing the precipitators than by cutting back the production. To motivate the firm to reduce the pollution, some subsidy equal to, or less than the reduction in marginal social cost, or increase in the marginal private cost may be given to the firm. This then would be a case of *Pareto improvement.*

**2.6 Buchanan’s Theory**

Buchanan (1968) asks a simple question previously unconsidered by economists. That is: “Why do individuals pollute? Why do they produce “public bads”? By what interaction process do publicly-acknowledged “bads” become “goods” in individuals’ utility functions?” Prior to Buchanan, it seems as if no positive explanation for the existence of pollution had been presented.

His theory consists of an explanation for pollution which allows for the questions to be answered. The analysis is developed geometrically and fitted in the modern-public goods theory. The explanatory relevance extends to several real-world policy issues such as air and water pollution, urban light, motor traffic. The theory id explained in two parts; where in the first, the analysis is based on a modified world of equals’ model. In the second part, individuals are divided into two groups, differing in income endowments but remaining identical in preferences.

**2.7 Coase’s Theorem and its Critique**

The Nobel laureate economist, Ronald Coase has shown that with the assumption of zero transaction costs, and assumption of standard economic theory, there is no need for governmental intervention in the market process in the form of pollution taxes for controlling environmental degradation optimally. The negotiations between the polluters and the victims in a free market can lead to the optimal level of pollution control, irrespective of the initial assignment of property rights for the use of an environmental resource.

The Coase theorem can be analyzed in two steps; first it is assumed that property rights can be defined; then we ask how the attribution of property rights will affect environmental allocation is asked. Later the problem of whether property rights can be defined is looked into.

Property rights approach proposed by R.H.Coase (1962) to environmental allocation has become very popular and it is known as Coase theorem.

Accordingly, let exclusive property titles to the environment be defined and let them be transferable. Let there be no transaction costs and individuals maximize their utilities and let them be non altruistic.

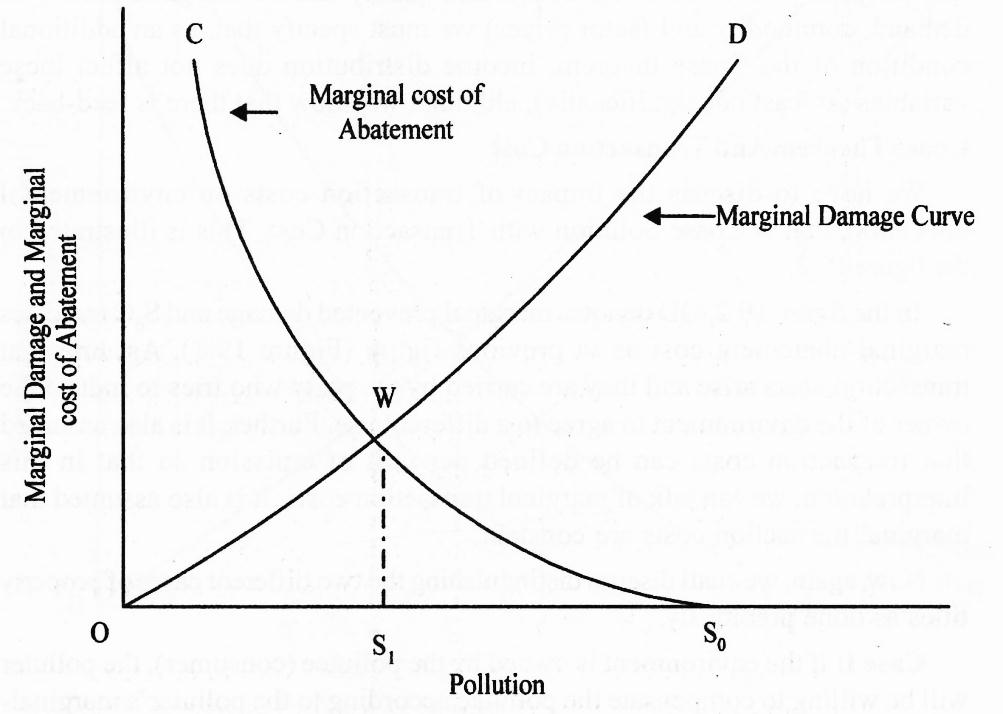
In such a situation, the bargaining solution among different users of the environment will result upper in a Pareto-allocation of the environment. The resulting allocation is independent of the initial distribution of property rights.

The Coase theorem can be analyzed in the background of two cases; which are

Case 1: For sake of simplicity, assume two individuals; wonder polluter another pollutee. Assume the exclusive property right to the environment is given to the pollutee that is consumer. In figure 2.3, the damage per unit of pollutants for polluting is indicated by curve OD. The pollutee will tolerate a certain degree of emissions if he is adequately compensated. But the sufferer will agree to the impairment of the environment, as long as their compensation per additional admission unit lies above the marginal damage curve. The bargaining position of the sufferer thus moves along the marginal damage curve OD. On the other hand, the polluter is willing to offer compensation for the use of environment, as long as the compensation per unit of pollution, is lower than his marginal abatement costs.

Thus, the position of the polluter is determined by the curve SoC Of the marginal abatement cost. The result of this bargaining process is found at point W.

**Figure 2.3 Coase Solution without Transaction Cost**



Optimal Environmental Quality will be OSI and the required abated emission will be SoS1 .The polluter will pay compensation per unit of emission to the owner of the environment.

Case 2: In this case, we assume that the polluter owns exclusive property right to use the environment. Here the pollute (consumer) has to pay compensation so that the polluter will avoid emissions.

The willingness to pay of the pollute (sufferer) is determined according to his marginal prevented damage; that is his position is determined by the curve OD.

The polluter will be willing to abate pollutants only if he receives compensation greater than his marginal cost of abatement SoC. The solution is found again at point W. The same environmental quality results, as determined in case 1 where the pollutee was enjoying the property right.

Thus, in Coase theorem, the optimal environmental allocation is independent of the initial distribution of property titles.

Coase theorem with transaction cost, indicates three different solutions to environmental allocation, namely, the optimization approach (Pareto-Optimum), the cost benefit approach and bargaining solution.

All three approaches require could the equality of marginal benefits (that is, marginal prevented damages) and marginal cost of abatement.

Though the environmental allocation is independent of property rights, the distribution of income is not. Since income distribution may have a feedback on the marginal evaluation of environmental quality and on marginal costs (via demand, commodity and factor prices) must be specified that, as an additional condition of the Coase theorem, income distribution does not affect these variables (at least not significantly) although it is known that there is afeedback.

**2.8 Pigouvian versus Coasian Solution**

Externality is caused by the inconsistency between marginal private cost and marginal social cost. Without externality, themarginal private cost of production or consumption of an item is equal to the cost of itself. When there are negative externalities, therewill cost to compensate these externalities.

By adding marginal private cost with the marginal external cost we will get the marginal social cost. On the other hand, when there are positive externalities, the benefits generated by business activities are not fully occupied by the company, but will also become some external social benefits. Through economic model, Pigou shows that because of the presence of external economic effects, the Pareto optimal allocation of social resource cannot be achieved by purely individualistic mechanism.

Since there is a deviation among the marginal private benefit and marginal social benefit, marginal private cost and marginal social cost; therefore the maximization of social welfare cannot be achieved only through free competition. The Government should take appropriate economic policies to reduce this deviation as much as possible.

The proper policy is that: when the marginal private cost is less than marginal social cost (negative externality), government should impose taxes; when the marginal private benefit is less than marginal social benefits (positive externality) then the government should provide incentives and subsidies.

Pigou believes that by using such taxes and subsidies, the externality problem could be internalized. And such policy is known as Pigovian solution, and the tax is called Pigouvian tax. Pigovian solution has been widely used. In the field of infrastructure, the policy is who invest and who benefits; in the environmental protection, the policy is who pollutes and who pays (Polluter Pays Principle).

Over the years, the problem of how to internalize external effects is dominated by Pigouvian theory. To some extent, Coase theory is developed through the criticizing of Pigouvian theory.

Coase’s critique of the Pigovian solution focuses on the following three aspects.

First, the externality is very complex; it is not as simple as “one side damages the other side”. For example, in the case of chemical factory verses residents, it is unfair to tax the factory without discussing whether the factory has the right to emission or not. Because, it may be the case that the factory is established years before any resident area was setup, and in this case, the factory may have the emission rights. In order to reduce the emission, perhaps the government should encourage residents purchase the redemption instead of just posing tax on the factory.

Second, in the case of zero transaction costs, the Pigouvian tax is absolutely unnecessary. Because in this case, through voluntary negotiation of parties, the optimal allocation of resources can be reached. In this case, with the help of clearly defined property rights, voluntary negotiation can also achieve the optimal level of allocation just as the same effect through the Pigovian solution.

Third, even in the case of non-zero transaction costs scenario, one still needs to balance the cost of using government and using voluntary negotiation. Pigouvian solution may be an effective institutional arrangement, it also maybe an inefficient institutional arrangement.

According to Coase theorem, If the transaction cost is zero, no matter how the initial definition of property rights is, optimal allocation of resources can be achieved through market; if there is non-zero transaction costs situation, then maybe the institutional arrangements and choice is important, however people still need to do a cost-benefit-analysis about the government intervention. In order to solve the problem of externality, Coasean’s market solution could just be as useful as Pigovian solution. Coasean solution shows that even there is a market failure it doesn’t automatically means we should use government intervention.

**2.9 Detrimental Externality and Non-Convexities in the Production Set**

The detrimental externalities tend to induce non-convexity of the social production possibility set. If externalities are sufficiently strong, convexity conditions must break down. In this case the society may choose among a set of optimums, instead of a unique optimum. Any detrimental externalities however minor can produce a non-convexity.

Moreover, even in theory, prices and taxes cannot help with this matter. Prices and taxes (which, in general, influence) can affect the decisions of individuals and firms and thereby determine the location of the economy in relation to its production-possibility set. However, prices or taxes cannot change the shape of the possibility set it to transform it from a non-convex into a convex region, for that is essentially a technological matter. Moreover, in the presence of non-convexities, these prices may also give the wrong signals – directing the economy away from the social optimum.

**2.10 Property Rights – Collective Action**

The degradation of environmental quality arises due to resources being public goods. The tragedy of Commons expresses that resources are totally depleted or degraded due to over use of or misuse by all the people without any control or norms to preserve the quality of the resources. Allocation of property rights method of controlling pollution is just the opposite of rating resources as public goods.

The resources are allocated to individuals or organizations as private property with the legal entitlement to make use of them, then the tragedy of commons can be averted and the resource use will become rational and also minimal. Thereby the externality arising out of commonality can be reduced to the minimum in short; this method advocates property rights over nature’s resources to prevent this spoliation of nature.

To cite an example as stated by Burton that the Sahel region of North Africa, which is now a desert, was once a fertile region, serving as a granary of the Roman Empire until the 6th century, when Arabs conquered that region, changed the property rights into a common property system for using the pastures. As a result of converting the private property into public property, with access to everyone, the tragedy of Commons manifested fully. The lands degraded quickly and nobody cared for the conservation and preservation of the quality of the resource and finally it became a desert.

In controlling pollution, it is suggested, if the public good environmental quality can be transformed into a private good, optimal environmental allocations can be reached. But for this, governmental intervention is necessary in assigning environmental property rights. But the problem arises in defining the property right to resources in order to make an approach in that direction.

**Property Rights Approach**

According to Furobotn and Pejovich (1972) a property right can be defined as a set of rules specifying the use of scarce resources and goods. The set of rules includes obligations and rights; the rules may be codified by law, or they may be institutionalized by other mechanisms such as social norms together with the pattern of sanctions.

Property rights may be defined over a wide range of specific resources users. Dales (1968) Distinguishes four types of property rights.

1. *Exclusive property* right which means right of disposal and destroy the resource, notably the right of sale. But even this extensive form of ownership is controlled by a set of rules which protect other individual individuals or maintain economic values. For example, if there is a mineral well in the property owned by an individual, he may not be permitted to build a factory on that. City zonings and criminal law are examples of restrictions on exclusive property rights.
2. *Status or functional ownership* refers to a set of rights accorded to some individuals but not to others. In this case, the right to use an object or to receive a service is very often not transferable. Examples of this type of right include licences to drive a taxi are notarised documents, and, during the middle ages, the right of admission into a Guild.
3. Thirdly, the *right to use a public utility* (merit good such as highway) or a public good [National Park] related to a specific purpose.
4. Fourthly, *common property resources* represent de facto a non-property because nearly no exclusion is defined. It is suggested in this context to have a closer look at some common properties. For instance, the village forest in the Swiss Alps may, at first glance, be interpreted as being a common property. A closer analysis shows that there is a set of rules regulating its use. This, the forest measure as a protection against avalanches and withdrawal of food is restricted.

**Implications of Property Rights Approach**

The main implication of property right approach to environmental problem is that the market cannot fulfill the allocation function of resources, in the absence of well defined property rights of environmental resources.

The result of treating the resources as a common property would lead to degradation and destruction due to over use. For example, the result of over use and abuse of resources commonly held.

The property right approach requires that the property rights (or constraints) for using environment should be more clearly defined, so as to change the character of common property.

The environment should no longer be used as a free good for receiving wastes; rather a scarcity prize should be charged. One method of introducing a price and redefining property rights is to introduce an emission tax. Another method would be auction pollution licenses or permits or certificates. Finally the government could specify maximum emission per firm which could implicitly set a price on pollutants. In all these cases, the environment, as a receptacle of wastes, could be transformed into a private resource with a positive price by defining a new set of rules.

Another implication of property rights approach is whether it will be possible to define property rights in such a way that environmental quality as a public good be transformed into a private good.

**Olson's Theory of Collective Action**

Mancur Olson Jr. (1971) has challenged a generally held view that groups of individuals having common interests usually work together to achieve them. He argues that: unless the number of individuals in a group is quite small or unless there is coercion or some other special device to make individuals act in their common interest, rational, self interested individuals will not act to achieve their common or group interests.

Olson considers this situation analogous to one that obtains in a perfectly competitive market situation where profit maximising firms act contrary to their interests as a group by expanding their output are till the market price falls and equals their marginal cost and industries excess profit is eliminated.

This happens despite the fact that every firm tries to maximise its profit and has a common interest in a higher price for the industry’s product. The logic underlying this phenomenon also explains the behaviour of people towards environmental goods and services, particularly CPRs. In the absence of well defined private property rights beyond and with no ban on the entry of new firms/users, a CPR is overexploited in the sense that each firm (CPR user) in the industry earns no more than the going rate of return on its investment, and all forms (CPR users) are worse off. This does not, however, mean that each co-user of a CPR is acting against its self-interest. In fact, each of the co-users behaves rationally because if it were to restrict his own output/use Of the CPR, anticipating a fall in market prices resulting from the increase in industry output, it would lose more than ever, for his prize would fall quiet as much in any case and he would, in addition, have a smaller output.

Olson does not specify the number of individuals that would make up the very small group, but he asserts that the group should be small enough so that the individual actions of any one or more members are noticeable to any other individuals in the group. An important implication of Olson’s theory for managing CPRs is that if a group using a CPR is very large and heterogeneous, it should be divided into a number of small and homogeneous subgroups, and each sub group randomly assigned a portion of the CPR that should be, as far as possible, proportionate to the size of the group. If there are marked variations in the quality of the CPR, the assignments may be rotated every year. This is, however, possible only if the CPR is divisible and if some arrangement exists for dividing and apportioning the CPR among the subgroups.

According to Olson, despite the free rider problem, voluntary groups can provide collective goods in a wide variety of areas, including education, labour unions and natural resources. Group action can also emerge in such less desirable forms as collusion and oligopolies in which firms or agents collaborate to restrict quantity and maintain high prices.

**2.11 Environmental Costs of the Economy**

The evaluation of the costs of economic growth in terms of environmental deterioration, first and foremost necessities the definition of both the terms in quantitative terms.

While economic growth implies increasing output of goods and services generated by economic activity, environmental deterioration refers to degrading changes in the ecosystems which are habitat of all life on the planet.

It is generally held by many economists that sustained economic growth increases human welfare. Basing their arguments on historical and international comparisons many economists consider economic growth as the necessary means to the end of greater human welfare.

Keynes, for example, saw economic growth as a pre-requisite for the good life. But measurement of economic growth in terms of output of goods and services is considered deficient as it does not take into account the external costs of environmental pollution.

Edward F Denison, in an article titled ‘Welfare Measurement and the GNP’ considers air and water pollution, volume of solid wastes generated etc. as the real cost of economic growth and suggested that the value of deterioration to environment by these real costs should be deducted from NNP to obtain better measure of output. But this poses the problem of measurement of value of the deterioration of environment.

William D. Nordhaus and James Tobin have evolved the concept of MEW (Measure of Economic Welfare) that allowed for the discrepancies between GNP and economic welfare. They reclassified GNP Consumption, investment and intermediate.

Besides allowing imputation for the services of consumer capital, for leisure and for the product of household work, correction for disabilities of urbanization was made. However, the Nordhaus and Tobin study does not settle the basic problem of properly accounting for pollution cost in the measure of net output or economic growth. Their inclusion of disamenity costs of urbanization includes only a portion of total welfare costs of environmental pollution. But all this is not to undermine the tone or emphasis of those economists who believe that economic growth is a perquisite for improving the lot of humanity.

Though a few growing economies today challenge unlimited growth, their continued growth of output and pollution will eventually lead to a environmental crisis. Since the amount of habitable space on earth and total stock of renewable and non renewable resources is limited, the assimilative and absorptive capacities of the earth’s air, water and land resources are affected. ‘Effluents reduce affluence’ is their claim.

Three major factors are set to influence environmental impact.

1. Population,

2. Per capita availability of good, and

3. Pollution per unit of economic good- i.e., Nature of technology.

Hence environmental impact I may be given as follows

*I = Population* x *Economic Good / Population* x *Pollutant / Economic Good*

This relationship enables us to estimate the contributions of three factors to the total environmental impact column the size of population, production (or consumption) per capita, and the amount of pollutant generated per unit of production (or consumption).

The last of these reflects the nature of technology. Environmental impact thus represents the environmental cost of a given economic process. It gives the amount of an agent external to the ecosystem which by intruding upon it, tends to degrade its capacity for self-adjustment. The degradation is caused by the introduction of substances, which are foreign to natural environment, into the natural environmental by the production and consumption activities of the human beings; the ever increasing population is using the earth as if its resources are limitless, in its pursuit for economic growth.

Therefore, the theory of externality, public good and techniques of evaluation as seen have their deep rooted theoretical bindings in welfare economics. The concepts are very significant for linking economic theory with environmental issues and concepts.

**MODULE-3**

**ENVIRONMENT AND POLLUTION**

The present module explains the interconnection and impact of pollution on environment. The different types of pollution like air pollution, water pollution, chemical pollution, their causes, consequences are discussed. The impact of population growth on environment is explained in the context of increasing population and urbanization. Land degradation as an environment problem is also explained.

**3.1 Environment and Pollution**

Environmental pollution problems are not a new phenomenon. Many developed countries have a long history in relation to their attempts to control pollution. However, in recent years, the problem has taken a serious dimension to create awareness in all governments.

Many countries are seriously devoting their efforts to reduce the impact of pollution. Through comprehensive data are not available in different sectors of the economy, the rapid increase in the quantity of solid waste, pollution of the air, impurities in water etc., are physically visible. Whatever be the pollution levels, we are justified in treating pollution as a problem because, it is clear even from casual observation, that the current level of emission is higher (perhaps much higher) than it would be, if the polluters had to bear all the costs of their activities. It is this that lies at the heart of the economic analysis of pollution.

Pollution is an economic problem, partly because, it reduces the value of some of the resources that society has at its disposal, the fact that pollution reduces the value of our resources are not, however, sufficient for it to constitute an economic problem. After all, for many types of pollutants, we have the technology to eliminate the major emissions.

Pollution is an economic problem, because it requires us to make choices, to resolve conflicts of interests; it is an economic problem because, the means by which pollution can be reduced are themselves resource-using. It is for this reason; much of the analysis relating to pollution is concerned with a comparison of costs associated with the ‘effects of pollutants and the costs associated with the various method of abating (preventing) pollution.

It is absurd to say that pollution is just an economic problem. It is a problem for society that transcends the artificial boundaries of academic disciplines. It poses problems for all of the natural sciences, largely concerning the identification and measurement of physical impact of pollutants on the environment and the living beings in it.

Pollution control challenges the engineer who is concerned with the design of abatement technology and also lawyer who sees law as a social instrument by which some form of restriction can be imposed; the doctor and bio chemist who are bewildered by the prevalence of vast array of strange and new diseases unknown to the medical world. Therefore, one can never come out with a solution for the trade-off between economic growth and environmental damage caused by pollution as a by-product of growth.

**3.2 Impact of population Growth on Environment with reference to Output, Growth and Urbanization**

Enormous increase in population results in;

1. Increased consumption of resources available in the environment and depletion of the same very quickly.
2. Due to over consumption of natural resources, the environment gets fully polluted.
3. There will be desertification, deforestation, soil erosion, loss of fertility and poor productivity.
4. Mass poverty, poor per capita availability of food for consumption and prevalence of diseases on a large scale.
5. Rapid urbanization resulting in growth of slums in cities and towns.
6. Inefficient management and ineffective control at all levels leading to poor quality of life.

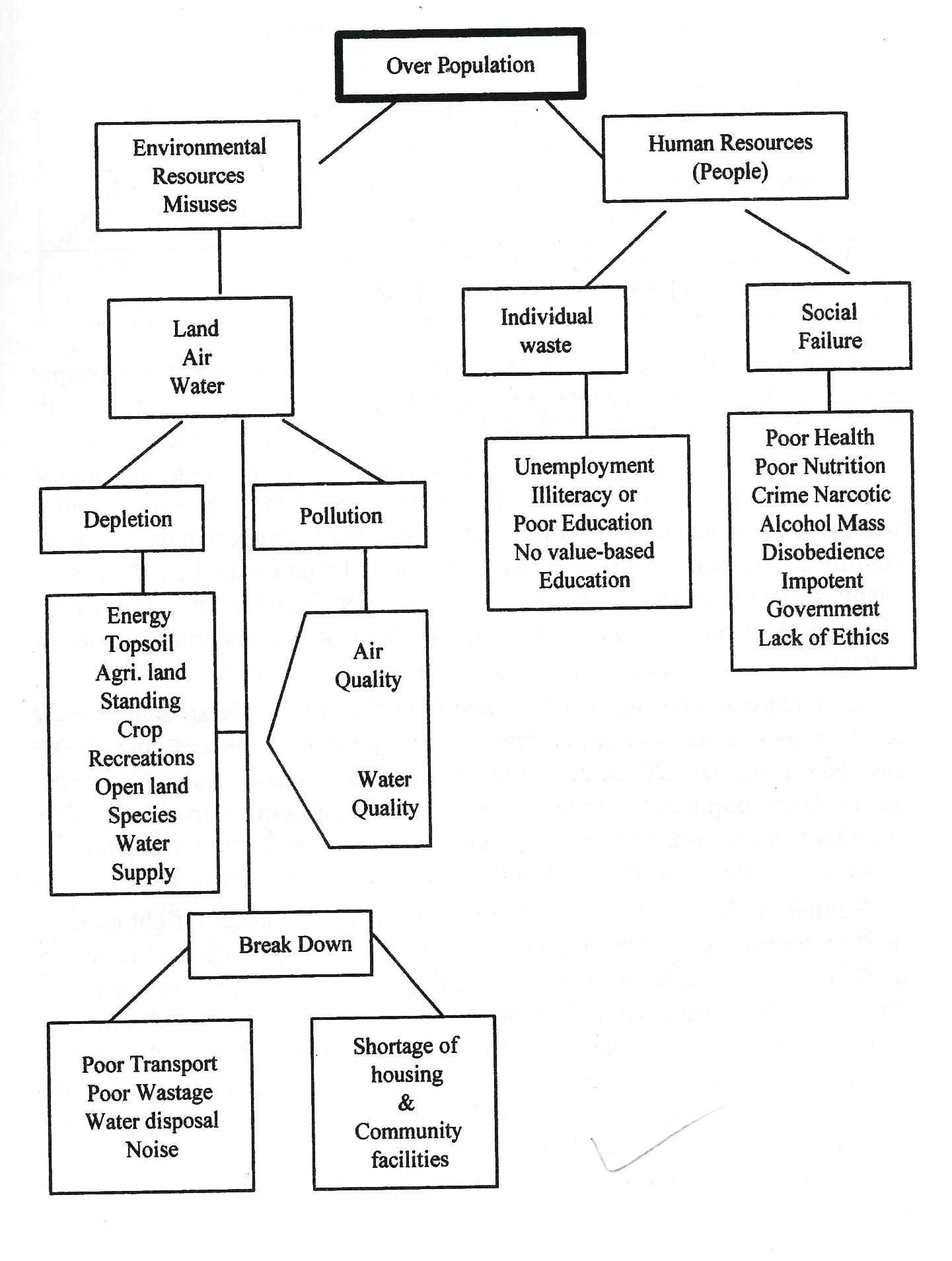
Over-population results in misuses of environmental resources on one side, and wastage of human resources on the other side. Land, air, water resources would get depleted and polluted and there will be shortage of housing and community facilities.

