

Chapter 1

Definition, Role and Significance of Environmental Economics

Introduction

Students of Economics are aware of the definition and content of the term 'Economics'. It is the study of scarce resources in the process of satisfying human wants; as scarce resources have to be harnessed at a price in a judicious manner. Economic development of a country depends on scientific utilisation of scarce resources with the help of improved technology, so that the society can be provided with better living conditions. Ever since *homo sapiens* set their mortal feet on this terrestrial globe, the attempt at exploiting natural resources for the benefit of human race is going on and there will be no end to this process.

Economics, in general, studies the cost of exploiting resources in the environment and the consequent benefit arising to the society at large. With the increase in population and development of science and technology, the environmental resources are over-exploited, leading to imbalance in the ecosystem. Much worse than this is the pollution of the environment leading to more of illfare, rather than welfare. Environmental Economics studies about the cause and effect in general, in over-exploiting the environmental resources, and the cost and benefit arising out of that to the society. Economics enters in every aspect of life of society and government, as we have Economics in every branch of our existence and development.

In this book we shall study briefly about the economics of environment, concepts connected with it and also the cost and benefit arising out of our greed in over-exploitation of environment, besides the damages done to environment and society.

Economics and Environment

Human life cannot exist in isolation. The life depends on the environment. The economic life, social and cultural activities of mankind are shaped by the environment. What exactly we mean by 'Environment'

According to Webster's New World Dictionary, environment means "all the conditions, circumstances, and influences surrounding and affecting the development of an organism or group of organisms." An Environmentalist is a "person working to solve environmental problems, such as air and water pollution, the careless use of natural resources, uncontrolled population growth, etc."

The type of living of Eskimos in the arctic regions is entirely different from people living in Sahara; the activities and culture of people living in the slopes of Himalayas are different from the people living in Coromandel coast. Similarly, the activities of people living near sea-shore or river basins will be totally different from the people living in mountains and forests; though in all cases, the people have to eke out their sustenance from their own environments. In short, the people exploit the resources in their environment and make out a living first and then better and comfortable living. With the advancement of science, technology and transport system, the resources of the environment were exploited not only for production to cater the local requirements, but also for a market, both national and international. The economic development of a society depends on the utilisation of resources offered by the environment. To be very precise, the term environment constitutes the earth, the surface of the earth, air, water, sunshine, rivers, mountains, natural landscapes, sea-shore, forests, flora and fauna and also the living space and the sky above, which are shared by all living creatures of the planet by means of beautifully perfected ecosystem.

Mother Nature is bountiful in giving all the resources to be shared by all living beings on this globe. She gives the gifts freely; but only so long as the stock lasts.

It should be understood that the ecosystem, the details of which we shall study in the next chapter, is a science which deals with inter-relationships between various organisms and their relationship with the physical environment. The smaller organisms are numerous and multiply at a faster rate than the stronger and bigger ones. Hence, an equilibrium is maintained between the various organisms in the biosphere. This is exactly what we mean by ecological balance. Man in his over-enthusiasm and aspiration for better and fast living, tampers with the ecosystem and upsets the ecological balance.

Herein comes the conflict between Economics and Ecology. Economics is a science which tells about utilisation of resources given by Nature for the development of humanity. Ecology tells about harmony between Nature and Man. Economics upsets the harmony between

Transformation Curve¹

The economy faces many problems of which economising the resources stands foremost while producing many commodities required for the economy. Prof. Samuelson introduced an ingenious device called 'production possibility curve' which tries to explain graphically the alternative production possibilities in an economy with limited resources.

In order to simplify the illustration, we make the following assumptions:-

- (i) We consider two commodities, viz., environmental quality, say, pure air and production of chemical fertilizer for agriculture with available resources.
- (ii) The resources are fixed in quantity, but they can be shifted from the production of one commodity to another.
- (iii) The resources are fully used with utmost efficiency. This means that the resources are not unemployed or underemployed. The economy is supposed to work at the level of full employment and achieving full production.
- (iv) The state of technology remains unchanged.

On these assumptions, we can draw production possibility curve or Transformation curve with the help of the following schedule.