Due to poor education and lack of employment opportunities, there will be wastage of human resources. Consequent on the poor quality of human resources, there will be conspicuous social failure, due to increase in crime, narcotics, alcohol, civil disorder and mass disobedience. Due to poor quality of human resources and breakdown of environmental resources, the economic system may not be able to deliver goods and political system would become weak, tardy and corrupt. In short, there will be population pollution.

Under these circumstances, democracy will deteriorate into monocracy which will ultimately degenerate into anarchy

The following figure gives the effect of population pollution and deteriorating quality of life.

**Figure 3.1: Effects of Population Pollution**



International organizations like the population crisis committee; the Nature Resource Council of America, Environmental Policy Institute and other similar organizations have categorically stated that environmental degradation is due to population explosion and increasing poverty in Third World Countries.

It is generally believed that population growth causes hunger and in the Third World, current pollution growth rates will outstrip the world’s capacity to provide food and other resources and it will impede economic development in the less developed countries.

All these arguments fail to address the real causes of poverty; primary among them is the distribution of resources, gross inequalities in the ownership of resources observed in the Third World Countries. Further, there is also the problem of over-consumption in developed countries and also over-consumption by the affluent sections of the less developed countries.

According to Marx, capitalism itself encourages population growth. Surplus population, i.e., unemployed and underemployed arises not due to natural increase of human numbers out stripping available resources, but because of the accumulation of capital, which this very population makes possible, allows investments in such things as automated machinery which makes the people superfluous. There superfluous ‘lumbers serve to drive down wages thus increasing profit. Yet, the laboring population continues seemingly irrationally to production. The poor, in order to increase their income, produce more laborers per household. Thus, while rich can reinvest capital and get richer. The poor can only ‘get children’. High birth-rates are therefore not the cause of continued poverty; they are a consequence of it.

**Effects of Urbanization**

Urbanization is a process of population moving towards towns and cities from rural areas and taking up the culture and work prevailing in those urban areas. Generally urbanization is associated with industrialization and development of secondary and tertiary sectors of the economy.

The unprecedented growth of population with technological development and economic growth, naturally leads to increased urbanization, as cities and towns have become focal points of trade, commerce and industry giving greater opportunities for the people to take out their living. Following are the adverse impacts of urbanization;

1. The first adverse impact of *urbanization is the disturbance of ecological balance*. The demand for fuel, building material, space for dwelling etc., will result in deforestation and conversion of prime agricultural and pastoral land for urban uses.
2. There will be impact on the *surrounding regions by the growing demands for energy*, food and materials. Rapid urban growth leads to accelerated and exploitative withdrawal on the resource base. Large areas around cities are dug up for making bricks for construction of buildings. These leave the soil in an unusable condition and all forms of vegetation, insects and animal life and even birds are destroyed. A matter of great concern is that the resources are converted into uses which are not biologically degradable and hence, cannot be recycled at the end of their utility.
3. *Environmental pollution* is another important effect of urbanization. The metabolism of the city increases, resulting in a higher generation of metabolic by products, such as, waste water, air pollution and noise. Apart from these, the effluents of economic activities affect the environment seriously. Much of the pollution of the rivers can be traced to the discharge of untreated human waste into the natural drainage system. The air is affected by gases from industrial units and vehicles. The weather undergoes a distinct change, as the density of population increases. All cities of the world have pollution problems.
4. *Proliferation of slums* is another important effect of urbanization, particularly in Third World countries; in these countries, the problem of pollution may not be much due to industries or transport, but due to pollution created by slum-dwellers. Nearly 30 per cent of the Third World population lives in slums; devoid of any basic human facilities like sanitation, hygiene, pure drinking water, housing, food, clothing etc. as a result they are affected by many diseases like cholera, malaria, tuberculosis, bronchial congestion and malnutrition. The condition of children dwelling in slums will be still worse; uncared, unattended, uneducated and under-fed. Many children die at the infant stage due to lack of medical facilities and those who survive prove to be inefficient and useless citizens. In such a condition, we cannot expect any moral standards from the slum-dwellers. They will be simply pawns in the hands of politicians to be vote-banks at the time of general elections.
5. *Poor living Standards*; this is yet another hall-mark of urbanization. Though the dualism will prevail with highly affluent classes imitating western style of living with over-consumption, majority of the people in urban cities will have only hand-to-mouth existence.

**3.3 Types of Pollution**

The word Pollution comes from the Latin “Polluere” that simply means contamination.Pollution is the process of making land, water, air or other parts of the environment dirty and not safe or suitable to use. This can be done through the introduction of a contaminant into a natural environment, but the contaminant doesn't need to be tangible. Things as simple as light, sound and temperature can be considered pollutants when introduced artificially into an environment.

The different types of pollution include; air pollution, water pollution, soil pollution, noise pollution, radioactive pollution etc.

**3.4 Causes and Consequences of Different Types of Pollution –**

**3.5 Air Pollution**

World Health Organization (WHO) has defined air pollution as “the presence in air of substances put there by acts of man in concentrations sufficient to interfere with the comfort safety or health of man or with the full use or enjoyment of his property. The presence of contaminants in the atmosphere is considered to be in sufficient quantities and duration, to cause them to be injurious to human health, animal and plant life and reduce welfare in general.”

Causes of Air Pollution

There are two sources of air pollution:

1. Natural Sources: There are many natural sources of air pollution. Such as volcanic eruptions, forest fires, dust storms, pollen grains of flowers, spores of fungus, etc.
2. Man-Made sources: Air pollution is also due to human activities. There are many causes of air pollution which are discussed below.
3. *Pollution by Industries*: The problem of industrial pollution is acute in areas where petroleum refineries, chemical industries, pulp and paper and textile industries are concentrated. Even small scale industries like foundries and brick making are significantly air polluters.
4. *Pollution by Vehicles*: Increasing vehicular traffic is the most important source of air pollution in big cities. Other reasons for this are two stroke engines, old vehicles, traffic congestions, bad roads and obsolete automotive technologies and lack of traffic management system.
5. *Old Methods of Cooking*: people residing in shanty towns, slums and poorly ventilated houses and using household stoves, wood and coal for cooking, further increase air pollution in underdeveloped countries. Smoky indoor air mainly affects the health of women and children.
6. *Agricultural Activities*: most of the pesticides are applied through spraying in the fields. This spraying increases the quantity of many chemicals used in pesticides in the surrounding atmosphere and hence pollutes the environment.
7. *Mining Activities*: Air pollution is mainly the outcome of the dust generated during mining and processing activities. During mining, dust arises from blasting excavation, crushing and transportation of one, and from ups stockpiles and dewatered tailing. Huge quantities of dust become wind borne.
8. *Thermal Power Stations*: The power stations that use the combustion of coal or petroleum for the generation of heat and power produce smoke and sulphur dioxide (SO2). It has been estimated that thermal power stations emit about two-thirds of total sulphur dioxide released in air. These gases result in air pollution.
9. *Other Activities*: There are many other sources which cause small amounts of air pollution. These include cigarette smoking, burning of heaps of solid wastes, air conditioning appliances, diesel generation sets and construction activities etc.

Effects of Air Pollution

Pollution of air differs in some aspects from pollution of waste. Discharge from industrial premises in the atmospheres is often more or less continuous during working hours and they can drift high or low and in any direction, depending on the wind and weather.

Air pollution is more widespread in its effects than other forms of pollution for people who have to breathe the air. Air pollution creates cancroids not only for animates but also for the inanimate. World wonder Taj Mahal at Agra is a burning example of stone cancer. But the immediate effect of air pollution can be seen on human beings.

i) *Effects on Human beings*: it is a universal truth that air pollution has an adverse effect upon human health. Cause and effect relationships have been proved between air pollution and diseases. It has been proved that people living in polluted areas are suffering from certain diseases than people living in fresh air. Air pollution generally enters human body through the respiratory system and thus causes many respiratory disorders. Moreover, toxicity due to absorbed toxic substances also affects human health. For example, lead particles from vehicle exhaust in higher dose can kill outright but in lower dose, can shorten life span by causing deterioration of the nervous system.

ii) *Effects on Vegetation*: Air pollution can affect plants to changing degrees, depending upon the level of air pollution. It causes injury to sensitive plants. The suspended particulates after deposition on leaves affect the photosynthetic activity in plants. Several chemicals such as insecticides, herbicides, fungicides and pesticides used widely in agriculture are known to produce foliar lesions, chlorosis and abscission of leaves and reduction in fruitset. Several other types of particles in air such as coal dust and asbestos have been linked with necrotic lesions, reduction in fruitest in plants, silicosis and lung respectively.

iii) *Change in Weather*: Emissions into the air that is intended to cause changes in the weather, such as local rainfall, and others that are suspected of causing permanent atmospheric changes. Quite recently concern has been expressed over the fate of the ozone layer enclosing the earth and the possible effects on climate.

iv) *Effect on Visibility*: Atmospheric particulate due to fuel combustion industrial and household heating purposes can scatter and absorb sunlight and hence reduce visibility.

v) *Other Effects*: The effect of particulate matter includes corrosion of metals, erosion and soiling of buildings, sculptures, etc.

**3.6 Water Pollution**

Water pollution is the result of economic growth. The main sources of water pollution are flushing waste down the domestic sewage, industrial effluents containing organic pollutants, and wastes of chemicals, heavy metals and mining activities. The major water polluting industries are refineries, fertilizers, pesticides, chemicals, leather, pulp and paper, and metal plating. Sewage waste and industrial effluents flow into lakes, canals, rivers, coastal areas and underground water sources.

Sources of Water Pollution

The following are the sources of water pollution

1. *Domestic Sewage*: The domestic sewage includes household wastes which pass through municipal sewage system. It includes food wastes, modern synthetic detergents used for washing clothes, cleaning bathrooms and latrines.
2. *Industrial Effluents*: Industries produce chemicals that contaminate water sources, when industrial wastes are discharged in the nearby rivers or streams through flush lanes of factories. The textile, sugar and fertilizer factories, oil refineries, synthetic plants for manufacturing of drugs, rubber, plastic and rayon fibres, paper industries and chemical factories all produce chemical pollution.
3. *Agricultural Sources*: Modern agricultural techniques require the use of fertilizers to improve the fertility of land and increase production. Excess of nitrates used as fertilizers seep into ground water and are further carried into ponds or lakes. On entering the drinking water, these produce several health hazards.
4. *Household Waste*: with the increase in population, the consumption of soaps and detergents also increases which pollute the water. Moreover rubber, plastics and polythene drain into waterholes and pollute them during rainfall.
5. *Miscellaneous Sources*: According to Hindu rituals, ashes of human bodies after death should also be immersed into the holy rivers. A large number of devotees also take bath in holy rivers which pollute the water.

Effects of Water Pollution

The following are the effects of water pollutants:

1. *Effects on Man*: Water polluted with domestic sewage can spread such epidemic diseases as cholera, typhoid, dysentery/diarrhea, and a number of other minor ailments and water borne diseases.
2. *Effects on Vegetation*: Polluted water also effects crops and reduces the fertility of the soil. Polluted water may contain some pathogenic bacteria which cause many diseases in the cropland. It also results in destruction of many useful bacteria and other micro-organisms in soil thereby reduce its fertility.
3. *Effects on Animals*: All organisms depend on surface water sources drinking water from polluted water- sources results in many diseases, especially in animals.
4. *Effects on Recreational Activities*: Polluted water also affects some recreational activities like boating, fishing, swimming and diving etc.

**3.7 Chemical Pollution**

**Chemical pollution**is defined as the presence or increase in our environment of chemical pollutants that are not naturally present there or are found in amounts higher than their natural background values. Most of the chemicals that pollute the environment are man-made, resulting from the various activities in which toxic chemicals are used for various purposes.

Chemical pollution is caused by the discharge of chemicals into the atmosphere through steam and wastewater.

Chemical compounds are organic or inorganic chemicals that are the main [causes of chemical pollution](https://www.environmentalpollutioncenters.org/chemical/causes/). The most common chemical pollutants are those compounds used across large areas and which are persistent, meaning they do not easily degrade in nature.

Examples are most pesticides, herbicides, insecticides used in agriculture and gardening, as well as chlorinated solvents used in many industrial processes and dry-cleaning activities.

The major pollutant chemicals in the liquid fraction are; hydrogen sulfide (H2S), arsenic (As), boron (B), mercury (Hg) and other heavy metals such as lead (Pb), cadmium (Cd), iron (Fe), zinc (Zn) and manganese (Mn). Other harmful constituents, although present in smaller quantities, are lithium (Li), ammonia (NH3) and aluminum (Al). High salt concentrations in certain geothermal brines cause additional problems. Disposal of water of this type is a risky endeavor, as As and Hg, in particular, may accumulate in sediments and organisms.

Chemical intoxication is caused by exposure to chemical pollutants and can have immediate effects or delayed effects, which may appear after weeks or even months after the exposure occurred. Severe chemical intoxication may cause the death of the person that inhales an increased quantity of such substances.

Based on their chemical structure, chemical contaminants can be classified into naturally-occurring and man-made categories. They can be organic or inorganic (organic compounds always contain carbon and carbon-hydrogen bonds, whereas most inorganic compounds do not contain carbon).

## Examples of Chemical Pollutants

Chemical pollutants mostly result from various human activities like **the manufacturing, handling, storing, and disposing of chemicals.** These occur in industrial places and activities such as oil refineries, coal power plants, construction, mining & smelting, transportation, agricultural use of pesticides and insecticides, as well as household activities.

**The chemical industry**is another example in this sense, mainly because it is usually linked to polluted waste streams. In fact, the waste streams from chemical industry are now strictly controlled and treated before being released into the environment. But this was not always the case in the past and many rivers and surface water bodies were contaminated by the numerous waste streams coming from various chemical plants, as well as other industrial sources. Even though measures were taken to reduce this type of pollution, its effects are still visible.

**Household chemicals** involve a variety of chemical products and mixtures that can easily become chemical pollutants when released into the environment. Even the everyday detergents are chemical compounds that may pollute our environment.

The Effects of Chemical Pollution

Chemical pollution can be caused by a variety of chemicals from a variety of sources and can involve a variety of health effects from simple digestive problems to chemical intoxication and sudden death by poisoning. The effects are usually related to the exposure to high amounts of chemicals. Chemical pollution leads to various serious diseases, generally by consuming poisonous food, drinking highly contaminated water, or breathing highly contaminated air.

Chemical intoxication can have severe health effects that may trigger immediate symptoms and diseases or delayed effects which may appear after weeks or months since the exposure occurred. This is based on the type of pollutants and on the amounts to which you are exposed.

Various chemical pollutants may accumulate in the aquatic sediments over longer periods of time. This means that, if no tests are performed, chemical pollution in the ocean water could pose serious health risks to the ecosystem and ultimately could cause mild or deadly chemical intoxication in humans after the consumption of contaminated fish or seafood. However, there are prevention tips you can follow to minimize exposure to chemical pollution.

The consequences of such disastrous events suggest the importance of the inclusion for long-term and indirect effects in addition to short-term effects when assessing or predicting ecological impacts of such catastrophic events.

**3.8 Degradation of Land and Habitat**

Land degradation is a global challenge that affects everybody through food insecurity and higher food prices, through climate change and environmental hazards, and through the loss of biodiversity and ecosystem services.

Land degradation is generally understood to be the reduction or loss of biological or economic productivity resulting in decreased yields, incomes, food security, and the loss of vital ecosystem services. These impacts, in turn, serve to undermine the peace and stability of land-dependent communities. Thus, there appears to be a demonstrable link between land degradation and human security, especially when we consider how poverty and hunger lead to migration and conflict.

Land degradation is happening at an alarming pace and is affecting regions inhabited by over one-third of the global population. This phenomenon contributes to a dramatic decline in the productivity of croplands worldwide, thereby, threatening food security and environmental quality.

Land degradation is, therefore, considered as a major global environmental issue of this century. Its environmental and socioeconomic–political effects involve a complex interplay of biophysical and anthropological factors acting at different spatial and temporal scales. The real extent of global degraded areas varies depending on the definitions. Globally, about 24% of the global land area has been affected by degradation and over 1.5 billion people live on degraded lands.

A certain level of land degradation is an inevitable consequence of natural processes and human activity. Any exploitation and use of non-renewable resources inevitably results in their partial or total depletion, as well as the degradation of the landscape and generation of waste.

Agricultural intensification leads to deforestation, cultivation of marginal lands and soil erosion while agricultural intensification leads to pesticide and fertilizer run-off(s), water logging and soil salinity. When identifying alternatives for mitigating the problems of land degradation, we should aim at minimizing it, or at least restricting it to a level consistent with society’s objectives, rather than trying to prevent or eliminate it altogether.

There are some problems engendered by land degradation that are common to all countries regardless of the type of economic system and levels of development prevailing there. For example, the underlying causes of land degradation, are fundamentally similar in all countries. Yet, its manifestations, dimensions and implications differ depending on the history, geography and level of development, among others. Even in the same country, land degradation evolves over time with population growth, migration, urbanization, industrialization, structural change and economic growth. India is no exception to this.

Environment and Pollution cannot be studied in isolation. Pollution is a by-product of growth and it impacts the environment adversely. The several kinds of pollution are threatening and require controlled focus in order to protect humanity and existence. The present module concentrated on these concepts.

**MODULE-4**

**TECHNIQUES OF VALUATION OF THE ENVIRONMENT**

The main issues of this module relate to the ways in which economic values can be placed on the environment, enabling environmental issues to be included in economic decision-making. Methods based on economic theory have been devised to assign monetary values to environmental goods and services, and these values can then be incorporated into decision-making at the project, sectoral and national levels. Although the methods and techniques which this module introduces represent the mainstream approach to environmental economic decision-making, there are many criticisms of such an approach, and the module also addresses these concerns and outlines alternative approaches to analyzing economy–environment links.

**4.1 Market and Non-Market Valuation**

Value can be broadly categorized as either instrumental or intrinsic. Instrumental value refers to the capacity of something when used, to satisfy a want or preference. Intrinsic value is regarded by ecological economists as being inherent in something. Instrumental or use value, can be defined as “accruing from those benefits which are attributed to present consumption of the resources”.

A distinction is made between direct and indirect use values. Direct use value may emerge from exchange or outside of exchange through self-consumption of resources to which individuals have access. On the other hand, indirect use value is the main consequence of the ecological functions that the natural resources perform. There is also option value and existence value. Option value refers to willingness of the people to keep the option of postponing the decision on the use of the resources. Existence value represents the value which an individual is willing to pay for the environmental amenity, even though that person receives no direct value. The existence value is often termed as non-use value.

**Conceptually, the Total Economic Value (TEV) of a resource consists of its Use Value (UV) and Non-Use Value (NUV)**

**TEV=UV+NUV... (1)**

Further, use value may be divided into Direct Use Value (DUV), the Indirect Use Value (IUV) and the Option Value (OV). Therefore, equation (1) can be rewritten as:

**Total Economic Value (TEV) = [Direct Use Value (DUV) + Indirect Use Value (IUV) + Option Value (OV)] + [Non-Use Value (NUV)]**

In the context of uncertainty, Quasi Option Value is said to define the value of preserving options for future use in the expectation that knowledge about the potential benefits or costs is associated with the option.

**Need For Environmental Valuation**

The need for environmental valuation arises for the following:

(i)Environmental Litigation:Non-market demand valuation has traditionally been used by government to assess the damage, compensation and need for further changes in environmental policy.

(ii) Environmental Dispute Resolution:Environmental disputes frequently arise with respect to logging, new water storage, new mines, power stations and resort development etc. Estimates of environmental values potentially has a role to play in supporting more informed decision making in these cases, and in making decisions more transparent to stakeholders.

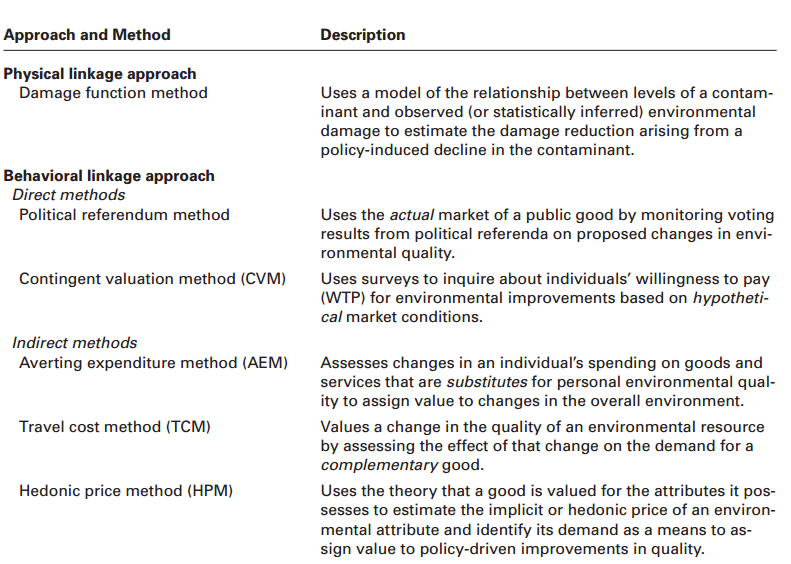
(iii) Guiding Environmental Regulations: Policy makers have to take decisions regarding environmental regulations. They will be better informed if environmental damage cost considerations are taken into account.

(iv) Evaluating Proposed Environment Programmes A public cost benefit framework is appropriate to assess the desirability of government initiative, such as greenhouse gas reduction programmes and health programmes. These usually involve various social and environmental impacts of these programmes which the policy makers want to assess.

As per Smith and Krutilla (1982) the various measurement techniques of environmental valuation can be grouped into two categories

* Physical Linkage Approach
* Behavioral Linkage Approach

**Table 4.1: Synopsis of Environment Evaluation Methods**



**4.2 Physical Linkage Methods**

The methods in the physical linkage approach use tangible attribute of the environment to make a connection to an individual; through which benefits can be observed or inferred and subsequently valued. The Physical Linkage Approach measures benefits based on a technical relationship between an environmental resource and the user of that resource. A common estimation procedure that uses this approach is the Damage Function Method. This method uses a functional relationship to capture the link between a contaminant and any associated damages. Based on this function, incremental benefits are measured as the reduction in damages arising from a policy-induced decrease in the containment. The damage reduction is then monetized to obtain a rupee value of the benefits brought about by the policy.