Table 1.1
Production Possibility Schedule

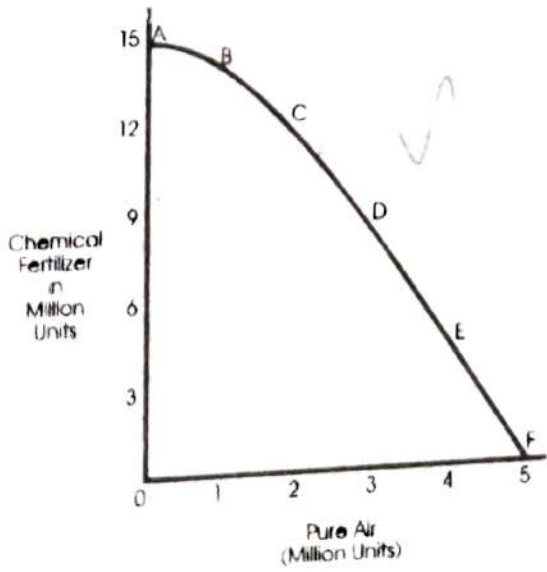
Production Possibilities	Pure Air (in Million units)	Chemical fertilizers (in Million units)
A	0	15
B	1	14
C	2	12
D	3	9
E	4	5
F	5	0

1. The reader may refer 'Micro Economics' of the author to have a detailed account of 'Basic Problems of an Economy and Transformation Curve.'

From the schedule, it is clear that the economy has half-a-dozen possibilities of having pure air (environmental quality) and chemical fertilizer in different quantities by properly apportioning resources.

According to possibility A, the economy can entirely devote the resources by producing 15 million units of chemical fertilizer with no pure air; or according to possibility F, it can use all the resources in having 5 million units of pure air and no chemical fertilizer at all. These are two extreme possibilities which are unrealistic, as the economy requires both, viz., environmental quality (pure air) and also chemical fertilizer. Other possibilities indicated are B, C, D and E by which the economy can have both commodities, i.e., pure air and also chemical fertilizer in different quantities. When the economy moves from B to E, more environmental quality can be had (in the form of pure air) at the cost of losing chemical fertilizer. Similarly, when it moves from E to B, more chemical fertilizers are produced at the cost of pure air in the economy. The data of the Schedule are represented in the graph given under figure 1.1 with Environmental Quality (Pure air) in 'X' axis and chemical fertilizer in 'Y' axis. By joining points A,B,C,D,E and F, we obtain Production Possibility Curve. This is also known as 'Transformation Curve'.

Fig. 1.1
Transformation Curve

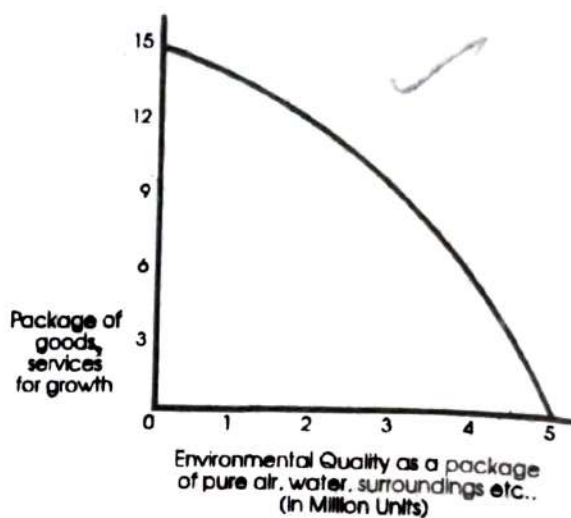


While moving down the transformation curve, we are in effect transferring chemical fertilizers into Environmental Quality in the form of pure air, by appropriately shifting the resources from chemical fertilizer to pure air.

The figure 1.1 indicates the transformation of resources from production of chemical fertilizer to pure air or vice versa. Taking 'Environmental Quality' as a combination of pure air, pure water, hygienic surroundings, etc., in the 'X' axis and the bundle of commodities and services required by the community in the 'Y' axis, we can have the transformation curve as depicted in Figure 1.2.

The figure 1.2 indicates that if the society wants better environmental quality, it has to necessarily give up some goods needed for economic growth. This environmental quality depends on foregoing certain material comforts and luxuries in life. It involves an 'Opportunity Cost' and thus environmental problems are problems that come under the purview of Economics.

Fig. 1.2
Choice between Environmental Quality and goods and services for development & growth.



SCOPE AND SIGNIFICANCE OF ENVIRONMENTAL ECONOMICS

The relationship between Environment and Economics is not only very close, but also very vast and numerous that the entire discipline of 'Environmental Economics' becomes multidimensional and holistic in nature. It is mainly the interaction between welfare aspect of the society and growth theories of economics. It covers almost all branches between economics of growth and welfare economics.

I. Economic Growth and Environmental balance

Economics of growth is mainly interested in the 'economic welfare' of the society and not 'general welfare', as the latter is a very wide, elusive and also complicated concept. General welfare of the society covers a very wide range of factors including economic and non-economic.

According to Paretian concept, social welfare is the collective welfare of all individuals in the society. Even if one individual is better off, without no one being worse off, the social welfare is said to have been increased. Welfare economists have attempted to associate welfare economics with ethics. According to them, under no circumstances can economics be kept separate from ethics. Samuelson, Bergson and others have pointed out that economics and ethics must go hand in hand and valued judgements cannot be avoided in welfare economics.

•Economics ends where ethics fails.

On the other hand, 'Growth Economics' concentrates its theories mainly on economic welfare which is measured in terms of high rates of growth of per capita product and population, the rise in productivity, high rate of structural transformation, urbanisation, international flows of men, goods and capital etc. Countries measure their growth by means of Gross National Product (GNP) in terms of millions of dollars in a year. There is little place for ethics in growth economics. Ethics does not come into the picture of taking decisions between butter and bombs; chocolates or cigarettes; wheat or whisky. So long, the commodities are demanded by consumers and resources are available, they are produced, irrespective of the fact, whether it is socially desirable or not.

In the process of over-utilisation of resources in the growth process, the ecosystem gets strained and consequently the sustainability of the ecosystem and the maintainability of economic growth get impaired and impeded. These two incompatible components of cost-benefit analysis have to be compromised, which becomes the basic fabric of the study of environmental economics. Ethics and social welfare have larger role to play in the integration of the economics of welfare and economics of growth.

So, the first theoretical dimension of Environmental Economics is the study of implications of Welfare Economics in environmental concepts. It is, in short, the study of Economic Growth versus Environmental Balance. It is the study of finding out the golden mean between the two.

II. Pollution Control and Environment

The next component of the study of Environmental Economics is the cost of pollution control and its implications on the environment. Product and growth result in pollution which is an externality in the process of production, deterring the efficient functioning of the market forces. Hence, the starting point of environmental economics is the theory of externality, pollution and other similar matters, causing deviation from optimality, i.e., the welfare maximising principle. Apart from being a starting point, it becomes the special branch of welfare economics.

III. Conservation of Resources or Economics of Resource use

(Environment is the repository of resources for the development of humankind.) All resources come from Nature, i.e., Environment. Production of goods are possible only with the help of resources supplied

by Nature. Whether food, clothing or shelter or any other commodities and services can be provided only with the help of resources supplied by Nature (Environment) in its crude and naked form, so to say, in the form of elements. The earth gives minerals like iron, manganese, zinc, aluminium, silver, gold, coal, petroleum, etc. The entire agricultural activities depend on soil, irrigation, humidity which are the results of natural gifts. Industrial production is impossible without the materials supplied by Nature. Even the production of so called synthetic materials is possible only with the elements and chemicals supplied by Nature. In short, our living on this earth is possible only by the resources supplied by environment. These resources have become scarce goods and hence conserving resources of environment becomes an important component of the study of Environmental Economics. Optimum use of resources, conservation of resources have become important issues in modern planning for development.

IV. Limits to Growth

The ultimate issue arising out of the study of Environmental Economics is the question of limiting economic growth to maintain environmental quality. No doubt, economic growth has increased the standard of living in the economic sense; but it has caused pollution, degradation, poor quality of life and slow suicide of human race, as we are at the epicentre of ecological destruction. Should our growth in terms of GNP be at the cost of environmental quality? What is the desired growth-rate in the context of environmental pollution and non-sustainability of the environment? Could pollution be reduced to minimum level? Are there technologies to bring down the rate of pollution to zero level? What are the methods of managing the increasing pollution, resulting out of growth and what are the methods of conserving the environmental resources, etc., form part of the theoretical study of Environmental Economics.

Thus, on the theoretical side, the scope of Environmental Economics extends to the study of theories of externality, theories of public goods and concepts of growth and development without deterioration in the quality of the environment.

On the practical side, the study is concerned with environmental problems and management of pollution by means of various fiscal tools like taxes, subsidies, etc. It is also concerned with pollution problems in different types of economies. It also considers cost benefit analysis of particular project like construction of a dam or nuclear plant and starting new industries. What are the impacts of such projects on the environmental quality?

The subject also studies about the distributive effects of resource abuse, the techniques and strategies available to reduce the social cost of pollution, and also the problem of bearing these costs.

At the heart of the Environmental Economics are the questions of equity. Who benefits from the world's natural resources and at what cost? This in turn may lead to a passionate indictment of the consumption values of the Western countries. The Human Development Report prepared for the UNDP and released in 1993 had evolved Human Development Index (HDI). This report points out that one-fourth of the world's population lives in absolute poverty and 90 per cent have no control over their lives; that the world's poorest 20 per cent find that the top 20 per cent enjoy 150 times their earning levels. This pattern is replicated within, between the rich and the poor.