**4.3 Behavior Linkage Methods**

The Behavioral linkage approach to quantifying benefits is based upon the observations of behavior in actual markets or survey responses about hypothetical markets for environmental goods. Another element of behavioral linkage methods deals with how closely the behavior or responses are linked to the environmental good. Techniques that assess responses immediately related to environmental changes are broadly termed Direct Methods.

There are two types of direct methods; Political Referendum Method which relies on actual market information and the Contingent Valuation Method (CVM), which uses hypothetical market data. Indirect Methods are those that examine responses not about the environmental good itself but about some set of market conditions related to it. They include Travel Cost Method (TCM) and the Hedonic Price Method (HPM).

**Contingent Valuation Method (CVM)**

Contingent valuation frequently elicits information on **Willingness to Pay (WTP)** or **Willingness to Accept (WTA)** a monetary equivalent, which would be necessary to compensate for the welfare gain or loss from the change due to an increase or decline in the environmental quality or level of resources which are usually non-marketed. The WTP measure is used when market prices do not exist. This method is more effective when the respondents are familiar with the environmental goods or services and have adequate information on which to base their preferences.

As part of contingent valuation approach, the trade-off game method, costless-choice method, and Delphi method shall be discussed.

**(1) Trade-off Game Method**

This method relies on the creation of a hypothetical market for some goods or services. In a single-bid game the respondents are asked to give a single bid equal to their willingness to pay or willingness to accept compensation for the environmental goods or services described. In an repeating bid game the respondents are given a variety of bids to determine at what price they are indifferent between receiving or paying the bid or receiving or losing the environmental goods at issue. When no money is involved, the approach becomes similar to the costless choice method.

**(2) Costless-Choice Method**

It is a technique whereby people are asked to choose between several hypothetical bundles of goods to determine their implicit valuation of an environmental good or service. Since no monetary figures are involved, this approach may be more useful in settings where barter and subsistence production is common.

**(3) Delphi Method**

It is a variant of the survey-based techniques wherein experts, rather than consumers, are interviewed. These experts place values on a goods or services through an iterative process with feedback among the group between each iteration. This expert-based approach may be useful when valuing very esoteric resources.

A sufficiently large sample of experts is presented individually with a list of events on which to attach probabilities and to which other events, with probabilities may be added. Some recent Delphi exercises have been recreation-specific. But testing the accuracy of their forecasts is not yet possible, especially since the predictions are only meant to be general perspectives.

**4.4 Revealed and Stated Preference**

The demand for environmental goods can be revealed by examining the purchases of related goods in the private market place. There may be complementary goods or other factor inputs in the household’s production function. There are a number of revealed preference methods such as travel- cost method, hedonic price method and property value method.

**Travel-Cost Method**

The travel-cost method is a widely used surrogate market approach that relies on information on time and travel costs to derive a demand curve for a recreational site. This curve is in turn used to estimate the consumers’ surplus or value of the site to all users. This approach is widely used to value the recreational benefits of public parks and other natural areas.

This method seeks to determine the demand for a recreational site (i.e. number of visits per year to a park) as a function of variables like price, visitors’ income, and socio-economic characteristics. The price is usually the sum of entry fees to the site, cost of travel, and opportunity cost of time spent. The consumers’ surplus associated with the demand curve provides an estimate of the value of the recreational site in question.

The most common forecasting technique for a specific site is the Clawson- Knetsch-Hotelling method. It is a technique commonly associated with benefit estimation in recreation cost-benefit analysis. This method uses information on travel costs to generate a final demand curve for a recreation outlet. Hence it is most appropriate for those outlets where travel cost is a major component of total visit costs typically to free countryside outlets.

According to Clawson and Knetsch, outdoor recreation activities satisfy individual needs, such as physical, social or psychological. It is necessarily a kind of package deal involving anticipation, travel to the site, the activity itself, the return travel and finally recollection.

The travel-cost approach looks at the pattern of recreational use of a lake and uses this information to derive a demand curve to estimate the total amount of consumers’ surplus. To do this, visitors are divided into a number of origin zones of increasing distance from the lake. Then a survey is used to determine the time and monetary cost involved in reaching to the lake.

**Criticism**

1. This approach is most successful where there is wide variation in the travel cost of various users and where recreation at the site in question will be the primary objective of visits. But wide variations in tastes and preferences and substitute availability at different distances from the site, distort demand estimates.
2. The travel-cost method is of limited value if congestion is a problem. Small changes affecting recreational quality may be difficult to evaluate using this method.
3. The basic assumption of travel-cost method is that consumers treat increase in admission fees as equivalent to increase in travel cost. This is subject to question.
4. Another problem associated with this method is that it assumes recreational quality remains constant over the range from zero use to full present use at the going admission fee. This is highly hypothetical.
5. Bateman is of the view that the travel-cost method measures only the use value of recreation sites. Underestimation of site value due to the truncation of non-visitors would be made worse if the non-use value of both visitors and non-visitors were relevant. This method is not capable of producing any total economic value estimate in that it cannot estimate non-use items such as existence value.

**The Hedonic Price Method**

The underlying assumption of the hedonic price method is that the price of a property is related to the stream of benefits to be derived from it. The method relies on the hypothesis that the prices which individuals pay for commodities reflect both environmental and non-environmental characteristics. The implicit prices are sometimes referred to as hedonic prices, which relate to the environmental attributes of the property.

Therefore, the hedonic price approach attempts to identify how much of a property differential is due to a particular environmental difference between properties, and how much people are willing to pay for an improvement in the environmental quality that they face and what the social value of improvement is.

The hedonic price method is based on consumers, which postulates that every good provides a bundle of characteristics or attributes. Again, market goods can be regarded as intermediate inputs into the production of the more basic attributes that individuals really demand.

The demand for goods, say housing, therefore, is considered as a derived demand. For example, a house yields shelter, but through its location it also yields access to different quantities and qualities of public services, such as schools, centres of employment and cultural activities etc. Further it accesses different quantities and qualities of environmental goods, such as open space parks, lakes etc.

**Criticism**

1. This method is of no relevance when dealing with many types of public goods i.e. defence, nation-wise air pollution and endangered species, etc., as it prices are available for them.
2. The hedonic price method may be used to estimate the environmental benefits provided to local residents by an area as it exists today. But in fact, it cannot reliably predict the benefits which will be generated by future improvements because those improvements will have the effect of shifting the existing function.
3. Another problem is whether an individual’s perceptions and consequent property purchase decisions are based upon actual or historic levels of pollution and environmental quality. If expectations are not the same as measured by present pollution estimate, then there are clearly problems relating to values derived from purchases.
4. Moreover, expectations regarding future environmental quality may bias present purchases away from that level dictated by present characteristic levels.
5. This method has been criticized for making the implicit assumption that households continually re-evaluate their choice of location.
6. Further, there is considerable doubt that such an assumption can hold in the context of spatially large study areas. If people cluster for social or transportation reasons, the results of this method will be biased.

**Surrogate Markets**

When no market exists for a good or service and therefore, no market price is observed, and then surrogate (or substitute) markets can be used to derive information on values. For example, travel-cost information can be used to estimate value for visits to a recreational area; property value data are used to estimate values for non-marketed environmental attributes such as view, location or noise levels.

The effects of environmental damages on other markets like property values and wages of workers are also evaluated. Valuation in the case of property is based on risks involved in evaluating the value of property due to environmental damage. Similarly, jobs with high environmental risks will have high wages which will include large risk premiums.

**Property-value Method**

In the property-value method, a surrogate market approach is used to place monetary values on different levels of environmental quality. The approach uses data on market prices for homes and other real estates to estimate consumers’ willingness to pay for improved levels of environmental quality, air, noise etc.

In areas where relatively competitive markets exist for land, it is possible to decompose real estate prices into components attributable to different characteristics like house, plot size and water quality. The marginal willingness to pay for improved local environmental quality is reflected in the increased price of housing in cleaner neighborhoods.

**Wage-differential Approach**

The wage-differential approach is a surrogate market approach that uses information on differences in wage rate for similar jobs in different areas to estimate monetary values for different levels of environmental quality. This approach has been used to estimate values for such environmental variables as different levels of congestion, air pollution and aesthetics.

Wages also vary in response to various factors such as education and training, natural dexterity, experience, demand and supply in each labour market area, occupational risks to health, probability of death, and associated living conditions including environmental ambience etc.

The hedonic wage approach has also been used in the wage-risk analysis to determine the value of life and limb in relation to the hazards faced at work. The general hedonic wage equation can be expressed as

P = P (J, R, S)

Where, P is the payment rate for a given job, У is a vector of another job- related attributes e.g. working hours, holiday, sickness benefits etc., R is the risk of death and S is a vector of skills required to do the job. The hedonic wage approach has traditionally been used to measure employment attributes, principally risk of death or injury in particular labour markets. However, by observing variations in wage levels over space, and netting out the influence of other attributes, they have also been used to value the quality of life over large areas such as countries or continents.

**4.5 Social Cost Benefit Analysis**

Cost-benefit analysis (CBA) is applied by economists to test the economic viability of an existing or proposed activity, and/or compare two or more ways of carrying out the activity. In a natural resource management context cost-benefit analysis involves subtracting the discounted monetary cost of a given project/activity from the discounted monetary value of all the benefits generated by the same development to obtain a net benefit or cost streams for the proposed activity.

CBA can either be carried out *ex ante* (before the actual implementation of a project) or *ex post* (after implementation of the project). CBA always involves with and without project comparisons to calculate the net incremental benefits that accrue from a given project. The final decision is based on one of the three possible criteria of maximum Net Present Value (NPV), benefit-cost ratio or positive net present value.

**Stages of Conducting Cost**

**Defining the Project**

The first step involves defining the project in terms of the resources being re-allocated, for example, clearing of a given forest to create human settlement and secondly the population that stands to gain or lose from the project over which costs and at which level (local, national or global). This stage is important because a project cannot be appraised unless what is to be appraised is known.

**Identifying Project Impacts**

Once the project is identified, the next step involves identifying all the impacts that result from its implementation. From example the settlement given in stage 1 above, this stage would involve listing all resources used e.g. (labor costs, material costs, costs of loss of forest), impacts on agricultural production, employment opportunities etc.

Two concepts are important at this stage; *additionality* and *displacement*. Additionality refers to the net impacts of the project, for example additional agricultural production arising from cultivating the cleared forest. Displacement is often important when applied by development authorities at regional level. A question arises of whether the project will displace output from an already existing project in another region.

**Identifying Impacts that are of Economic Relevance**

This step involves identification of all impacts including the non-priced impacts (those not traded in the market). The positive impacts are classified as benefits, these impacts either increase the quantity or quality of goods that generate positive effects or reduce the price at which they occur. Negative impacts are counted as costs will include any decrease in the quantity or quality of such goods or increase their prices. The negative effects also include the using-up of resources (inputs of production) in a project (including the opportunity costs). The actual physical amounts of impacts and the time when they occur in the project life are determined at this stage. All transfer payments such as taxes or income transfers are excluded since they are not real impacts but merely redistribution from one group in the economy to another.

**Physical Quantification of Relevant Impacts**

This stage involves determining the physical amounts of costs and benefit flows for a project, and identifying when in time they will occur. In the forest settlement example, likely future agricultural production, the disrupted ecological services arising from forest clearing will be considered. The likely environmental impacts can be well captured by using an environmental impact assessment (described in more details in the consequent section). It is important to note that at this stage all calculations are carried out with varying levels of uncertainty.

**Monetary Valuation of Relevance Effects**

The identified physical measures of impact must be valued in common units. The common unit in CBA is money, whether in Kshs, dollars, pounds or any other appropriate currency. Markets generate relative values of all traded goods and services as relative prices. The other tasks of CBA at this stage include; predicting prices for value flows extending into the future, correcting for market prices where necessary and generating prices where none exist.

**Discounting of Costs and Benefits Flows**

After expressing all the relevant costs and benefits in monetary terms, then they have to be converted into present value (PV) terms. This is in important because of the time value of money or time preference aspect. Taking a simple example, holding all other things constant (*ceteris paribus*), an individual would differentiate between receiving cash 1,000 today and receiving the same amount in one year’s time. The more immediate sum might be preferred due to impatience, alternatively the individual might not want to spend money now but he or she could invest it in a bank at an interest say 10% and have cash 1,100 at the end of the year. So, this time effect has to be taken into account by discounting all costs and benefit flows by using a discount rate which can be assumed for now to be the interest rate (i). The present value of a cost or benefit (X) received in time t is calculated as following:

PV (Xt) = Xt [(1+i)-t] or PV (Xt) = Xt [1/ (1+i) t]

**Applying the Net Present Value Test**

The main purpose of CBA is to help select projects which are efficient in terms of their use of resources. Therefore, after carrying out a CBA the criterion of Net Present Value (NPV) is used. This criterion simply asks whether the sum of discounted gains exceeds the sum of discounted losses. If the sum of discounted gains exceeds the sum of discounted losses, then the project is said to represent an efficient shift in resource allocation. The NPV of a project is calculated as follows:

**NPV = **

The summation run from t =0 (the first year of the project) to t =T (the last year of the project. The criterion for project acceptance is; accept if and only if NPV>0. Given two project with positive NPV the one with a higher NPV should be selected.

There are a number of alternatives to NPV, such as internal rate of return (IRR) and benefit-cost ratio. IRR is a measure frequently applied in financial investment. It is the rate of return if used as the discount rate of the project would yield a NPV of zero. It is interpreted as the rate of return on the resources used up in the project, be compared with the opportunity cost of funds (the prevailing interest rate). However, IRR is criticized as a measure of resources allocation for two main reasons: first many projects can generate multiple IRRs for the same data set hence the analyst does not know which criteria to select as the decision-making criterion. Second IRR is unreliable when comparing performances across many projects in a portfolio because it compares the returns on one project to the opportunity cost of funds. Benefit-cost ratio is another way of presenting NPV. The decision rule is; accept the project if the ratio is above unity.

**Conducting Sensitivity Analysis**

As noted in stage 4 above, calculations of physical quantification of impacts are carried out with varying level of uncertainty. Therefore, it becomes necessary to conduct a sensitivity analysis to capture the different likely future scenarios. In all ex ante cases of CBA the analyst must make predictions concerning future physical flows (e.g. agricultural production) and future relative values. None of these predictions can be made with perfect foresight. Therefore, NPV values must be recalculated when certain key parameters are key parameters are changed. Such parameters include: discount rate, physical quantities and qualities of inputs, shadow prices of these inputs, physical quantities and qualities of outputs, shadow prices of these outputs and project life span.

**Major Challenges of Conducting CBA**

The following main problems arise in applying CBA to environmental issues:

1. Valuation of non-market goods such as wildlife and landscapes.
2. Ecosystem complexity
3. Discounting and discount rate;
4. CBA may or may not be a truly objective way of making decision or can institutions capture it for their own ends
5. Uncertainty and irreversibility, how can they be included in CBA.

**Social or Distributive Analysis in CBA**

The distributive analysis of a conservation project should involve the following questions: who will benefit from the project and by how much? Who will pay for the project and how much will they pay? Project sustainability is heavily impacted by which party in the project’s sphere of influence gains or losses. If an influential group is expected to bear the burden of losses, then the successful implementation of the project may be hindered. The risk of a strong political opposition to the project mobilized by the losing party is a contingency that the project implementers should be prepared to tackle.

Another aspect of distributive analysis is concerned with cases in which projects will facilitate or hinder the process of helping society address its basic needs. For example, a road project may not only reduce transportation costs, but also increase the level of security in a village or allow more children to attend school, both of which are viewed positively by society. In such cases, society may want to credit a net social external benefit to the project.

**Difficulties in Measuring Environmental Values**

Some problems in measurement of environmental values are discussed below;

1.Market Prices: When there are adverse health effects and loss in productivity due to environmental damage, market pieces are to evaluate them. The procedure is to evaluate damages due to soil erosion, deforestation and air water pollution. For this purpose, the ecological relationship between environmental damages and its effects on production or health are estimated on the basis of prices to derive monetary values. Welfare losses relating to health risks due to polluted environment are measured by income foregone because of illness or premature death. Such estimates are difficult to compute because they rely on loss in income.

2. Costs of Replacement: People and firms invest in installing alternate devices to avert environmental damage of air, water and land. Such investments can provide an estimate of environmental damage. But the effects of damages cannot be evaluated.

3. Surrogate Markets**:** The effects of environmental damages on other markets like property values and wages of workers are also evaluated. Valuation in the case of property is based on risks involved in evaluating the value of property due to environmental damage. Similarly, jobs with high environmental risks will have high wages which will include larger risks premiums. But this technique is impracticable because property owners and workers are ignorant of the effects of environmental damages.

4. Social Discount Rate**:** Environmental degradation leads to costs and environmental improvements confer benefits on resource users.

(i) The problem of measuring environmental damage is to evaluate it and compare it with the cost of preventing it. It concerns comparing the benefits of environmental protection with the costs incurred on it.

(ii) But the main problem is how to measure costs and benefits of environmental effects on the present and future generations. For this, a rate of discount is needed for discounting all costs and benefits.

When discount rates are high the level of investment falls which discourages development projects and slows down the pace of development. It thus shifts the burden of high costs to future generations. The problem is also regarding which rate to choose as the social discount rate. But like the social discount rate, they have their problems of measurement and the effects on environmental degradation on the present and future generations are unclear.

**4.5Environmental Impact Assessment (EIA)**

Environmental Impact Assessment (EIA) refers to the evaluation of the effects of a major project on a man-made natural environment. It is the basic tool for the sound assessment of development proposals. The increasing scale, complexity, uncertainty and risks of the major development projects have culminated in the use of EIA, this is due to the public awareness of and activism against environmental effects of mega projects.

Early attempts as project assessment relied on technical feasibility studies and cost benefit analysis. The CBA placed a monetary value upon non-economic variables such as marine ecosystems or the social and health impacts of pollution. On account of its failure to incorporate temporal changes such as changes in price level, discount rate and interest rate, CBA often yielded inflated measure of benefits.

**Definition of EIA**

EIA is an “anticipatory, participatory, integrative environmental management tool which has the ultimate objective of providing decision makers with an indication of the likely consequences of their decisions relating to new projects or new programmes, plans or policies”.

As the U.K Department of Environment puts it, an EIA, “is essentially a technique for drawing together, in a systematic way, expert qualitative assessment of a project’s environmental effects and presenting the results in a way which enable the importance of the predicted effects and scope for modifying or mitigating them, to be properly evaluated by the relevant decision making body, before a decision is taken.”

EIA helps the decision makers to identify the likely effects of a project 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.

The EIA is both a science and art. It is a science in terms of its methodologies and techniques employed to identify, predict and evaluate the environmental impacts of developmental programmes. It becomes an art when it is used to influence decision making. The significance of EIA has been summarised by Calwell as follows:

1. EIA is a means to a larger end- that is the protection and improvement of environmental quality.
2. It is not just a single technique or method but a procedure that uses many approaches to evaluate environmental impacts.
3. It is interdisciplinary
4. It is an integral part of project planning and not just an appendage.
5. EIA does not make decisions but its findings should be considered in policy and decision making.

Therefore to conclude, though environmental valuation is the practice of assigning monetary values to nature and its associated functions, environmental “goods” and “services” are not normally traded on markets. Therefore, economists have designed various methods, for arriving at monetary values that reflect what individuals are willing to pay. Environmental valuation is primarily undertaken with the aim of (i) incorporating environmental goods and services into cost–benefit analyses; (ii) internalizing environmental costs in market transactions; (iii) setting up markets in environmental services; and (iv)assessing compensation for environmental losses or for maintaining an ecosystem service. Human geographers have only recently engaged with environmental valuation.

**Module-5**

**Environment Protection: Policies and Strategies**

Human beings exist in the environment, the relation they share needs to be conducive, cordial and sustainable. The protection of the environment is important for human existence. One of major problems threatening the environment recently is environmental pollution. The present module focuses on this aspect by discussing the various theories, policies and strategies relating to the environment.

**5.1 Pollution as an Economic Problem**

Environmental pollution problems are not a new phenomenon. Many developed countries have a long history relating to their attempts to control pollution. However, in recent years, the problem has taken a serious dimension to create awareness in all governments. Many countries are seriously devoting their efforts to reduce the impact of pollution. Though comprehensive data are not available in different sectors of the economy, the rapid increase in the quantity of solid waste, pollution of the air, impurities in water etc., are physically visible.

Whatever be the pollution levels, it is justified in treating pollution as a problem because, it is clear even from casual observation, that the current level of emission is higher (perhaps much higher) than it would be, if the polluters had to bear all the costs of their activities. It is this that lies at the heart of the economic analysis of pollution.

Pollution is an economic problem, partly because, it reduces the value of some of the resources that society has at its disposal. The fact that pollution reduces, the value of our resources is not, however, sufficient for it to constitute an economic problem. After all, for many types of pollutants, we have the technology to eliminate the major emissions.

Pollution is an economic problem, because it requires us to make choices, to resolve conflicts of interests; it is an economic problems because, the means by which pollution can be reduced are themselves resource-using. It is for this reason; much of the analysis relating to pollution is concerned with a comparison of costs associated with the ‘*effects* of pollutants and the costs associated with the various method of obtaining (preventing) pollution.

It is absurd to say that pollution is just an economic problem. It is problem for society that transcends the artificial boundaries of academic disciplines. It poses problems for all of the natural sciences, largely concerning the identification and measurement of physical impact of pollutants on the environment and the living beings in it.

Pollution control challenges the Engineer who is concerned with the design of abatement technology and also lawyer who sees law as a social instrument by which some form of restriction can be imposed; the doctor and bio chemist who are bewildered by the prevalence of vast array of strange and new diseases unknown to the medical world.

**5.2 Optimum Level of Pollution**

Pollution control absorbs scarce resources that could be used to produce other things of value. It is a question of choice in going ahead with pollution control forgoing other things of value, or making alternative measures and evaluating them. The criterion for the choice, as stated earlier, is the economic welfare of the people. Pollution can be defined as “the impairment environmental services by residual discharges”.

Let E1 represent the value of the flow of services of the environment in the absence of any residual discharge or pollution. Imagine D is the damage due to pollution resulting in reduction of flow to the level of E. Similarly, imagine the economy could produce goods and services worth N1 in the absence of any pollution control measures. Pollution control would absorb scarce resource worth T reducing the flow of goods and services to N. This can he slated as follows:

Welfare W = N + E………eqn(1)

= (N1 – T) + (E1 – D)

= (N1 + E1) - (T +D)

In this, only D and T are affected by the way in which residuals are disposed off. Their sum (T + D) is the total cost of residual disposal and represents a reduction in economic welfare. The pollution control policy that maximizes economic welfare is the one that minimizes these costs.

From equation (1), small change in economic welfare (ΔW) associated with pollution control is given by the equation;

(Δ W) = - ΔD - Δ T

Where - ΔD denotes reduction in pollution damages. An increase in Welfare requires a decrease in damages (-ΔD) holding treatment costs constant; a decrease in treatment costs   
(-ΔT) holding damages cost constant or an increase in treatment costs that is more than offset by lower damages. *Additional pollution control steps should be undertaken, as long as the reduction in damages* (ΔD) *exceeds the cost of achieving them* (ΔT).

For example, if an increase in pollution control reduces damages by, say, Rs.500 (i.e., -Δ D = Rs. 500), but costs only Rs. 300, (i.e.,ΔT= Rs 300). Taking this step eventually produces a net gain of Rs.200 in economic welfare. If additional treatment expenditures bring diminishing returns, or equivalently, damage reductions come at increasing treatment cost, then economic welfare is maximized by extending pollution control to the point where –Δ D equalsΔT.

This statement of optimum condition is made on the assumption that money value in terms of rupees can be attached to all the environmental services and damages (losses in services), so that they can be added to national income to determine welfare.

**5.3 Control Model Basic Approach to the Problem of Pollution Control Pollution Control Model**

The optimum in pollution control model, the following assumptions are made.

(a) There is only one harmful residue discharged into the environment causing damages.

(b) The damages of environment depend on the concentration of this residues discharge.

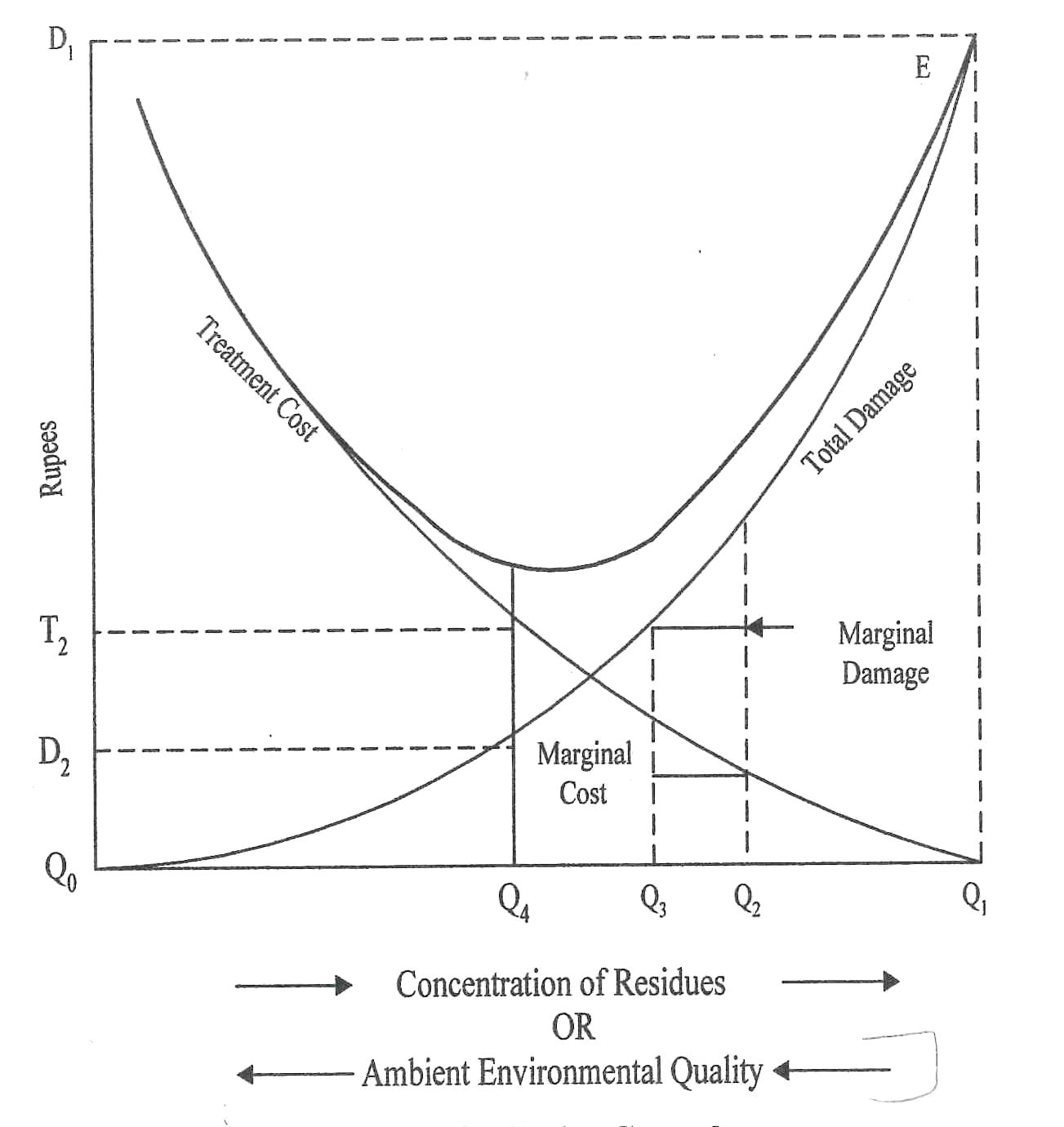
(c) Data relating to discharge of residues and the level of concentration of residues are available.

(d) We can ascribe rupee values to these effects or damages.

(e) These rupee values can be interpreted as the willingness to pay on the part of all people affected by this residual in order to avoid these damaging effects.

This means that these rupee values are the maximum aggregate willingness to pay to restore the environment to a natural or unpolluted state.

**Figure 5.1: Damages and Treatment Costs for Environmental Quality**



The figure 5.1 illustrates Damages and Treatment Cost Curves. Moving on the horizontal axis from left to right indicates increasing concentration and damages to the environment. Moving in the opposite direction, i.e., from right to left indicate improving ambient environmental quality. Q0 indicates zero pollution state or the maximum, environmental quality.

In the absence of any pollution control efforts, the level of pollution (or environmental quality) depends on the level of and nature of economic activity. Assume, at a point of time, the level of pollution is Q1 depending on economic activity and production. This level of pollution can be reduced by increasing pollution control costs; improving environmental quality (Q1) is called the “Treatment Costs”. Treatment in this context denotes all technological options to reduce the pollution.

The optimum level of pollution control can he had where the total cost of residual disposal is, at a minimum. The total cost of residual disposal is the sum of damages and treatment cost (D +T). This is also shown in figure 5.1 by a thick line representing the vertical summation of the total damage and treatment cost curves (EE).

The total cost curve has its minimum at point Q4. Thus Q4 is the optimum level of environmental quality. This indicates that treatment cost equal to Rs T2 should be incurred in order to improve environmental quality from Q1 to Q4 and to reduce the damaging effect of pollution from D1 to D2. An expenditure of Rs. D2 buys pollution control which is worth Rs. D1 minus Rs. D2.

**Basic Approach to the Problem of Pollution Control**

Production cannot be stopped altogether in order to avoid pollution. With advancement of knowledge and development of the economic system, production will be expanding and pollution will come to stay with us permanently. There cannot be a situation where there will be zero pollution, and it would be altogether impossible to have a technology by which the pollution level can be brought to zero. The only alternative is to reduce the level of pollution by taking effective governmental actions. This depends on two important things, namely, the desired rate of economic growth and the sustainability of the environment for achieving that goal. It will be a question of trade-off between the growth and environmental quality with available instruments of pollution control.

Many methods have been suggested for the control of activities in the economy that damage the quality of the environment. They are:

1. Moral Suasion
2. Regulation
3. Prohibition
4. Fiscal Techniques etc.

**5.4 Moral Suasion**

Moral Suasion is a non-mandatory investment made by industries and organizations making a moral appeal for the control of pollution by behaving themselves as the pioneer or forerunner in reducing the emissions.

The industrial organization has some social obligations in the present democratic society. By adopting advanced techniques of pollution control or at least erecting pollution control equipment, they could set an example in the industrial world for other units to take up such efforts on a voluntary basis without government mandate. Besides reducing emission at their own level, these industrial units could also undertake voluntary programmes of reducing the pollution in the city or town by collection garbage and recycling them.

The success of this type of voluntarism depends on the civic conscience of the people and also national conscience of the promoters of the industries. In the industrial world of the present day, in countries like India, most of the units will be highly cost-conscious, as many would be under the pressure of competition, and industrial units may not be willing to add to their cost. When most of the mediocre sized units depend on subsides and concessions, undertaking programmes on a voluntary basis for reducing pollution would be out of question.

However, giants in industrial sphere could come forward for such type of voluntary programmes. It is also criticized that the so called voluntary programmes undertaken by some firms are only ruse to avoid other mandatory charges like effluent charges etc., and they gain more by circumventing the mandatory charges to be paid to the government. This may be true which speaks about the character of the business firms.

Many modern firms spend a lot on advertisements, conducting cricket matches and sports, as well as motor rallies etc. These voluntary programmes by the firms could be given attention for pollution control which would also be a form of advertisement which go to educate the citizens that environmental quality is a must in the process of production and also enthuse the citizens to think in right direction.

Further, voluntarism by the business firms would also help the government in assessing the extent of damages caused by pollution in the environment. Identification of the level of pollution and the monitoring of activities to reduce pollution could also be undertaken so that ‘a systematic surveillance programmes could be initiated by the government. The voluntary programmes could be initially restricted to certain zones only to make the management of the programme effective and the results most successful.

Many firms are interested in maintaining the traffic islands in the road junctions and also of maintain of parks in the traffic islands to make the area attractive, neat and also environmentally pleasant. In the same manner “Litter Free Zones”, “Lungs of the Town” programmes can be taken care of voluntarily by the business firms.

Extensive policing will very difficult by the government and the firms. Extensive policing will be very difficult by the government and the firms could undertaken such type of work to evoke a conscience and culture that business firms are eco-friendly and they care a lot for the welfare of the nation in preserving the environmental quality.

The voluntary organization in the country could come forward in educating the public about the environmental hygiene and care, civic responsibilities of the citizens. The political culture in our country has created a very wrong attitude among most of the people that they don’t mind even flouting laws of the land. They don’t even obey the ‘rule of the road’ whether they are pedestrians or driving vehicles. They do not adhere to the rules of the government knowing full well that they are mandatory and also punishable for the breach of the same. Unless the political culture of the country is aligned with civic culture, any amount of voluntarism or programmes educating the public will be very difficult and moral suasion will miserably fail, as there is divergence of moral culture and political culture.

However, voluntary programmes have their role to play in a democratic set up to mitigate the severity of pollution, and they help to augment the measures of the government in this direction.

**5.5 Direct Control**

**Regulation**

Regulation is the direct controlling activity of the government by means of directives limiting the actions of firms or household in the private sector. By this method, the government may impose restrictions on the polluter to maintain only the minimum quantity of emissions or create certain minimum standards in the activities of the polluters.

In India, direct control is exercised by means of Central Board for Prevention and Control of Water Pollution and Air Pollution. The Pollution Control Board fixes up minimum national standard (MINAS) for emission discharged from industries. Besides imposing a ceiling on the amount of discharge, the Board has powers to insist on certain activities within the industry to reduce pollution. For instance, the Board can regulate the industry by issuing direction to install such equipment like scrubbers, electro-static precipitators to reduce the emission of gas particulates.

The direct control by means of regulation is beset with many practical difficulties. When minimum standards are prescribed, it is presumed that the quantum of discharge could be measured and quantified and also the extent of pollution in the ambient air could be assessed so the polluting activities of the industries be perfectly regulated and monitored. This will be rather a difficult task as pollution depends on so many factors like the absorbing or assimilating capacity of the environment which will be changing.

During atmospheric inversions, the dispersion of pollution would be restricted to a particular region leading to a very grave consequence. The emission levels that considered normal may suddenly become abnormal and dangerous due to other factors which cannot be predicted. In such a situation, regulating authorities may have to impose a ban on certain activities of the industry to bring the pollution level to normalcy.

Further insisting on any genuine anti-pollution measures through regulation will result in passing on the cost to the consumers in full without adopting advanced technology over time. For example, if a firm is insisted on using certain type of clean fuel or superior quality coal, the firm can pass on the higher costs of clean fuel to its customers and it can also bid the price of the fuel to whatever level is necessary to force previous users to switch to the relatively cheaper dirty fuel or to do without fuel entirely. Under such conditions, we cannot presume social efficiency in the allocation of different grades of fuel between competitive users by the market system.

Moreover, regulatory commissions, in India, is still worse, particularly when the lobby of industrialists is strong and when most of the legislators have direct links with many firms, strict implementation of regulatory provision would be only in paper and not in reality.

When the politics of corruption is pervasive and the nexus between politicians and the executive is prevalent, and the practice of hoodwinking rules and regulations, one cannot expect any tangible results from direct regulatory measures. However, this method would augment the other methods to restrict pollution by the firms. Direct controls could be made more effective only when the fines imposed are too high on the polluter for non-compliance of regulatory direction. Nominal fines would not have any effect.

Economists are of the view that regulation is simply inefficient. Pricing techniques like taxes, effluent charges and subsidies would help better to internalize the external economies of pollution.

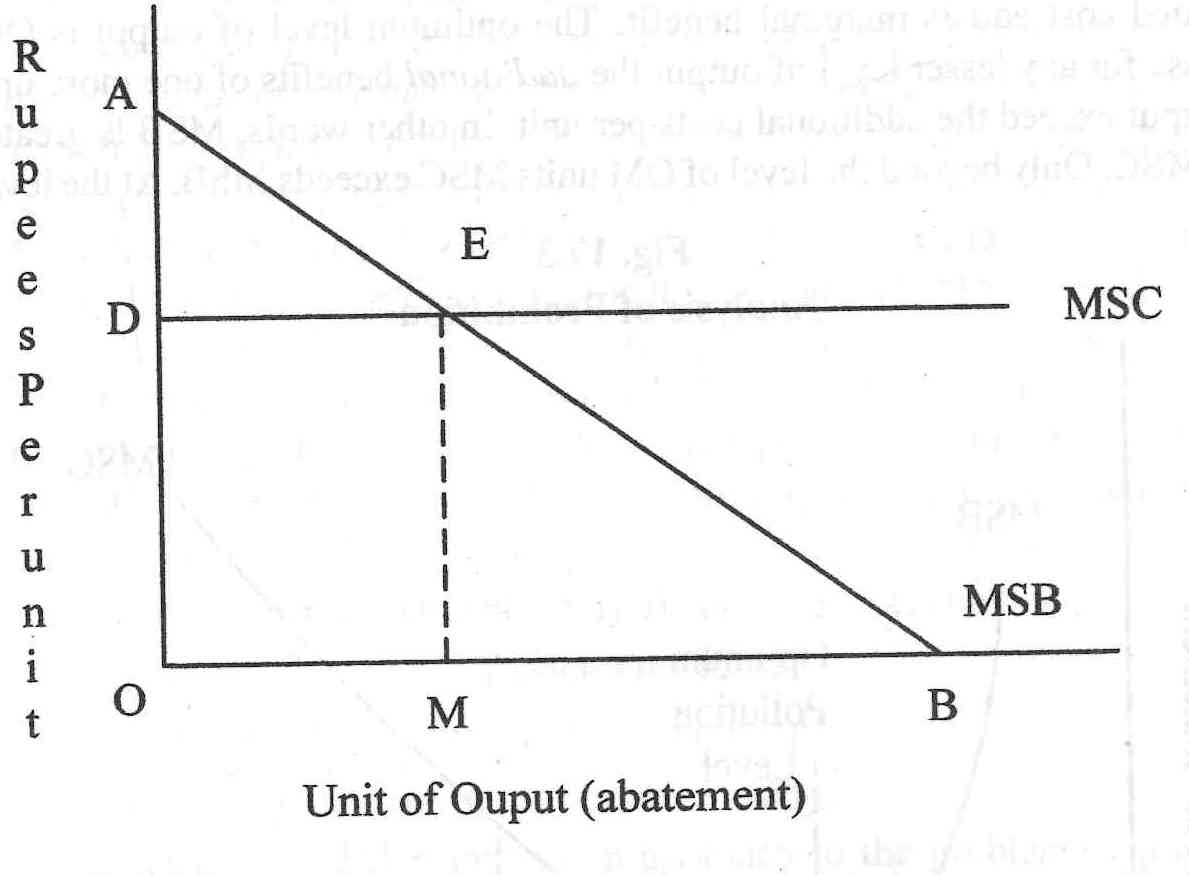
**Prohibition**

In contrast to regulation, the method of ‘Prohibition’ attempts to ban the activities outright by means of legislation. The laws relating to ban such activities will be subsequently enforced by police and the judicial system. This type of prohibition or ban may be permanent as in the case of DDT in USA or it can be a temporary measure to mitigate emergency air pollution situations.

The rationality of prohibiting an activity causing pollution depends on the benefit-cost analysis accruing to the society and to make a choice of continuance of the activity or not and to what extent the activity could be permitted. The society, in effect, has to trade-off some potential gains in environmental quality in return for more than compensating gains in the production and consumption of goods and services.

Benefit-cost analysis, in the broad sense means a systematic evaluation of advantages and disadvantages of any activity of production or consumption which may be real or conceptual or hypothetical. In the present context, the benefit-cost analysis is discussed relating to pollution prevention programme of the government. The benefit of such a programme is the reduction in pollution costs which includes both pollution damage avoidance cost and pollution welfare damage.

**Figure 5.2: Benefit-Cost Analysis**



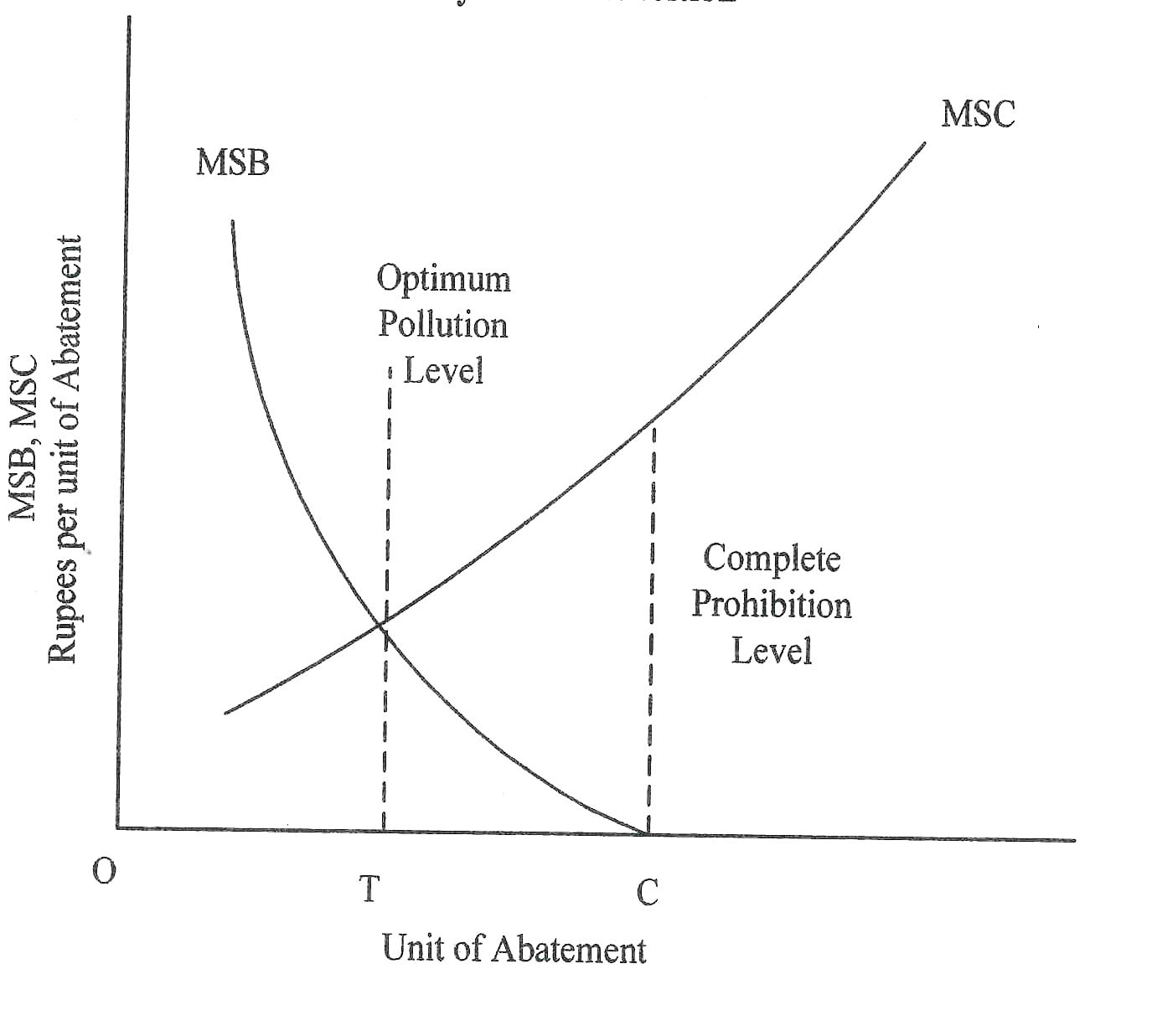
The actual costs of such a programme will be the total money outlays of the government, a measure of the value in alternative uses of the resources required to carry out the programme. The figure 5.2 gives Benefit-Cost representation for an hypothetical pollution abatement programme.

For simplicity, let us assume that in the pollution abatement programme, each additional rupee spent results in one more unit of output of pollution abatement, i.e., removal of a given amount of pollution from the environment. Further, in the initial stages, the society generally values the first few units of abatement highly than the subsequent units. This assumption is real, as the society’s health hazards will be conspicuously lessened in heavily pollution area by removing pollution to that extent.

The removal of pollution till the last unit will only reduce the annoyance with little increase in aesthetic values only and the society may not bother of the existing pollution, if it is below the health hazard level; to remove pollution to zero level is not possible either. With these assumptions, the Marginal Social Benefit Curve (MSB) and the Marginal Social Cost Curve (MSC) arc drawn. The horizontal MSC corresponds, to the assumption that every rupees of expenditure on the programme yields the same number of units of pollution abatement. The MSB represents the sum of all benefits to households at each level of output of the programme, that is the sum of amounts each household is willing to pay to remove one more unit pollutant at a particular level of concentration.

The downward slope of MSB, marginal social benefit reflects output abatement which initially is valued more than the benefits per unit in subsequent abatement. The MSB and MSC curves are analogous to demand and supply schedules in competitive private market. On the basis of benefit-cost interpretation, this programme is worth undertaking upto the level where marginal cost equals marginal benefit. The optimum level of output is OM because for any lesser level of output the *additional* benefits of one more unit of output exceed the additional costs per unit. In other words, MSB is greater than MSC. Only beyond the level of OM units MSC exceeds MSB. At the level of OB output, the society is supposed to demand complete pollution abatement is justified up to the level of OM, as at that level the marginal social cost and marginal social benefit equalize.

**Figure 5.3: Analysis of Prohibition**



Based on this benefit-cost analysis, economists are against “prohibition” as a general environmental policy. Alternative policy measures can reduce pollution to an acceptable degree. This will be more efficient than prohibition. Rigidly enforced prohibitions may move the society along the horizontal axis as in the figure 5.3. The marginal social cost of obtaining perfect purity may be very large and it may even involve in complete shutdown of some of the firms or even public utilities.

Alternative environmental policy measures like regulation, effluent charges are possible if the processes of measuring emission flows and monitoring are possible. On the other hand, prohibition will be simple affair which requires determination of *on or off* for potential polluters. But, the problem with ‘prohibition’ is that prohibitions do not enforce themselves and it has to be enforced strictly by the police and the judiciary.

If the potential gain to violators is very high, the law will not stop them. In many countries prohibition of narcotic drugs has proved failure, as the police, as well as judges are most reluctant to act against the wrong doers. In India, we are very familiar with the total failure of ‘Prohibition Policy’ with reference to liquor. Therefore, ‘prohibition’ as an instrument can be used in extreme cases of emergency in the interest of public safety.

**5.6 Fiscal Techniques: Pigouvian Taxes and Subsidies**

Instead of depending on the use of the fiat authority of the government in regulating or prohibiting pollution, which would be rather very difficult, the alternative strategy suggested is the use of pricing through fiscal techniques.

In prohibition, the private property rights of using air, water and natural resources are curbed or restricted. The fiscal technique uses the tax and subsidies to encourage or discourage private economic behavior conducive to improved environmental quality. By this method, it is suggested that the polluter may be taxed for the privilege of polluting the environment, so that the firm would be inclined to pollute less. For this purpose, a contrivance in the form of ‘meter’ would be installed in the premises to record the extent of discharge of effluent waste water or emission of smoke with pollutants. Large quantities of discharge would attract larger amount of the tax and lesser quantity of discharge would attract only little tax. This is what exactly we mean by *Pollution Tax.* The tax on residual discharge of water or water disposal is called *Effluent Charge.*

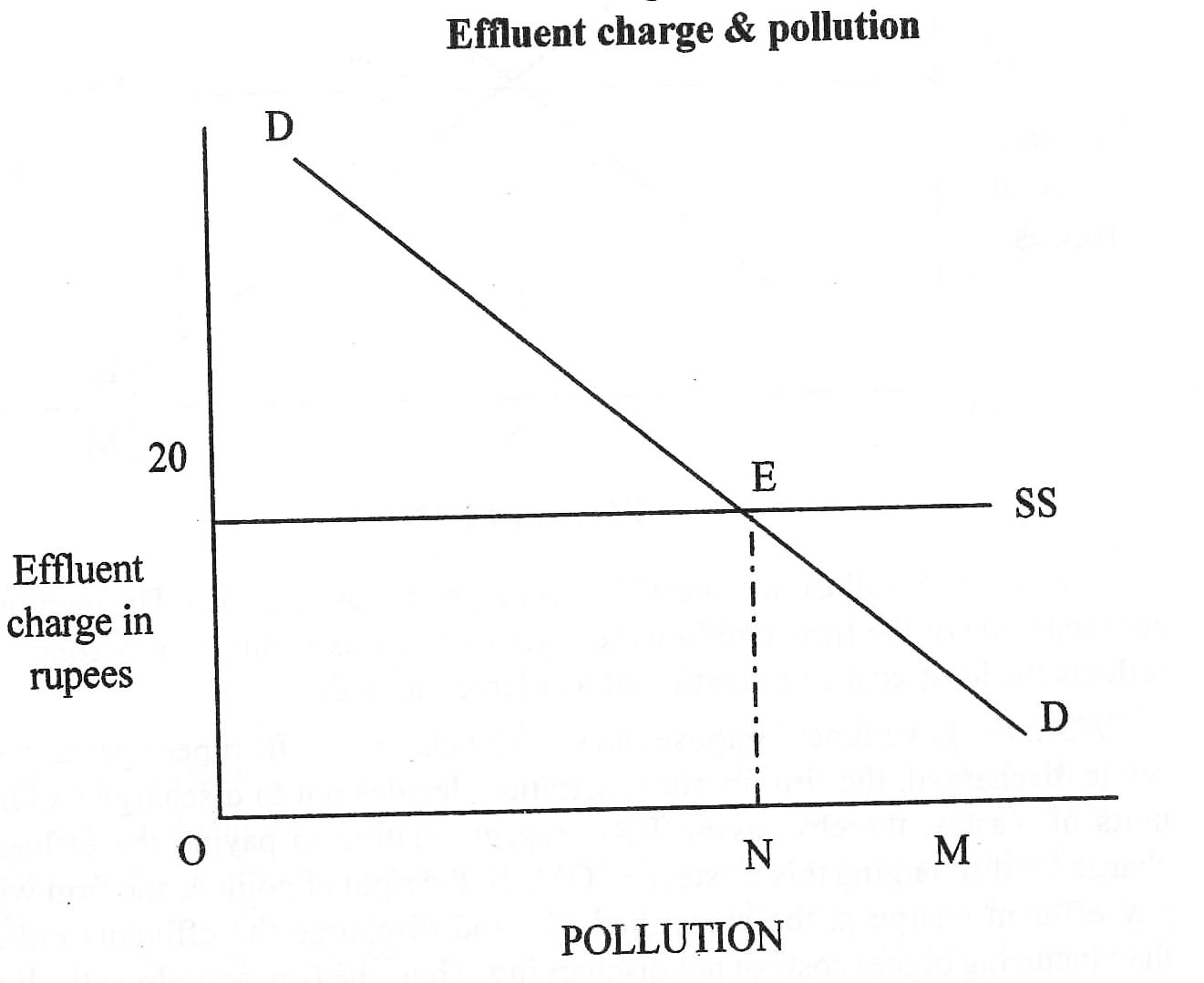
1. **Taxes**

A per unit tax on effluent discharged is levied. This is *the price the polluter has to pay for* the opportunity of discharging the residual wastes and waste water into the environment. By doing so, the unrestricted property right of using the natural resources free of cost is restricted.

If there is zero price tag associated with the use of natural resources, like water or air, then the price for the opportunity of polluting the environment becomes zero. With a policy of effluent charges, the government establishes its property rights to natural resources and determines price for their, use. By this, the polluting firms will be forced to consider “effluent charge” as another cost of business.

Therefore, it will create an incentive for firms to avoid this tax by reducing the effluents which means to evaluate alternative cost associated with avoiding the tax. Profit motive in business will induce the polluter to adopt a minimum cost solution. The solution may be a combination of treatment of waste water, reduction of output and payment of effluent charges.

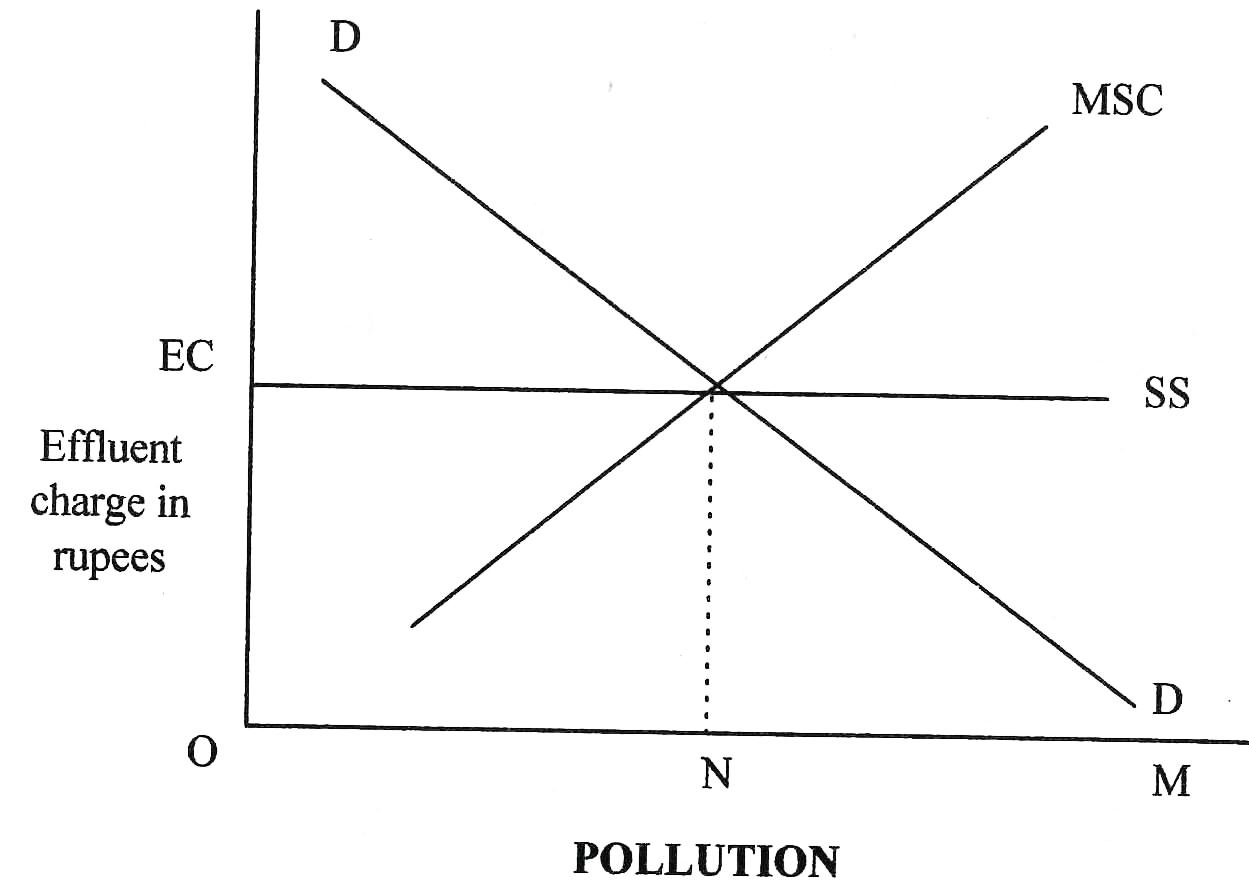
**Figure 5.4: Effluent Charge of Pollution**



The figure 5.4 indicates that effluent charge (pollution tax) will reduce the level of pollution. In the absence of any effluent charges the polluter’s price for opportunity of pollution becomes zero and as such the polluter’s supply curve for pollution opportunities coinciding with X axis, as there is no effluent charge to be paid. If a certain amount has to be paid, say Rs. 20/- towards effluent charges per unit of waste discharged, then the supply curve of the firm will be at the position SS in the figure, at a level of Rs. 20/- parallel to X axis. In the figure DD indicates the demand curve for pollution opportunities. It can also be seen as marginal abatement cost curve. This DD is a sloping down curve showing that, the polluters will pollute less if the effluent charge is high and pollutes more if the effluent is low.

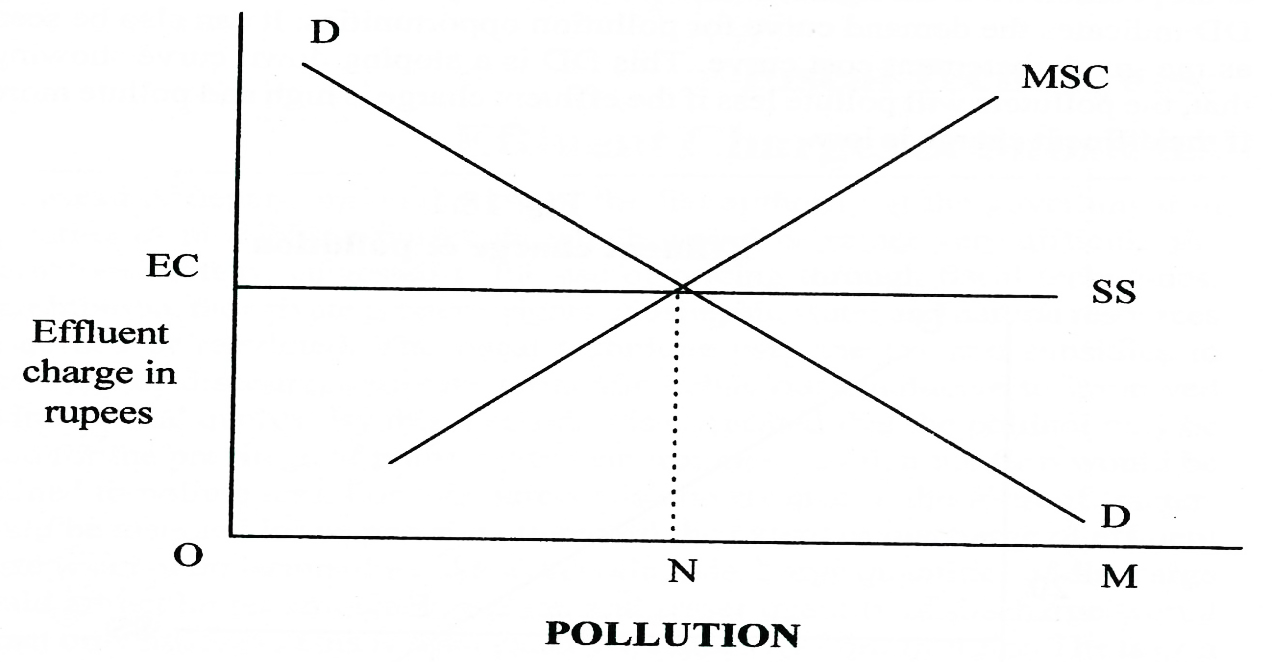
When the effluent charge is Rs. 20/- per unit of waste discharged, the polluter will pollute only upto the level on ON as the equilibrium point between SS and DD is E. By imposition of effluent charge, the level of pollution has been reduced from OM to ON.

**Figure 5.5: Optimal Effluent Charge**

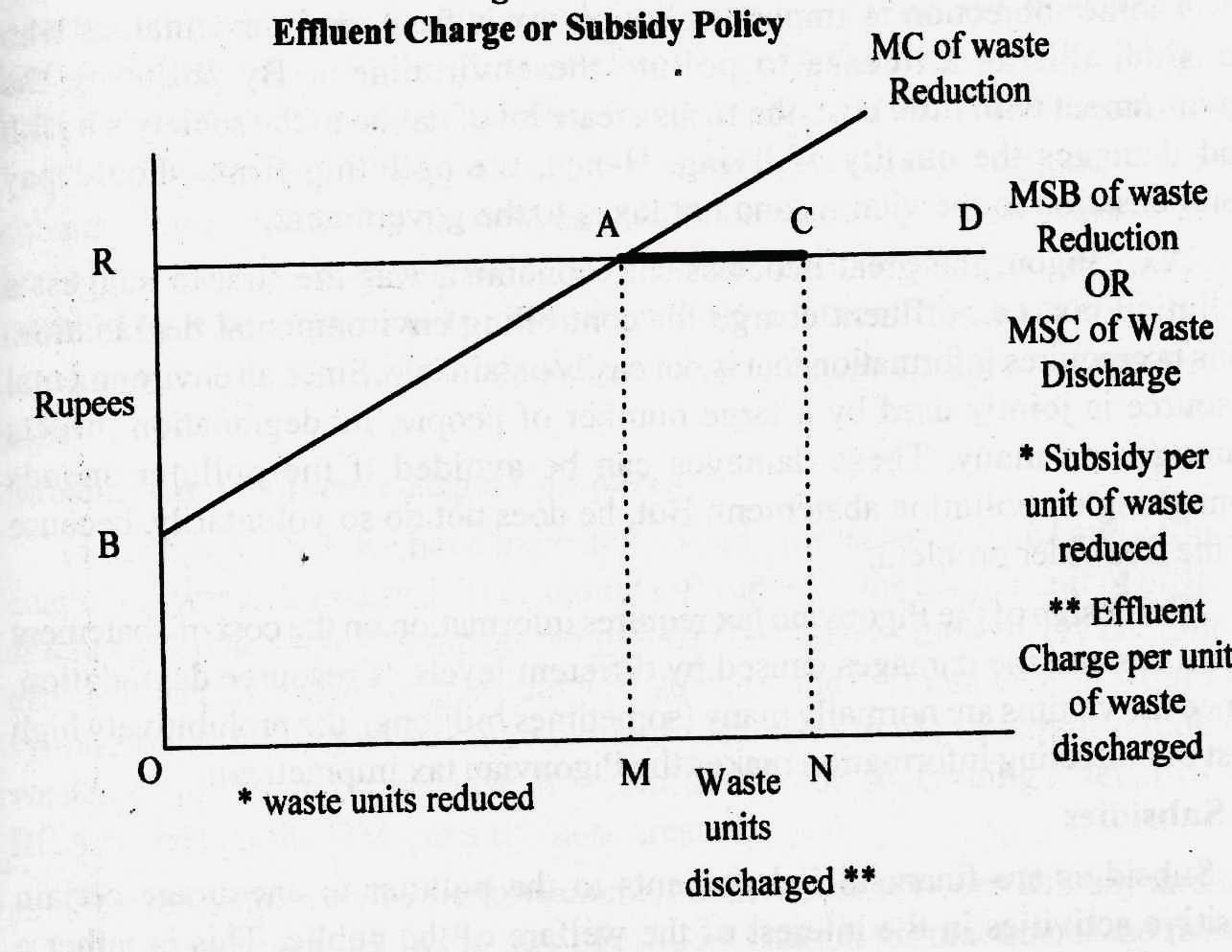


The figure 5.6 illustrates optimal effluent charge by indicating demand curve DD for pollution opportunities and marginal social cost curve (MSC) and also supply curve passing through the intersection of MSC and DD curves. The optimal effluent charge is EC in the figure 5.5 at which ON units of wastes (pollutant) are discharged by the polluter.

**Figure 5.6: Optimal Effluent Charge**



**Figure 5.7 Effluent Charges or Subsidy Policy**



The figure 5.7 illustrates the effluent charges or subsidy policy. The marginal cost schedule of the firm avoiding the discharge of waste into the environment reflects the least-cost combination of available methods.

When the government imposes and effluent charge of OR rupees per unit of waste discharged, the firm in our illustration decides not to discharge its OM units of wastes, thereby saving BRA rupees relative to paying the effluent charge for discharging this waste, i.e., OM.

To the right of point A, the firm will pay effluent charge at the prescribed rate and discharge the effluents rather than incurring higher costs of not discharging. Thus, the firm acts along the line BACD taking internal action to avoid waste discharge from B to A, i.e., OM units of waste; and if the waste load exceeds OM units, the firm elects to pay the OR rupees of effluent charge on the remainder. Suppose the total waste load for the firm is ON.

The firm would choose to reduce OM units of waste and discharge MN units of waste into the environment. By choosing this type of action, the firm has to pay an effluent charge for an amount equal to MACN rupees (MN is the total units discharged and AM is the effluent rate). This amount of MACN exactly compensates society for the external damages imposed by MN waste units. (By assumption the MSC of each unit of waste discharged is OR).

Therefore, under the effluent charge programme, the total costs of the firm are then OBAM (waste reduction cost) plus MACN (effluent tax payment). Changes in waste treatment technology, factor costs and price of final output will shift the marginal cost curve.

The effluent charge method of fiscal technique is supposed to be very efficient, dependable and also offers a permanent solution. However, the pollution tax is objected on the following grounds. The firms complain that the residual charge leads to “double burden” to the firm which is very unfair, first in incurring expenditure for pollution abatement equipment and then paying pollution tax. But the argument is beside the point. The firm can choose either installing pollution plant and reduce the commitment in effluent charges or pay more effluent charge without committing to effluent abatement programme or it may combine these two based on least cost.

Hence, the pollution cost is not a double burden as imagined. Secondly, the objection from consumers’ side is that the industry passes on the burden of the pollution tax on the consumers of the commodity produced by the industry in the form of higher prices. This is true; but the industry cannot pass on the burden of the pollution tax entirely on the people. The shifting of burden depends on the elasticity of demand for the commodity produced ‘by the polluting industry and also the elasticity of supply, as well as the conditions under which the commodity is produced. If the commodity is having very elastic demand only a portion of the tax can be passed on to consumers. If the commodity is having very inelastic demand, then a major portion of the tax can be passed on to the consumers. Generally, the tax burden of the commodity will be shared by the producer and consumer, based on elasticity of demand and elasticity of supply. The proportion of bearing the burden of the tax will be ‘Elasticity of demand *divided* by Elasticity of supply’.

Another objection to impose pollution tax is from environmentalists who consider this as a license to pollute the environment. By polluting the environment with little cost, the firm create lot of havoc to the society’s health and damages the quality of living. Hence, the polluting firms should pay compensation to the victims and not taxes to the government.

A.C, Pigou, the great neoclassical economist, was the first to suggest a pollution tax, i.e., effluent charge for controlling environmental degradation. This tax requires information that is not easily obtainable. Since an environment resource is jointly used by a large number of people, its degradation inflicts damages on many. These damages can be avoided if the polluter spends something on pollution abatement. But, he does not do so voluntarily, because of the free-rider problem.

The design of the Pigouvian tax requires information on the cost of abatement measures and the damages caused by different levels of resource degradation. Since the victims are normally many (sometimes millions), the prohibitively high cost of collecting information makes the Pigouvian tax impractical.

**B. Subsidies**

Subsidies are financial inducements to the polluter to encourage certain positive activities in the interest of the welfare of the public. This is rather a reward for good behavior and performance in the act of pollution. While tax is considered a penalty, subsides are considered as rewards. The subsidies may take any of the following forms:

1. Partly subsidizing the cost of installation of pollution control equipment. This subsidy is on the investment side.
2. Offering a fixed reward or concession for reducing emission from the base level used to be generally emitted by the firms in that line of production.

The Government of India offers a grant of investment allowance at the rate of 35 per cent of the actual cost of new machinery or plant installed for pollution control. At times, it takes the form of outright grant. Similarly, the Central Board for the Prevention and Control of the Water pollution in India gives a rebate of 7 per cent of cess payable by polluting industries under the Water (Prevention and Control of Pollution) Cess Act, if the industry installs any plant or machinery for the treatment of effluents.

Subsidy will have greater impact on the polluter if the amount is given for the purchase of equipment which will give some benefit to the firm. For example, a subsidy on a recycling plant will help the firm in reusing the resource and after also treatment. This will have dual effect of reducing pollution some benefits to the polluter. The firms would try to go in far the installation of such of plants where it stands to benefit, instead of having equipment controlling emissions in which the polluter has no advantage except obeying the rules. A subsidy is only a partial payment of the cost incurred. The other part of the cost should have to be borne by the firm. In the absence of any benefit, the firm would not opt for installation of equipment by incurring the other part of the cost availing subsidy.

Finally, a subsidy based on reduction in emissions is similar to the effect in subsidy. Pollution tax, as the both cases will be similar. A larger polluter loses heavily by paying large amount of tax; a larger polluter receives very little or nothing by way of subsidy. In both cases the polluter will be worse off.

**5.7 Allocation of Property Rights**

In one of the previous chapters, we had studied that degradation of environmental quality arises due to resources being public goods. We had also studied about the “tragedy of commons” wherein the resources are totally depleted or degraded due to over use or misuse by all people without any control or norms to preserve the quality of the resources. Allocation of property rights method of controlling pollution in just the opposite of treating resources as public goods. If resources are allocated to individuals or organizations as ‘private property’ with a legal entitlement to make use of them, then the tragedy of commons can be averted and the resource use will become rational and also minimal. Thereby the ‘externality’ arising out of commonality can be reduced to the minimum In short; this method advocates property rights over nature’s resources to prevent the spoliation of nature.

It is stated by Burton that the Sahel region of North Africa, which is now a desert, was once a fertile region, serving as the granary of the Roman Empire until the sixth century. The Arabs conquered that region, changed the property rights into a common property system for using the pastures. As a result of converting the private property into public property, with access to everyone, the tragedy of commons manifested fully. The lands degraded quickly and nobody cared for the conservation and preservation of the quality of the resource and finally it become a desert.

In controlling pollution, it is suggested, if the public good environmental quality can be transformed into a private good, Optimal environmental allocation can be reached. But the problem arises in defining the property right to resources in order to make an approach in that direction.

**5.8 Distributive Effects of Environmental Policy**

Pollution control is a very complex exercise and it is very difficult to assess who will benefit more and will benefit less. Generally, a programme of environmental policy will attempt to improve the quality of the environment. The Implementation of environmental policy programmes should have two important criteria, viz., efficiency and equity.

As a matter of fact any governmental programmes, in any sphere of activity, should have these criteria. Efficiency in resource allocation can be defined in terms of Pareto-Optimum about which we had already studied. But this Pareto-optimum which aims at making at least one better off without making anyone worse off is rather a highly generalized criterion. If income distribution in the society has been taken into consideration, there will be infinite number of Pareto Optimal states, as there are infinite numbers of income distribution. For an environmentalist, the approach is rather very easy.

According to him if the polluter is asked to pay for using the environmental resources, then programme is a successful one and equity is achieved. But, according to politicians and economists the entire programme is governed by the problem of distribution of costs and benefits.

**Equity and Benefits**

The problem of equity can be put in the following way; who gets hurt most by pollution; the rich or the poor, or everyone in the society? In the same way, we can put the question, who will benefit most from effective pollution control programmes, the poor or the effluents?

The environmental quality is a luxury good which will be demanded by affluent and upper middle class. The poorer sections of the society, as their income is very less, are more concerned with the essentials of living, viz., food, clothing and shelter and they discount environmental qualities in their consumption goods. The impact of environmental policy programmes will not be equal and uniformly felt by all sections of the society. The priorities of the poorer people and nations are entirely different form rich people and affluent nations.

Even if attention is limited to the benefits of pollution control programme, it is very difficult to make a categorical prediction of the nature a relationship (if any) between benefits received and income level. The point is that there are two influences on the distribution of benefits which may conflict with each other.

Firstly, if pollution levels are fairly uniform in a pollution control area, then the benefits of abatement will be equally available to all and this is a public good. If everyone values the pollution reduction equally, the benefits will spread evenly across the income scale and will consequently represent, as a percentage of income, a greater benefit to low - income recipients. But, if richer classes attach greater value to a given amount of pollution abatement, then the situation will be different. Even the benefits of public goods can be progressive or regressive depending on the tastes of people in different income groups.

Secondly, the rich may benefit relatively by their ability to select a pollution free place to live. The fact that rich suburbs are polluted less than interior city slums is not in itself evidence of a greater benefit of the rich from pollution control.

It may simply reflect the access of the rich to the unpolluted areas which do not need pollution control and rich do not benefit from pollution control policies of the government. Only if the rich tended to live in areas that offer heavy benefits from pollution control, there would be a regressive element in the benefits distribution. The regressiveness, progressiveness or otherwise of the benefit distribution can be found only by measuring the impact of a particular pollution control programme.

Further, the improved air quality in a particular locality of the urban area will tend to make the land prices in that area to rise. In fact, it has been found that air quality and land prices tend to be related in urban areas, i.e., higher land values in areas with higher air quality, other things being equal. If the urban poor tend to rent their dwellings, in the long run, the benefit will pass on to the urban poor in the form of higher rents. However, the cost of housing will also be higher. Nevertheless, the improvement would benefit the poor, who happened to rent out their dwellings.

Any programme relating to water pollution control and improved recreational opportunities and amenities will result in more benefit to the richer classes, as these higher-income groups would tend to value more these recreational amenities like swimming pool etc., and they would be prepared to pay more money, as they have more money.

Thus, any environmental programme relating to water quality and improvements connected therewith would tend to accrue disproportionately more benefit to the more affluent. Hence, this tendency is modified by offering better water-based facilities in places where more poor people are concentrated in large cities.

**Costs**

The distribution of the costs relating to pollution control programme is also a complicated affair. First, we must distinguish between two types of pollution control costs, viz., (i) real resource cost; and (ii) factor income costs.

*Real resource cost* are costs related to the land labour and capital that must be used in clearing the pollution generated, recovering the wastage and recycling them, so that they may not be discharged in the environment. When public agencies like Panchayats or Municipal Corporations undertake this job of collecting wastage and treating them to reduce pollution, the costs involved are passed on to the tax payers of the city or town.

On the other hand, if firms polluting are asked to undertake pollution control efforts of their own, the resource costs will be passed on to consumers in the form of higher prices for goods and services. The resource costs are all real costs or opportunity costs, because they represent opportunities foregone. All the resources used in pollution control could have been put to some other use. The cost to society is what their value would have been in their next best use.

*Factor-income costs* represent those changes in labour and capital incomes due to pollution control measures. The factor income costs are not necessarily real costs. Polluiton control porgrammes may result in changes in factor prices, as some resources become less valuable and their owners may thus experience a reduction in income. For example, any air pollution control programme will result in the poor demand for coal with high sulphur content. The price of such type of coal will become less due to poor demand. However, such type of coal will be continued to be extracted. But, the mine owners will receive lower income: Thus, in the case of factor income cost, they are not necessarily real or opportunity cost. However, in the short run, factor income costs may also be real costs. For example, as a result of pollution control policy, the real costs to firms would get increased.

With increased prices, the firms would have to reduce output. Consequent on the reduction, of output, some firms may go out of business and the released resources, particularly labour would remain unemployed for some time. If the labour remains unemployed for a fairly long time due to immobility or other causes like imperfect information in job opportunities, there is significant factor income cost.

This cost is a real cost, since the unemployed resources could be producing something of value for society.

Resource costs are passed on to consumers as high prices of goods and services. This will have a regressive incidence, i.e., the poor and lower income groups would have to ‘*pay higher proportion* of their income in the form of higher costs of goods and services, than, the higher income groups. This is due to the fact that lower income groups tend to spend a higher proportion of their income on goods and services in general, due to their poor income. It is possible to design public policies to redistribute or shift some of these pollution control costs in the interest of greater equity in income distribution.

There are two categories of cost shifting policies. The first deals with resource costs. It consists of direct and indirect grants and subsidies designed to shift the costs from consumers as a group to tax payers as a group, and within the group of tax payers from lower income to higher income tax payers. It is called a policy of *Cost Subsidy.*

The second type of policy deals with real factor income cost, i.e., costs that arise from slow or imperfect adjustments of resources, particularly labour to the changed economic conditions brought about by the implementation of pollution control programmes. We can call this as adjustment assistance.

**Cost Subsidies**

Cost subsidies to pollution control activities may be of two kind, viz., indirect subsidy and direct subsidy.

In indirect subsidy, the government will extend some favorable treatment to firms engaged in pollution control. For instance, some favorable tax treatment may be extended by exemption sales tax or excise duties in the purchase and installations of pollution control equipment further, the government may permit an accelerated depreciation of that equipment for corporate income-tax purposes.

In the case of direct subsidy, the government may grant cash payments to municipalities and firms engaged in pollution control activities. These direct cash payment will go to the extent of either fully or partially reimburse the expenses of the local authorities and firms.

If the State and Central Government tax systems are more progressive than the local taxes, then this shifting of cost benefits more towards the lower-income group. Similarly, the indirect subsidy to firms in pollution control will result in reduction of prices of commodities and services produced by the firm and low income consumers of those products and services will benefit more.

However, the advocacy of widespread use of cost subsidization policy on distributional grounds has its limitations. Though this can change the distribution of the burden between rich and poor, they may increase the total burden, because they distort the economic incentives faced by discharges. If discharges are relieved of the responsibility of paying the full costs of treating their wastes, they will have no economic incentive to reduce the waste generated.

Consequently, the total volume of wastes to be treated will become too high and the total cost of a given level of pollution control will be higher than necessary. Thus, the benefits arising out of cost subsidies, whether given to municipalities or industry will be counterbalanced by the higher treatment costs.

In the case of cost subsidies given to firms, there may be possibilities of those benefits are not passed on to consumers in the form of lower prices. For example, if a multi-plant firm selling in a national market receives a subsidy for pollution control equipment installed in one plant, this is not likely to affect the prices at which the product is sold. In such a situation, the benefit will go as profit to the firm and more dividends to share-holders.

Further, such cost subsidies may also result in inter-regional transfers. For example, a State subsidy to a municipal treatment plant which is also heating industrial wastes could flow largely to out of State consumers or stock-holders, if the industrial discharger was producing for a national market, or if stock-holders were spread across the nation.

Thus, the benefit arising out of cost subsidies present a mixed picture and it is very difficult to have a decisive subsidy policy that will not result in gross inefficiencies. These inefficiencies may outweigh any intended redistribution effects. Cost subsidies may partly go to increase the profits and one may not be sure whether the distributional or equity benefits are realised. However, on this ground, one cannot oppose cost subsidies. The only defect is, one cannot precisely judge the beneficial group.

**Adjustment Assistant**

Adjustment assistance consists of payments to owners of factor inputs who were adversely affected by the environmental control policy. This payment is made to enable the factor owners to make adjustments to newly imposed environmental standards. Hence, this type of assistance in called “Targeted” assistance.

For example, in order to prevent pollution, a factory is closed down and the environmental quality is ensured as the closed down factory cannot discharge effluents. This is the best and quickest way of ensuring perfect air quality and the people who yearn for better environmental quality standard would welcome it and would be willing to pay for such a clean atmosphere.

But, the disadvantage arising out of this policy decision would be thrown out of employment and the remedy of closing the factory to achieve air quality will become worse than the malady. Implementing pollution control policies may result in rising costs of products leading to shrinking of markets and finally it may also lead to shut down of the plant, at least temporarily and the low-income wage earners would have tough time. The problem will become severe in those areas where factor inputs are relatively immobile, particularly in small towns and one-industry mill towns where scope for factor movement is very much limited.

*The Adjustment Assistance Policy* could try to ameliorate the adverse effects of pollution control policy on labour and capital that would get unemployed. By this Adjustment Assistance Policy firms can obtain technical assistance in developing new products or lowering cost. They can obtain technical assistance in developing new products or lowering cost. They can obtain low-interest loans or loan guarantees for new equipment or conversion to a new activity where market conditions are better. By this policy, workers can get unemployment influences on the compensation and relocation allowances for moving to areas where prospects of employment are better. This policy will also facilitate retraining programme to workers and also grants to support labour in learning new skills.

Another disadvantage in closing the factory in the wake of pollution control programme is the loss of revenue to the municipality due to the shut down or closure of the factory. Hence, the well-conceived pollution control programme should be properly structured and effectively tailored with Adjustment Assistance Programme to help the factors, viz., labour and capital and also to help the municipalities that loose revenue. This is a very delicate and tough job in defining the eligibility criterion. However, the governments with their experience in adjustment assistance in tariff cut programmes in international trade could be able to design appropriate subsidy and adjustment assistance policy.

The policy of cost subsidies and adjustment assistance should be consistent with achieving pollution control at least cost. The Adjustment Assistance Policy deals directly with the problem of easing the plight of poor who are forced by circumstances to bear disproportionately larger share of the cost of pollution control.

Adjustment assistance serves to redistribute the costs of environmental improvement where these costs are borne by a few for the benefit of many. The effectiveness of pollution control policy depends on empirical studies of each programme and it is very difficult to precisely predict in theory. Several empirical studies made on the consequences of environment policy reveal that distribution of costs is regressively falling on the lower income groups.

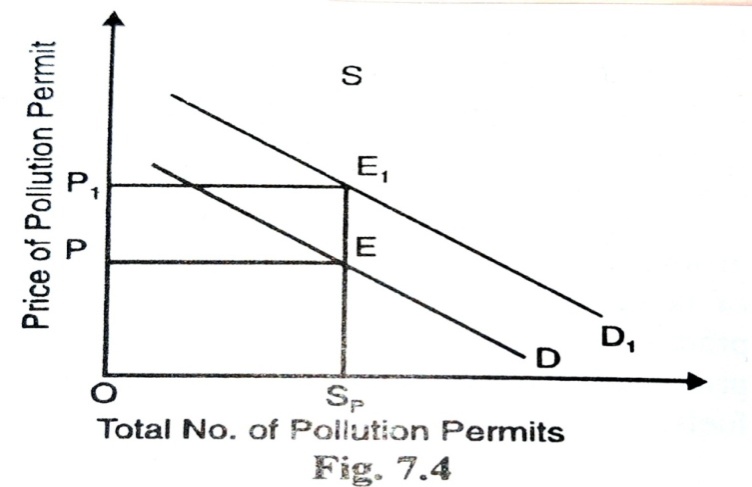
**5.9 Tradable Permits**

J. H. Dales has proposed the idea of sale of pollution rights. Tradable quotas or permits assign “rights to use resources or emit certain levels of pollution.” These pollution rights can be bought and sold in the market.

In practice, governments issue the permits or assign a quota for emissions of a specified pollutant of consumption of a resource over a given period. Once an overall level of pollution or resource use has been set, the permits or quotas can be bought and sold among the industries. This strategy can be extremely cost-effective. The tradable permits have great potential to yield social welfare gains by allowing trade between groups to save costs, when there is agreement on a goal of total pollution levels or resources usage. Since the issuance of permits creates property rights, it is important that initial allocations of permits are determined equitably and that there is no artificial obstruction to trade permits.

The market mechanism for pollution permits is illustrated in Figure 5.8. Price of pollution permit is measured in the vertical axis and total number of pollution permit is measured in the horizontal axis. The curve D represents the demand for pollution permits. The supply of permits is limited by the pollution control agency in the country.

**Figure 5.8: Tradable Permits**



SSp is the supply curve for pollution permits and OSp, is their limits. Initially, the demand curve D cuts the supply curve S at point E. At price OP, an efficient level for permits is OSp. There is a secondary market for pollution rights now. If overtime, the demand for pollution rights increases, then the demand curve will shift from D to D1. Therefore, the price of pollution rights will increase to OP1.

**5.10 Prices v/s Quantity Instruments**

**Economic Instruments**

Economic instruments can be divided into three categories:

* Price based instruments,
* Quantity based instruments and
* Hybrid instruments.

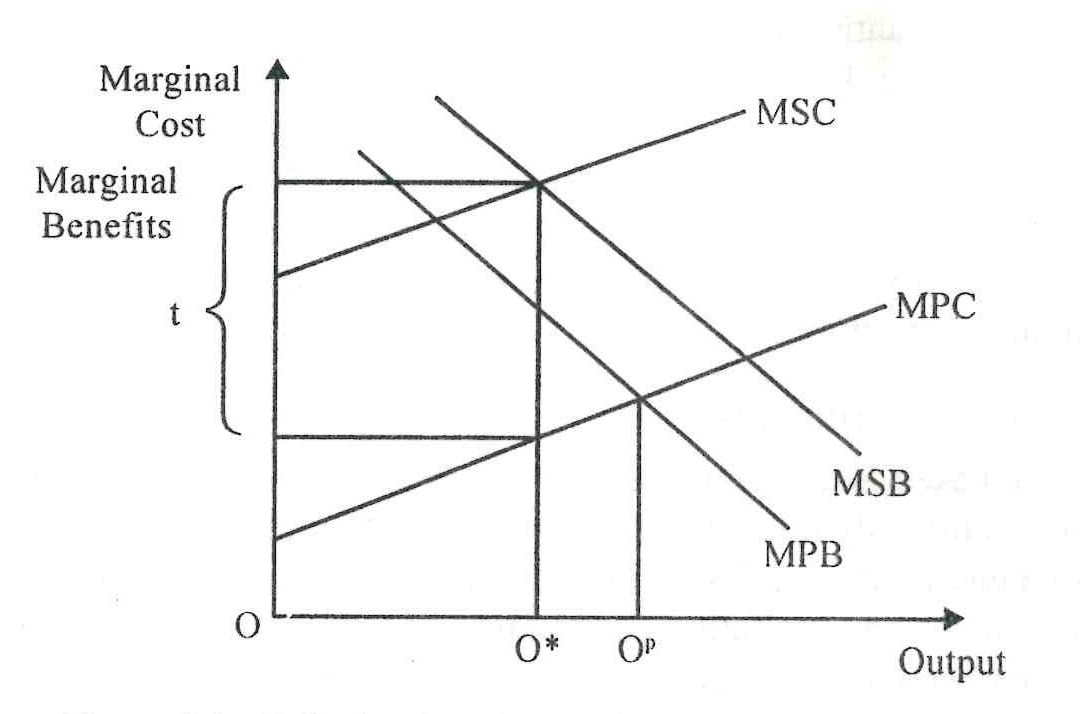
These instruments are known as market-based instruments since they complement the market processes to achieve Pareto efficiency even with the presence of environmental externalities like air and water pollution. In other words, if these instruments are used, free-market equilibrium of the economy will be Pareto optimal even when environmental externalities are present.

**Price Based Instruments**

The price based instruments were first suggested by Pigou in the form of taxes and subsidies to deal with detrimental and beneficial environmental externalities in production and consumption.

They are pollution taxes on a polluting commodity either through its production (paper, leather, electricity etc.) or consumption (cigarettes, packed food etc.) or on a polluting input (fuel inputs, chemicals etc.). Also, they can be subsidies on the commodities, the production of which generates environmental benefits.

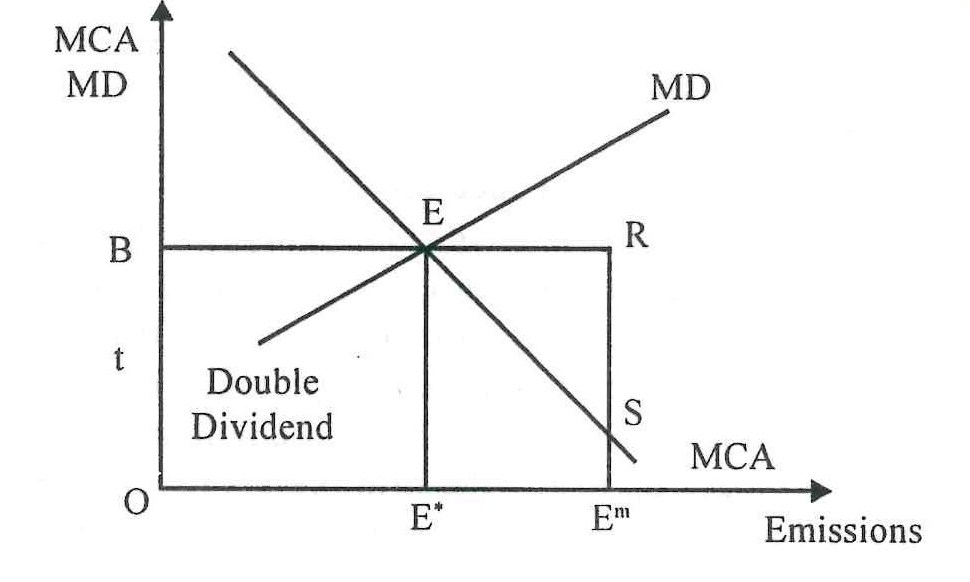
**Figure 5.9: Pollution Tax for a Socially Optimum Output Level**



The pollution tax or Pigouvian tax is a corrective instrument to realize the socially optimal level of economic activity generating pollution. This is illustrated in Figure 5.9, where MPC, MSC stand respectively for marginal private cost, marginal social cost (marginal private cost plus pollution abatement cost); MPB, MSB represent respectively marginal private benefits (marginal benefit from the commodity produced), marginal social benefits (marginal benefit from the commodity produced), marginal social benefits (marginal private benefits plus the marginal benefits from reduced pollution); Op, O\* represent respectively free market level of output, the optimal level of output and t stands for the optimal tax.

With pollution externality free market level of output Op is larger than the optimal level, O\*. A pollution tax equivalent to‘t’ will bring the level of polluting economic activity to O\*, the optimal level. Also, this tax is equivalent to the difference between the marginal social cost and the marginal private cost at the optimum.

**Figure 5.10: Pareto optimal Solution for a Polluting Industry**



In figure 5.10 MCA, MD respectively represent the marginal cost of abatement, and marginal damages from pollution; E\*, Em stand respectively for pollution loads with and without tax instrument and t stands for the pollution tax.

With the polluters using the pollution abatement technologies, the Pareto optimality requires that the pollution has to be reduced up to the level at which MCA is equal to MD as shown in Figure 5.10. If a tax equivalent to‘t’ is levied per unit of pollution on the polluter, based on the polluter pay principle, the polluter has an incentive to reduce pollution up to the optimal level, E\* in the free market.

The polluter has two choices: pay tax equivalent to E\*EREm or reduce pollution load from Emto E\*, incurring the cost equal to E\*ESEm. If he reduces the pollution, he will save cost equal to ERS as in Figure5.10. Therefore, given the tax rate equivalent to‘t’, he chooses to reduce pollution rather than pay the tax.

The models of general economic equilibrium based on Pigou’s original analysis have shown that with Pigouvian taxes and subsidies, the competitive equilibrium of an economy with environmental externalities is Pareto optimal.

It is in this sense, that Pigouvian taxes and subsidies are regarded as the best instruments. The Pareto optimality with externalities requires that the marginal environmental pollution abatement cost of the firm is equal to the marginal damages from pollution in addition to other optimality conditions for the supply and demand for private goods. The damages from pollution (for instance air and water pollution) accrue to a large number of people and therefore the damages from increasing a unit of pollution at the margin is the sum of marginal damage to all the affected people.

Therefore, to design a Pigouvian tax, the information about abatement cost functions of polluting firms and damage functions for all the affected people is required. The cost of collecting the information to estimate these functions can be prohibitively high (for example millions of people are affected by the pollution of a major river like the Ganges and an urban air shed like Delhi) and therefore it may not be economically feasible to design the Pigouvian tax.

**Quantity Based Instruments**

D.H Dales (1968) suggested an alternative to the pollution tax, a system of tradeable pollution rights for the management of the environment. He has proposed that property rights be assigned to environment and offered for sale to the highest bidder. This system like tax can achieve the specified environment target at minimum cost.

For example in the case of air pollution, this approach first determines the optimal level of pollution in a given geographical area. This level of pollution is then divided into a number of permits among the various polluting units within the area (either by free distribution or by auctioning).

Firms which are comparatively more efficient in controlling their wastes (the ones that face lower unit cost for pollution control) may not only be able to continue their original level of production and emissions but may even have some pollution permits. This Surplus may be sold to firms which are less efficient in controlling their wastes (the ones that face higher unit costs for pollution abatement). Provided monitoring is possible and effective, the net result is that total pollution is kept within the prescribed levels.

The more efficient firms will sell their surplus permits to less efficient firms which require more permits in order to continue with original production plans. In this process, a market for pollution permits is created in which trading in permits takes place up to the point at which the aggregate supply of permits is equal to the aggregate demand for permits and the equilibrium permit price is equal to the marginal cost of abatement to each firm.

**5.11 Mixed Instruments**

**5.12 Other Instruments**

A mixture of both command controls and economic instruments should be used in practice. Economic instruments alone may not be feasible because of prohibitively high information costs and command and control measures alone are inefficient measures (they result in the use of costly pollution abatement technologies by the firms) the estimation of damage functions of affected people in the case of pollution tax, and knowing a priori the optimal level of pollution in the case of tradable permits pose practical problems for the design of economic instruments.

Fixation of pollution standards a priori and using either pollution tax or marketable permits instrument to induce the polluter to meet those standards is a hybrid method using regulatory and economic instruments. However, in this case the criteria for fixation of environmental standards are a subject of debate. Scientifically they have to be based on the evidence concerning the effects of air pollution on health or of polluted water on fish life; they can alternatively be decided through a political process by having a referendum on the choice among alternative sets of pollution standards.

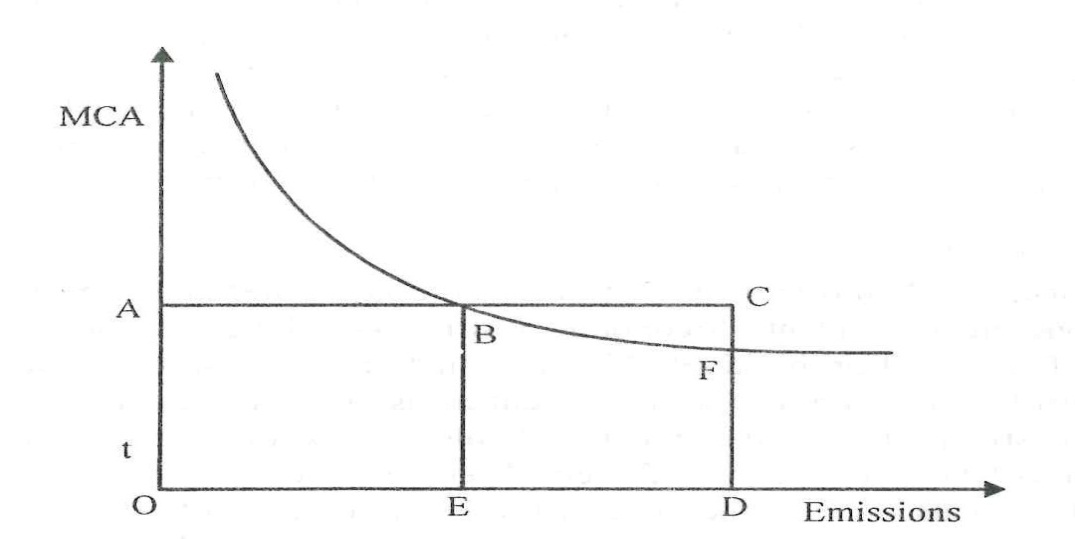
Once the environmental standards are given a priori, the difficult problem of estimating the damage functions for all the people affected by pollution can be avoided for designing the economic instruments. However, we need an estimate of the pollution abatement cost function.

It is economically feasible to obtain an estimate of pollution abatement cost function because;

(a) The polluters may normally be much less in number than the affected people, and

(b)Tangible information can e obtained about technologies used by the polluters, pollution loads and levels of production. Given the environmental standards and an estimate of the marginal abatement cost function, a rate of tax can be fixed such that the firms will automatically have an incentive to reduce pollution for meeting the standards. This is explained in Figure 5.11.

**Figure 5.11: Pollution Abatement Cost**



If the firm has to reduce pollution load from D to E as per the environmental standard, the rate of tax equivalent to OA will make the firm do so. The rate of tax‘t’ in this case is the marginal abatement cost corresponding to the level of pollution permitted by the given standard.

The firm has an incentive for pollution abatement rather than paying tax because the cost of abatement given by the area BFDE in the figure 5.11 is lower than the tax liability given by the area BCDE. Similarly marketable pollution permits can be used to obtain the reduction in pollution loads by the firms as required by the environmental standards (a priori fixed ambient pollution concentrations). It can be shown that the taxes and standards or tradable permits and standards method result in the adoption of least cost technologies by the firms.

There can be many situations in which command-and-control instruments are unavoidable. In several cases, the social cost of particular activity depends on the variables beyond the control of those directly involved.

For example, the effects of discharge of effluents into a river depend upon the conditions of the river at that particular point of time. Similarly, stagnant air can trap air pollutants, perhaps even collecting them until they become hazardous. Therefore, exogenous meteorological conditions may contribute to occasional crisis, requiring temporary emergency measures in the form of commands and controls.

Pollution tax rates cannot be changed on short notice to deal with emergencies and even if the changes are effected the polluter’s response follows with a longer time lag. Marketable permits also result in long run adjustments in environmental quality and are not suitable for emergencies.

Command and control measures on the other hand can be quickly operated to deal with more than normal amount of emissions arising out of emergencies, since they do not require extra monitoring. Therefore, in practice neither economic instruments nor commands and controls alone constitute an optimal environmental strategy. The cost minimizing strategy to realize given environmental standards is a mixed strategy consisting of economic instruments and commands and controls.

Therefore, it is realised from the above that environmental protection is an essential part of a study. Economic analysis too gives ample evidence to this fact, the various policies and strategies too echo this concern.

**MODULE-6**

**ENVIRONMENTAL ISSUES AND PROBLEMS IN INDIA**

The present module deals with environmental issues and problems in India from a multi-dimensional perspective. Pollution has been a persistent problem in the country. There are various sources and types of pollution contaminating the environment. The module also looks into the status of pollution and environment in India, the rural and urban problems with regard to environment and the inter-linkage between population, poverty, urbanization and pollution. Energy as a keystone of human prosperity and a vital component of human rehabilitation in India is discussed in the context of energy environment interaction. The various governmental injections in protecting the environment through policies and programmes are also dealt.

**6.1 Sources and Types of Pollution**

Environment Pollution is the addition of contaminants into the natural environment that causes detrimental effects to nature, natural resources and mankind. Any unnatural and negative changes in all the dimensions like chemical, physical and biological characteristics of any component of the ecosystem i.e. air, water or soil which can cause harmful effects on various forms of life and property is called environmental pollution. A pollutant therefore is any substance which causes harmful effects or uneasiness in the organisms, then that particular substance may be called as the pollutant.

There is a varied classification of pollution based on several criteria, some of them are;

*The materials that cause pollution are of two types*:

1. Persistent pollutants: Those pollutants which remain consistent in the environment for a long period of time without any change in its original form are called persistent pollutants. For example: pesticides, nuclear wastes, and plastics etc.

2. Non-persistent pollutants: These pollutants are the opposite of persistent pollutants and break down in the simple form. If this process of breaking down is done by living organisms, then such pollutants are referred to as biodegradable pollutants.

*From another perspective, pollutants can be classified as follows*:

1. Primary Pollutants: Primary pollutants are those which remain in the form in which they were added to the environment for example. DDT, Plastic etc.

2. Secondary Pollutants: Secondary pollutants are formed due to interaction of primary pollutants amongst themselves viz. PAN by the interaction of NOx& Hydrocarbons.

*According to their existence in nature*:

1. Quantitative Pollutants: These substances are already present in the atmosphere but they become pollutant when their concentration level reaches to a particular level which is above a threshold limit.

2. Qualitative Pollutants: These are man-made pollutants eg. Fungicides, herbicides etc.

*According to origin*:

1. Man-made Pollutants

2. Natural Pollutants

*According to the nature of disposal*:

1. Biodegradable Pollutants

2. Non-biodegradable Pollutants

There are several sources of pollution in India, the important ones are;

* Domestic sources: Domestic sources of pollution include toilets, latrines and waste water from kitchens and bathrooms. If these wastes are properly contained and prevented from getting into the environment, they will not cause pollution. However, frequently this is not the case. Open defecation obviously releases human waste into the environment, which can then be washed into rivers and other surface waters.

### Industry: Pollution from the industrial sector in India has been on the rise, posing a serious problem to the environment. Many industrial processes produce polluting waste substances that are discharged into the environment, frequently through chimneys (to the air) or through pipes (to surface water). Among the most polluting industries are food processing, tanneries and textiles with processing plants and factories that produce liquid effluents which are discharged into rivers, often without treatment

### Agriculture: Agriculture is also responsible for gaseous pollutants in the form of methane produced by livestock and solid pollutants from crop residues, packaging materials and other wastes similar to those produced domestically. Animals also contribute to waste products and potential pollutants with their excrement.

### Transport: Pollution emitted by vehicles is a major source of pollution in India.

**6.2 Air, Water and Noise**

* *Air Pollution*: Air pollution is the presence of one or more disadvantageous content in such quantity and for such duration, as it is catastrophic, or tends to be catastrophic, to human health and welfare, animal or plant life. It is the contaminants of air by the discharge of detrimental substances.

**Table 6.1: Some of the Air Pollutants, their Sources, and Effects**

|  |  |  |
| --- | --- | --- |
| **Name of the Pollutants** | **Sources** | **Health Effects** |
| Nitrogen oxides | Industries, vehicles and power plants | Problems in the lungs, respiratory systems and causes asthma and bronchitis. |
| Carbon monoxide | Emission and burning of fossil fuels | Severe headache, irritation to mucous membrane, unconsciousness and death. |
| Carbon dioxide | Burning of fossil fuels | Vision problem, severe headache and heart strain. |
| Suspended particulate matter | Vehicular emission and burning of fossil fuels. | Lung irritation reduces development of RBC and pulmonary malfunctioning. |
| Sulphur oxide | Industries and power plant | Irritation in eyes and throat, allergies, cough etc. |
| Smog | Industries and vehicular pollution | Respiratory and eye problems |
| Hydrocarbons | Burning of fossil fuels | Kidney problems, irritation in eyes, nose and throat, asthma, hypertension and carcinogenic effects on lungs. |
| Chlorofluorocarbons | Refrigerators, emission from jets | Depletion of ozone layer, global warming |

Other pollutants are cadmium, lead, mercury, silica, coal dust and particles and radioactive pollutants.

*Control measures*:

* Policy measures
* Modification of industrial process and selection of suitable fuels and its utilization.
* Collection of pollutants and convert it into less toxic forms by different methods.

*Government initiatives*:

* National air quality monitoring programme (NAMP)
* National ambient air quality standards (NAAQS)

**Water Pollution**

Water Pollution: Water pollution is the addition of certain substances such as organic, inorganic, biological and radioactive to the water, which degrades the water quality and makes it unhealthy for use. Water pollution is not only confined to surface water but also spread to groundwater, sea, and ocean.

*Sources:*

* Point sources: These are directly pointed towards the water bodies from the source of origin of pollution and are thus easy to regulate.
* Non-point sources: These sources are related to many diffuse sources and are thus difficult to regulate.

*Some of the sources are*:

* Industrial and community wastewater: Industries like mining, iron and steel, pharmaceuticals, food processing, soap and detergent and paper and pulp.
* Agricultural sources: thermal pollution (discharge of hot water by thermal power plants cause deficiency of dissolved oxygen in water) and underground water pollution.
* Marine pollution: river discharge, manmade pollution and oil spills etc.

*Effects:*

* An excessive amount of mercury in water can cause Minamata disease in humans and dropsy in fishes; Lead in large amount can cause dyslexia, Cadmium poisoning causes Itai – Itai disease, etc.
* Polluted water has less amount of Dissolved oxygen (DO) content which is important for sensitive organisms, thereby eliminates sensitive organisms.
* Excess of nitrate in drinking water is dangerous for infants and human health, excess fluoride causes neuromuscular disorder and teeth deformity, hardening of bones and painful joints.
* Biological magnification and eutrophication (‘Eu’ means healthy and ‘trophy’ means nutrition. The improvement of nutrients in water bodies causes eutrophication. Domestic waste discharge, agricultural waste, land drainage and industrial waste in a water body leads to a rapid increase in nutrients in a water body which initiates early ageing of water bodies).

*Control Measures:*

* Usage of water should be minimized by changing the techniques involved.
* Recycling and treatment of water should be used to the maximum extent possible.
* The quantity of discharge of wastewater can be minimized.
* Excessive use of pesticides and fertilizers should be avoided.
* Organic farming and efficient use of animal residues as fertilizers.

**Noise Pollution**

When unpleasant noise is created by machines or people which is annoying, distracting and physically painful then it is called noise pollution. Sound is measured in decibels (dB), a person’s hearing can be damaged if exposed to noise levels over 75 dB over a period of time. WHO recommends 30 dB sound levels for indoor.

*Sources of Noise Pollution*

* Indoor sources: It includes noise produced by radio, television, generators, electric fans, air coolers etc. Due to the higher population, industries and transportation, effects of noise pollution is more in cities.
* Outdoor sources: It includes loudspeakers, industrial activities, automobiles, rail traffic, aero-planes and activities in social religious places etc.

*Effects of Noise pollution*

* It is annoying and irritating. Noise causes many problems like disturbs sleep, causes hypertension (high blood pressure), emotional complications such as aggression, mental depression and annoyance.
* Noise pollution adversely affects the efficiency of individuals.
* Noise pollution can cause damage to the material of building due to exposure to ultrasonic/infrasonic waves.

*Control measures*

* Making noise mounds, walls for noise attenuation and well-maintained roads and smooth surfacing of it are some of the noise abatement measures.
* Air traffic noise can be tackled by the appropriate introduction of noise regulations for takeoff and landing of aircraft at the airport.
* Use of soundproofing equipment like generators in areas producing a lot of noise can reduce industrial noise.
* Reducing noise level from domestic sectors, maintenance of automobiles, and prohibition of uses of loudspeakers for certain time. A green belt of trees is a good noise absorber.

**6.3 Chemicals and Land Degradation**

***Chemical pollution***is defined as the presence or increase in our environment of chemical pollutants that are not naturally present there or are found in amounts higher than their natural background values. Most of the chemicals that pollute the environment are man-made, resulting from the various activities in which toxic chemicals are used for various purposes.

Chemical pollution is caused by the discharge of chemicals into the atmosphere through steam and wastewater.

*Chemical compounds* are organic or inorganic chemicals that are the main [causes of chemical pollution](https://www.environmentalpollutioncenters.org/chemical/causes/). The most common chemical pollutants are those compounds used across large areas and which are persistent, meaning they do not easily degrade in nature.

Examples are most pesticides, herbicides, insecticides used in agriculture and gardening, as well as chlorinated solvents used in many industrial processes and dry-cleaning activities.

The major [pollutant chemicals](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/chemical-pollutant) in the liquid fraction are [hydrogen sulfide](https://www.sciencedirect.com/topics/engineering/hydrogen-sulfide) (H2S), arsenic (As), [boron](https://www.sciencedirect.com/topics/chemical-engineering/boron) (B), mercury (Hg) and other heavy metals such as lead (Pb), [cadmium](https://www.sciencedirect.com/topics/engineering/cadmium) (Cd), iron (Fe), zinc (Zn) and manganese (Mn). Other harmful constituents, although present in smaller quantities, are lithium (Li), ammonia (NH3) and aluminum (Al). [High salt concentrations](https://www.sciencedirect.com/topics/engineering/high-salt-concentration) in certain [geothermal brines](https://www.sciencedirect.com/topics/engineering/geothermal-brine) cause additional problems. Disposal of water of this type is a risky endeavor, as As and Hg, in particular, may accumulate in sediments and organisms.

*Chemical intoxication* is caused by exposure to chemical pollutants and can have immediate effects or delayed effects, which may appear after weeks or even months after the exposure occurred. Severe chemical intoxication may cause the death of the person that inhales an increased quantity of such substances.

Based on their chemical structure, chemical contaminants can be classified into naturally-occurring and man-made categories. They can be organic or inorganic (organic compounds always contain carbon and carbon-hydrogen bonds, whereas most inorganic compounds do not contain carbon).

**Land Degradation**

Increase in population in the urban areas due to urbanization, industrialization has resulted in the disposal of wastes in the vast land areas. Land is polluted by solids and liquid waste from the paper and pulp mills, oil refineries, power plants, etc.

The excessive use of fertilizers, pesticides, herbicides and insecticides for enhancing agricultural productivity results in land pollution besides water pollution. Land pollution is caused by industrial waste, and domestic waste. Land is also adversely affected by soil pollution or erosion.

Soil erosion is one of the gravest disasters caused by human activity. It poses a severe threat to the livelihood and food security of the people, especially those in the lower economic strata.

In India, it is seen in its worst form in the Himalayan watershed that sustains a huge population and replenishes several perennial river systems. Soil erosion due to water flow, constant high velocity winds and shifting cultivation (jhuming) extensively practiced in the North-East are the major causes of the problem. Serious consequences are desertification and heavy siltation of major reservoirs. Wrong farming practices lead to the depletion of topsoil. An extensive cattle grazing is also a contributory factor.

**6.4 Status of Pollution and Environment in India**

In recent years, rapid urbanization in India has been detrimental in many ways to the country’s environment. [An increase in the country’s population](https://www.statista.com/statistics/263766/total-population-of-india/) and inadequate infrastructure has rendered many [Indian cities with unhealthy living conditions](https://www.statista.com/chart/17239/average-level-of-particulate-matter-pollution/). With existing challenges of poverty, depleting natural resources, poor water quality, and a [lack of sanitation](https://www.statista.com/statistics/586352/india-access-to-improved-sanitation-by-country/), many citizens bear the brunt of the toxic, unhealthy living conditions. The most affected are the poor and vulnerable sections of society from disadvantaged economic and social backgrounds. Depending on the type of pollution, the health effect varies, based on exposure and age.

India's environmental protection started as early as in the 1970s; it has stringent environmental policies and regulatory instruments in place. The government implemented a nationwide ban on single-use plastics in late 2019. Despite this, the environmental conditions deteriorated as a result of increased industrial production since the 1990s.

Air pollution is one of the major concerns, specifically in urban areas. This was primarily caused by [fossil fuel burning in the transportation and industrial sectors](https://www.statista.com/statistics/486019/co2-emissions-india-fossil-fuel-and-industrial-purposes/). Additionally, the burning of agricultural waste, as a cleaning field process, introduces more pollutants in the air. Since this was mainly in the vicinity of the capital region, Delhi became [the most polluted capital city](https://www.statista.com/statistics/1135370/most-polluted-capital-cities-in-the-world/) in 2019. However, a positive effect of the coronavirus (COVID-19) lockdown in 2020 was a [significant reduction in pollution levels](https://www.statista.com/statistics/1115024/india-aqi-by-city/)across many Indian cities.

Pollution in the country permeates into other levels, and significantly so. Most water resources are heavily polluted due to effluent discharge. As of 2017, about six percent of [deaths were caused by unsafe water sources](https://www.statista.com/statistics/1097489/unsafe-water-death-rate-global/). Apart from this, India is home to massive landfills and dump yards from which leachates contaminate the surrounding land and groundwater.  
  
 The country has been successful in introducing environmental education and awareness initiatives right from school level. In the business world, Growing awareness has led to the establishment of corporate social responsibility (CSR) committed towards social and environmental issues. One of the earliest acts of environmental protection that had gained international attention was the “Chipko Movement” – a nonviolent protest against deforestation. Following its success, several projects that could bring about environmental degradation have been successfully stopped since. With the support of NGOs and support groups, environmental activism is at the forefront. Climate change action has led to an obvious [shift in consumer behavior](https://www.statista.com/statistics/1105629/india-consumer-behavior-adjustments-due-to-climate-change/) in recent times. Despite these measures, India, like most other developing economies, has not yet tangibly put sustainability over, if not equal to its economic growth and development.

**6.5 Causes and Effects of Environmental Degradation**

Environmental Degradationcomes about due to erosion and decline of the quality of the natural environment. It is caused directly or indirectly by anthropogenic activities that extract various environmental resources at a faster rate than they are replaced, and thus depleting them. On this regard, degradation means damage or reduction in quality of environmental features, primarily influenced by human activities. Some natural events such as landslides and earthquakes may also degrade the nature of our environments.

Continued environmental degradation can completely destroy the various aspects of the environment such as biodiversity, ecosystems, natural resources and habitats. For instance, air pollution can lead to the formation of acid rain which can in turn reduce the quality of natural water systems by making them acidic. This is a typical example of environmental degradation. Environmental degradation is therefore a concept that touches on a variety of topics namely deforestation biodiversity loss, desertification, global warming animal extinction, pollution, and many more.

**6.6 Population, poverty, Urbanisation and Pollution**

**(Check for content in the second Module)**

**6.7 Urban and Rural Environmental Problems**

Environment is essential for continuation of life on earth. It performs several functions which can be divided into four categories. These are,

1. Production functions,
2. Regulation functions,
3. Habitat functions, and
4. Information functions.

Environmental degradation restricts the flow of environmental services. Dumping of pollutants in excess of its assimilative capacity into air, water and soil results in deterioration of the quality of these vital resources.

The nature of environmental problem depends upon the level of economic development and the geographical condition of the area under consideration. India being a developing economy with a low per capita income, high population density, agriculture-dependent labour force, and high percentage of rural areas, the problems here are different from those in developed countries.

The tropical climate with scanty rainfall in many areas also brings in a specific set of environmental problems. Poverty, illiteracy and lack of awareness have aggravated environmental problems in many cases. Poverty in rural areas, largely due to unavailability of gainful employment, compels people to go to the nearby forests to collect fuel wood and minor forest products to supplement their household income. Agriculture being the backbone of the country and draught animal being the major source of power, animals are reared in large numbers and sent to forests for grazing.

Cooking by using fuel wood not only aggravates destruction of forest but also releases harmful gases into the air. Lack of proper sanitation both in rural areas and urban slums vitiates the local environment. High population density in urban areas without adequate infrastructure such as water and electricity supply, public transport and waste disposal has brought in many environmental problems. For example, lack of public transport and rise in per capita income have led urban households to go for private vehicles which has increased fuel consumption, traffic congestion, and increased emission from vehicles. Tightening of emission standards and use of cleaner fuel has not been able to offset the pollution load. Technological progress has also contributed to environmental problems in lndia.

Pollution abatement technology is available in many cases, but it is not adopted as it increases costs of production. The incentives offered through tax concessions and subsidies for installation of pollution abatement technology are not found to be adequate. Disposal of effluents without treatment have increased pollution of air, water and soil.

Technological progress in agriculture has led to increased use of fertilizer on land which has increased pollution of land. The cultivation of water intensive crops by using ground water has depleted ground water table. In order to attract investment several governments offer concessions to industries overlooking environmental concerns. In the process industries come up in the area but convert the state into a pollution haven.

**6.8 Energy Environmental Interaction**

Energy is the keystone of human prosperity and vital component of environmental rehabilitation. Energy is the ultimate resource and at the same time, the ultimate pollutant.

The extreme differences in the living standards around the world are due to wide range of differences in annual per capita energy consumption. In 1970, the per capita consumption in USA was 8.4 times that of rest of the world; 20 times that of China; 34 times that of the average developing country and was 59 times that of India. In 1970, USA had only 5.7 per cent of world’s population; but it was consuming 33.4 per cent of the world’s energy expenditure. “Power” is the motive force behind “prosperity”. Lenin said, “Give me workers’ Councils and *Electricity*, and I will give you *Revolution*.” No doubt, the extraordinary economic growth of western nations and USA could be attributed to the large per capita energy consumption.

But, there is the shadow side of this tremendous progress. The ecological consequences due to massive use of energy are manifold;

1. In USA “the transportation system and fossil fuel-fired electric generation plants annually produce 36 per cent of the particulates, 37 per cent of hydrocarbons, 83 per cent of carbon monoxide, 84 per cent of the sulphur oxides and 95 per cent of the nitrogen oxides emitted into the air.”
2. The land area distributed by coal surface mining in the USA by the mid 1980s had reached more than 57 million acres, an area equal to the size of New Hampshire. Of this total, more than 3 million acres remained ‘*unclaimed’,* creating and abandoned sterile wasteland.
3. During the 1980s, an average of more than 10,000 large spills of hazardous substances, mostly petroleum, was reported in US waters yearly. More than 20 million gallons of petroleum and chemicals were spilled annually during the decades.

The association between “energy” and “environmental quantity” is very intimate; larger consumption of the former leads to greater deterioration of the quality of the latter. Hence, the environmental movement has always recognized the interdependence of energy and environmental policy.

Policy makers and planners must strike a balance between increased energy use and minimal environmental costs. Energy is the largest growth industry and must be used to provide employment and not to be used to profligate consumption. To strike a *trade-off* between energy consumption and environmental degradation is rather a complex and tough task.

India brought out the first Energy Survey in 1965 and has done little since to take an overall view like quality, quantity, mix of energy resources needed for the country and the ecological cost connected with them. If this is not worked out fairly accurate, the energy will charge the user twice; once when it is used; and next when the bill for its damage to the environment has to be paid.

Firstly, the havoc created by coal-fired thermal stations in the environment, and then contribution to the green house effect or how much carbon dioxide is spewed by them is immense. It is estimated, a plant burning 1000 tonnes of coal a day with an ash content of 30 per cent (which is normal in Indian coal) will add 2500 tonnes of carbon monoxide a day to the atmosphere, besides other green house gases at a high temperature adding to the environmental damage. Besides, these plants also discharge fly ash in large quantities.

The energy policy insists on much higher efficiency and higher maintenance standards to minimize the carbon dioxide emission. Further the CO2 emissions could be used in agricultural sector. It must be seen if the CO2 emission from super thermal plants at Ramagundam, Korba, Frakka and Singrauli can be harnessed for agriculture to absorb the excess CO2 emissions.

It is estimated that sugarcane can photosynthesis’ about 70 grains per day square meter. To absorb about seven tones of CO2 a day, an area about 1000 sq.km is required. This is will be rather difficult. Instead the excess CO2 emission can be used for generating power. This, in practice means a small local unit which can give employment potential and reduce transmission losses in power. The Philippines has successfully done this by setting up several thermal power plants.

Cogeneration of power and process heat in industries such as paper, sugar, cement will help a lot in raising the efficiency and reducing environmental damage. This will reduce pollution to a greater extent in all power plants. Instead of transmitting power through long distance grids from Mega Plants where the loss of electricity would be abnormal, this type of localized power generation would have dual advantage of reducing environmental damage with more power and employment potential.

Apart from this, the policy should be aimed at reducing the wastage on the demand side. Particularly in urban areas, there is no ethics or code in power utilization to have energy-efficient units. Sports in floodlit courts should be altogether banned, when these sports could be conducted in broad day light. Permission for setting air-conditioners, heaters, as luxury should be restricted. Similarly wastage due to illumination at the time of fairs and festivals etc., should be controlled to the minimal level. In India, efficient management of power resources could save up to 30 per cent of present consumption.

Secondly, the transport sector in India is the biggest offender in environmental pollution. The supply and uses of energy in this sector is very anachronistic. Most of the energy fuels contain lead which causes lot of damage to all types of organisms. Further, roads in India are energy-inefficient. In major cities, no car could ply with optimum speed and most of the vehicles emit poisonous smoke. The energy policy should be evolved in relation to road transport policy and maintenance of vehicles.

Thirdly, the ‘fertilizer industry and the paper industry are the biggest energy consumers in our country and also destroyers of the environmental quality, Indian paper is the most energy expensive and it is twice that of Sweden or the USA. The paper industries destroy the environment by cutting forests and thereby reducing the supply of oxygen and absorption of CO2. The policy should be to use only tree crops or annual crops for paper-making. Land and forest should be used for making paper; only the usufructs of plants and forests should be used for making paper. The bagasse, the stalks, the straw, the husk and other bio-materials could be used instead of cutting down forests.

In its attempts to have a meaningful energy policy, the Government of India conducted an extensive field survey in 1953 to assess the consumption of different fuels in the household sector. The survey revealed a larger dependence on cow dung as a source of energy. Hence, the government decided to produce soft coal from low grade coals in rural areas at subsidized prices.

In the year 1962, the government appointed an *Energy Survey Committee* as it was felt that supply of adequate energy holds the key for economic development through planning. It was also felt that the supply of coal, kerosene, diesel etc., should be significantly increased. The Committee recommended efficient transport of coal from the pit to the washeries and plants demanding coal. The Committee also recommended the reduction of the duties and taxes on motor gas so as to increase the level of its use. Finally the committee advised that the country should exploit hydroelectric resources to meet the energy needs of the nation.

Again in the year 1970, the government set up another committee called *Fuel Policy Committee of India* to undertake a survey of fuel resources in the country and the pattern of consumption and also to forecast the future demands for fuel sector-wise. The Committee was expected to outline a national policy for the next 15 years which would help the best use of available resources. The need for appointing this committee was that during the period 1965 to 1970, the oil consumption of the nation increased by 50 per cent while the consumption of coal was stagnant. The Fuel Policy Committee of 1970 made the following suggestions;

1. Commercial fuel could be substituted in the place of coal and reduction of use of oil products wherever should be attempted.
2. In domestic sector, kerosene could be replaced by soft coke, and electricity could replace kerosene in lighting.
3. In the agriculture sector, diesel pumps could be substituted with electricity.
4. In the industrial sector, furnace oil could be replaced by oil.
5. The committee also suggested that in the transport sector, use of gasoline could be reduced and this can be achieved by reducing the price of diesel oil and using optimal-sized vehicles and their better maintenance.
6. The committee made systems study on the choice of fertilizer food stock on a programming model and recommended the use of different feed stocks, such as naptha, furnace oil and coal at different levels.
7. The committee favored electricity generation at the pithead rather than load-centre stations.
8. The committee also suggested popularizing bio-gas plants in rural areas to meet the energy demands and also increasing the efficiency of cooking appliances.

The Rajadhyaksha Committee on Power in 1980 suggested greater role for the Central Government in high voltage transmission lines and that underutilization of capacity should be avoided.

Another important land mark in the history of energy policy of India is the report of Committee constituted by the Advisory Board of Energy in 1985. It was decided to have a centralized source of energy information to forecast energy for all important sectors of the economy, through setting up a *computer energy information system* and a Data Bank. This would help in developing strategies for energy conservation, inter-fuel substitution and efficiency optimization.

**6.9 Policy Measures**

In India, legislations directly aimed at environmental protection were implemented for the first time in 1974 in the form of the Water (Prevention and Control of Pol1ution) Act. Prior to that, however, there were certain legislations enacted which have a bearing on environment indirectly (e.g., Motor Vehicles Act, Factories Act and Insecticides Act). After the Water Act, two notable laws have been introduced: First one is the Amendment of the Constitution in 1977 which has two sub divisions:

1. Entry 48A mentions that the state will protect and improve the environment and safeguard forests and wildlife; and
2. Entry 51 A suggests that it is also the duty of the citizens to protect and improve the natural environment including wildlife. The forty second amendment was followed by the Forest Conservation Act, 1980; and subsequently the Air (Prevention and Control of Pollution) Act, 1981. A comprehensive legislation on environment covering all aspects was enacted in 1986 in the form of the Environment Protection Act, 1986.

Two international conferences on environment and development-one at Stockholm in 1972 and the other at Rio de Janeiro in 1992- have influenced environmental policies in most countries, including India. Many countries and international agencies have accepted the 'polluter pays principle', the 'precautionary principle' and the concept of 'intergenerational equity' as guidelines for designing environmental policies.

The United Nations Conference on Environment and Development held at Rio in 1992 specifies the following objectives of environment policy:

1. To incorporate environmental costs in the decisions of producers and consumers, and not to pass these costs on to the other parts of society, other countries or to fume generations.
2. To move more towards the integration of social and environmental costs into economic activities, so that prices will appropriately reflect the relative scarcity and total value of resources and contribute towards the prevention of environmental degradation;
3. To include, wherever appropriate, market principles in the framing of economic instruments and policies to pursue sustainable development.

**Provision in the Constitution**

The Indian Constitution provides for a federal structure within the framework of  
parliamentary form of government. Part XI of the Constitution governs the division  
of legislative and administrative authority between the centre and the states. Subject  
areas for legislation have been divided into three lists, viz., Union List, State List and Concurrent List.

Article 253 empowers the Parliament 'to make any law for the whole or any part of  
the territory of India for implementing any treaty, agreement or convention with  
any other country or countries or any decision made at any international conference,  
association or other body'. Provisions in the Constitution of India envisage a  
significant role for the central government on matters relating to environmental  
protection.

Even though location-specific subjects generally come under the jurisdiction of local  
bodies (municipalities and panchayats) until 1992, they were not given the necessary  
power to deal with these subjects. It is stated that 'the state shall take steps to  
organize village panchayats and endow them with such power and authority as may  
be necessary to enable them to function as units of self-government'.

**The Environmental Protection Act, 1986**

The Water (Prevention and Control of Pollution) Act was passed in 1974. It aimed at maintaining the purity of water by preventing water pollution and provided for establishment of Pollution Control Boards at State Level. Similarly, the Air (Prevention and Control of Pollution) Act was passed in 1981 to control air pollution. In spite of these acts, it was realized that environment was deteriorating at an alarming rate in the country. Therefore, a more comprehensive and general piece of legislation was framed in the form of the Environmental (Protection) Act, 1986.

The Act was passed with the following objectives:

1. To Improve the quality of Environment
2. To lay down limits for emission or discharge of environmental pollutants from various sources
3. To Protect and regulate discharge of environmental pollutants and handling of hazardous substances
4. To prevent accidents which may cause environmental pollution and provide remedial measures for such accidents and deterrent punishment to those who endanger human environment, safety and health.

**Salient Features of the Act**

Environment has been widely defined under the Act as inclusive of “Inter relationship that exists among and in between water, air, land and human beings, other living creatures, plants, micro-organisms and property”.

1. Under the Act, the Central Government has been empowered to take all appropriate measures to prevent and control pollution and to establish an effective machinery to achieve the purpose of protecting and improving the quality of the environment.
2. The Act has adopted a new stand with regard to the question of *locus standi* so that now even a citizen has the right to approach a court provided he has given notice of not less than 60 days of the alleged offence and his intention to complain to the Central Government or the competent authority.
3. The Act strengthens the penal provisions. The maximum penalties for contravention of the Act are imprisonment up to five years or fine up to one lakh rupees or both. If the failure or contravention continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.
4. The Government has been given the powers to collect samples of air, water, soil or other substances as evidence of the offences under the Act.
5. It applies to the pollution generated by the government agencies or any department of government as well.
6. A special procedure can be prescribed for handling hazardous substance and no person can handle such substance except in accordance with procedure.
7. The Central Government has been vested with powers of entering and inspecting any place through any person or agency authorized by it.
8. It authorizes the Central Government to issue direction for the closure, prohibition or regulation of any industry, operation or process.
9. It also authorizes the Central Government to stop or regulate the supply of electricity or water or any other service directly without obtaining a court order.

**Other Environmental Laws of India**

Besides having a general & comprehensive law on Environment that is Environment Protection Act of 1986, a number of Environmental laws can be seen as classified into Specific Laws and General laws (Brown and green laws) the list of which are as follows:

* The Indian Forest Act 1927,
* The Forest (Conservation) Act, 1980
* The Wild Life (Protection) Act, 1972
* The Prevention of Cruelty to Animals Act, 1960 The Animal Welfare Act
* The Biological Diversity Act, 2002

**Other Environment related laws are**

1. Indian Easement Act,1882,
2. Indian Fisheries Act,1897
3. Indian Ports Act,1908
4. The Shore Nuisance (Bombay &Kolaba) Act,1853, etc.,

**Intellectual Property Rights related Laws**

1. The Patent Act, Copy Right Act, Trade Marks, Designs Act
2. Geographical Indications of Goods for registration& Protection Act,1999
3. Plant Varieties Protection and Farmers Rights Act,2001

**The Remedial Laws**

1. Public Liability Insurance Act,1991
2. The National Environmental Tribunal Act,1995
3. The National Environmental Appellate Authority Act, 1997.
4. The National Green Tribunal Act, 2010
5. Noise Pollution (Regulation and Control) Rules,2000
6. The Specific Relief Act,1963
7. IPC, Cr.P.C., CPC,
8. The Freedom of Information Act, 2005
9. Tort Law remedies
10. The Cigarettes and other Tobacco Products (Prohibition of Advertisement and Regulation of Trade and Commerce, Production, Supply and Distribution)Act,2003
11. The Energy Conservation Act, 2001.
12. The Ozone Depleting Substances Regulation and Control Rules, 2000 Water Pollution.

“Energy” means any form of energy derived from fossil fuels, nuclear substances or materials, hydro-electricity and includes electrical energy or electricity generated from renewable sources of energy or bio-mass connected to the grid. An Act to provide for efficient use of energy and its conservation and formatters connected therewith or incidental thereto & also confer powers to the Bureau of Energy Efficiency**.**

**Hazardous Substances Management**

1. The Air (Prevention and Control of Pollution) Act 1981, amended 1987
2. The Water (Prevention and Control of Pollution) Cess Act, 1977, amended 1992
3. The Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003
4. The Water (Prevention and Control of Pollution) Act, 1974, amended 1988
5. The National Green Tribunal Act 2010

**Constitutional Commitments towards Nature Conservation can be highlighted in**

1. Part-III: Fundamental rights where, Supreme Court mandates in environmental issues as Right to life includes, right to live in healthy & hygienic environment
2. Part-IV: Directives Principles of States Policy, Article 48-A, under Protection and improvement of environment and safeguarding of Forest & Wildlife, the state shall endeavor to protect and improve the environment and to safeguard the forest and wildlife of the country
3. Part-V-A: Article 51-a(g) Fundamental Duties states that it shall be duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures
4. Art:31-A permits the Governments, to acquire wetlands for public purpose R/w entries17(a) & (b) power for protection of wildlife & forests through legislation

Under Legislative relations between the Union &State, Article 246 the subject forests and protection of wild animal and birds were brought in concurrent list by 42nd Constitutional Amendment 1976 from State List.

**Enforcement of Environmental Laws**

For enforcing the environmental laws, the following forums are created in the country at various levels

1. Law enforcing agencies at the Central and State level
2. Constitutional obligations on the Centre & States
3. Implementation through the Judiciary viz., Public Interest Litigation(PIL), Writs, Supreme Court /High Court directions,
4. Governmental Agencies, Local Authorities,
5. Urban and Rural level central pollution control board (CPCB)/ state pollution control boards (SPCB’s)

**Environment Protection Rules & Notifications**

For environmental protection, the following Rules & Notifications are created in the country for various issues.

1. Environment Protection from Air Pollution
2. The Environment Act for Protection, 1986, amended in 1991
3. Environment Rules for Setting up Industrial Projects, 1999
4. Coastal Regulation Zone
5. Eco-mark Scheme of India
6. Eco-sensitive Zone
7. Environmental Impact Assessment Notification-2006
8. Environmental Clearance in General
9. Environmental Impact Assessment Notification-2009
10. Wetland (Conservation & Management) Rules 2010

Since there is too much ground to cover under this topic, only few of the acts are explained briefly.

**The Motor Vehicles Act, 1988**

The Motor Vehicles Act, 1939 which was amended over the years after independence did not carry any provision about air and noise pollution generated by automobiles. In 1988, the Motor Vehicles Act was passed which became operative throughout the country from July 1989. The new Act covers both air and noise pollution generated by automobiles. The Act is enforced by the State governments in their respective States with the concurrence of the central government; the States can amend this Act, keeping in view their local needs and circumstances.

The Motor Vehicles (Amendment) Act was passed in July 2000 which permits the use of CNG as an environment friendly auto fuel.

**The Factories Act, 1948**

The Factories act of 1948 may be considered as an important milestone in environmental legislation. It is an old legislation amended substantially to make it more comprehensive and effective.

Chapter IV (A) is relevant to hazardous process where permissible limits of exposure of chemical and toxic substances are specified. Further, Section 12 of the Factories Acts 1948 requires every factory to make an effective arrangement for the disposal of wastes and effluents concerned with neighbors living in and around the vicinity and environment thereof.

**Prevention and Control of the Water Pollution Act, 1974**

Water pollution has assumed such high proportion today that not only the aquatic eco-systems are greatly damaged but even the lives of animals on land are threatened. The pollution of rivers, lakes and seas is a direct result of the population explosion and large scale industrialization. This Act tends to provide legal deterrents against the spread of water pollution.

**Its Objectives**

1. To Control Water Pollutionand maintaining or restoring of wholesomeness of water in streams or wells or sewer or on laundry.
2. To Maintain the Quality of Waterfrom discharge of industrial waste into the rivers and streams with provision to take action against industries or persons in this regards.
3. Establishment of Central and state Boards with a view to carry out the above objectives.

**Prevention and Control of the Air Pollution Act, 1981**

This Act has been passed to provide for the prevention, control and abatement of air pollution. According to its statement of objectives, “Various pollutants discharged through industrial emission and from certain human activities connected with traffic, heating, use of domestic fuels, and refuse have detrimental effect not only on the health of the people, but also on animal life, vegetation and property”.

The Act was amended in 1987. Failure to comply with the provisions of this Act or directions shall be punishable with imprisonment for a term which shall not be less than one year and six months but which may extend to six years and by imprisonment for a term which may be extended to Ten Thousand Rupees or with both.

In contravention of the New Industrial Policy of 1980, the Act extended certain rules for setting up of industries in the country. It issued new guidelines in this regard: (a) clearance certificate from State Pollution Control Board; (b) shifting of industries from urban areas; (c) industries have to follow the air quality measurements as per State/Central pollution boards; and (d) replacement of pollution generating machinery.

**Regulation and Control the Noise Pollution Rules, 2000**

Under the Environment (Protection) Act, 1986, the Central Government made the Noise Pollution Rules in 2000 for regulation and control of noise producing and generating sources.

The Rules explain the objectives in these words: “Whereas the increasing ambient noise levels in public places from various sources, inter-alia, industrial activity, construction activity, generator sets, loudspeakers, public address systems, music systems, vehicular horns and other mechanical devices have deleterious effects on human health and the psychological well-being of the people, it is considered necessary to regulate and control noise producing and generating sources with the objective of regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise”. The Rules relate to the following:

1. Development Activities arecarrying out functions relating to town and country, planning shall take into consideration, all aspects of noise pollution as a parameter of quality of life to avoid noise menace and to achieve the objective of maintaining the ambient air quality standards in respect of noise.
2. Silence zone: An area comprising not less than 100 meters around colleges, schools, hospitals and courts comes under silence zone.
3. Noise Standards for Different Zones: For the purpose of implementation of noise standards for different zones, the State governments may categorize the areas in to industrial zone, commercial zone, and silence zone.

The State Government shall take necessary measures for abatement of noise emanating from vehicular movements, where noise levels do not exceed the ambient air quality standards specified under Rules 2000.

**Restrictions on the use of Loudspeakers or Public Address System**

1. A loud-speaker or a public address system shall not be used except after obtaining written permission from the district/local authorities.
2. A loudspeaker or a public address system shall not be used at night (between 10 P.M. to 6 A.M) except in closed premises for communication within an institution’s auditorium, conference rooms, community halls, and banquet halls.

If the noise level exceeds the ambient noise standards by 10dB (A) or more, a person may make a complaint to the authority and action shall be taken against the violator in accordance with the provisions of these rules.

**The Wildlife Protection Act, 1972**

The Act is meant to prevent the rapid decline of wild animals and birds in the country. Poaching of certain animals has been completely prohibited under this Act. It also provides that the State Government may declare any area to be a sanctuary or as a national park if it considers that such area is of adequate ecological, geo-morphological, natural or zoological significance for the purpose of protecting, propagating or developing wildlife.

The Act has the following objectives:

1. Protection of wildlife in the country
2. To prevent hunting and treading in wildlife in any form
3. Control and maintenance of national parks and sanctuaries in the country

**The wildlife (Protection) Act 1972 was amended by the Parliament in 2002.**

The Act provides for the establishment of **The National Board** under the chairmanship of the Prime Minister of India who may constitute committees, sub-committees or study groups, as may be necessary from time to time in proper discharge of the functions assigned to it. Similarly, State Boards for wildlife under the chairmanship of Chief Minister of the State will function for the protection of wild life. The Act was further **amended in 2006** to set up of a **Tiger Task Force in tiger reserve hotspots.** Now there is also a provision of forfeiture of property in case of illegal hunting and trade of wildlife.

**Forest Conservation Act, 1980**

After independence, the Government of India adopted the National Forest Policy wherein it emphasized on the need of protection of forests and categorized forests of India in to four categories, namely, protected forests, national forests, village forests and tree forests. The Act has been passed to prevent deforestation which results in ecological imbalance and environmental deterioration. The Act prevents even the State Governments and any other authority to de-reserve a forest which is already reserved. The Act also prohibits forest land or portion thereof for cultivation or any purpose other than reforestation.

**Amendments to Forest Conservation Act**

In 1992, some amendments were made in the Forest Act of 1980.

1. Some non-forest activities in forests were allowed without cutting trees with the prior approval of the Central Government. These activities are setting of transmission lines, seismic surveys, exploration, drilling and hydroelectric projects.
2. Prior approval of Central Government is required in the case of cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value.
3. Removal of stones, bajri or boulder etc, from river-beds located within the forest area will be considered under non-forest activities.
4. Ban on mining activities near forest area and prior approval of Central Government is mandatory.
5. Wildlife Sanctuaries and National Parks are totally prohibited for any exploration or survey without prior approval of Central Government.
6. Cultivation of cash crops is included under non-forestry activities. Their cultivation is not allowed in forest reserve areas.

**The Environment Rules for Setting of Industrial Projects, 1999**

The New Industrial Policy of 1980 recognized the need for preserving the ecological balance and improving living conditions in the urban centre’s of the country. On the basis of this policy, indiscriminate expansion of the existing industries and setting up of new industrial undertakings within the limits of metropolitan cities and the larger towns shall not be permitted. The Environment Rules of 1999 were framed with the following provisions.

The industrial licenses should be issued under the fulfillment of the following conditions:

1. The State Director of Industries confirms that the site of industrial project has been approved from environmental angle by the competent State Authority.
2. The Concerned State Pollution Control Board has certified that the proposal meets with the environmental requirements and that the equipments installed for proposed to be installed are adequate and appropriate to the requirements.
3. The industries will be required to submit half-yearly progress report on installation of pollution control devices to the respective State Pollution Control Boards.
4. Depending on the nature and location of the industrial project, the industrialists will be required to submit comprehensive Environmental Impact Assessment Report.
5. **Areas To Be Avoided**

No new unit of the industries shall be allowed to be set up in the following areas:

1. The entire area within the municipal limits of all municipal corporations, municipal councils and Nagar Panchayats and a 25 Kms. belt around the cities having population of more than one million;
2. 7 Kms. belt around the periphery of the wetlands.
3. 25 Kms. around the periphery of National Parks, Sanctuaries and core zones of Biosphere Reserves.
4. Half Km. wide strip on either side of national highways and rail lines
5. No new industries shall be allowed to be set up within 7 Kms. periphery of the important archaeological monuments listed in Annexure.
6. No forest land shall be converted into non-forest activity for the sustenance of the industry.
7. No prime agricultural land shall be converted into industrial site.
8. **Requirements For Industry**

The following are the requirements to set up industries:

1. Land acquired shall be sufficiently large to provide space for appropriate treatment of waste water.
2. The green belt between two adjoining large scale industries shall be one Km.
3. Enough space should be provided for storage of solid wastes so that these could be available for possible reuse.
4. Layout of the industry that may come up in the area must conform to the landscape of the area without affecting the scenic features of that place.
5. Associated township of the industry must be created at a space that have physiographic barrier between the industry and the township.
6. Efforts should be made to recycle or recover the waste materials to some extent safely.
7. Intensive programmes of tree plantation on disposal area should be undertaken by industries.
8. Industries should plant trees and ensure vegetable cover in their premises. This is particularly advisable for those industries having more than 10 acres of land.

**Hazardous Wastes/Management and Handling Rules, 1989**

The Hazardous Wastes Rules 1989, notified under the Environment (Protection) Act, 1986 lay down that before hazardous wastes are delivered at the hazardous waste site, the occupier or operator of a facility shall ensure that the hazardous wastes are packaged, in a manner suitable for storage, transport, labeling and packaging shall be easily visible and be able to withstand physical conditions and climate factors.

Imports of hazardous wastes from any country to India shall not be permitted for dumping and disposal of such wastes. However, imports of such wastes may be allowed for processing or reuse as raw material after examining each case on merit by the State or Central Pollution Control Board. Any person importing hazardous wastes shall maintain the records of the hazardous wastes imported. The exporting country or the exporters as the case may be, of hazardous wastes shall communicate in Form 6 to the Ministry of Environment and Forests of the proposed trans-boundary movement of hazardous wastes.

**The Bio-Medical Waste (Management and Handling) Rules, 1998**

These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio-medical waste in any form. Bio-medical waste shall not be mixed with other wastes. Bags should be attached with special labels.

**The Recycled Plastics Manufacture and Usage (Amendments) Rules, 2003**

Under the Environment (Protection) Act 1986, the Central Government has amended the Recycled Plastics Manufacture and Usage Rules, 1999 that lay down the following:

1. No vendor shall use carry bags or containers made of recycled plastic for storing, carrying, dispensing, or packaging of foodstuffs.
2. No person shall manufacture, stock, distribute or sell carry bags made of virgin or recycled plastic bags which are less than 8 X 12 inches (20 X 30 cms) in size and which do not conform to the minimum thickness specified in Rule 8.

**The Role of Ministry of Environment and Forests**

The Department of Environment was created in November, 1981 and since then it has acted as a nodal agency for environmental protection. It has also been assigned administrative responsibility for pollution monitoring and regulation, as well as conservation of ecosystems and biosphere reserves. It has set up a computerized Environment Information System at Botanical Survey of India. There is also the Ministry of Environment and Forests which performs the following functions in the country:

1. Survey of natural resources in the country.
2. Conservation of natural resources including forestry and wildlife.
3. The management action plans for wetlands and coral reefs of Andaman and Nicobar.
4. Lake conservation.
5. Biodiversity Conservation from 1994
6. Forest Conservation
7. Wildlife conservation consisting of 89 national parks, 490 sanctuaries and 13 biosphere reserves covering an area of 1,48,700 sq.km
8. *Animal Welfare through* Nodal Officers.
9. Environmental Information System network with its 20 centers on various subject areas continues its activities in environmental information collection, storage, retrieval and dissemination to all concerned.
10. Forestry Education and Research through The Indian Council of Forestry Research and Education on forest management.

Therefore, environment and environmental issues have been given lot of importance in India, yet there is a need for sustainable approach towards environment.

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