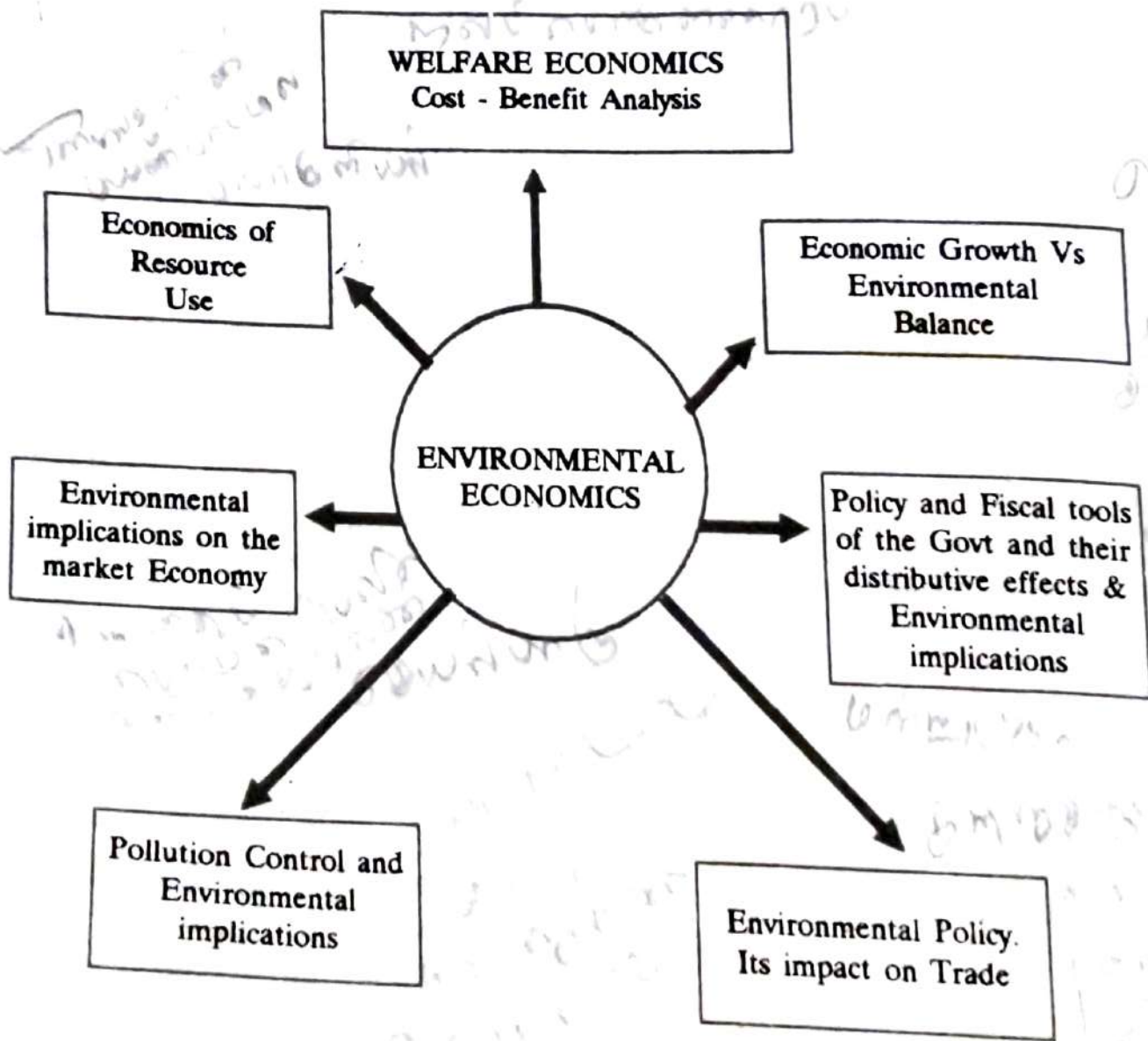
Environmental Economics studies a lot about the policies of the governments. In the context of framing suitable policies for the prevention of pollution and preservation of environment, governments have a major role to play. Our Municipalities are incapable of providing civic amenities and as such, more and more of people will be left to fend for themselves and in the process succumb to dreaded diseases. The devastating cholera epidemics in places which never had the disease, like Mexico and Peru, are examples of this general malaise. In India, the outbreak of many types of diseases in an epidemic form in many towns and villages are quite common, due to poor functioning of local bodies.

International trade too has serious environmental repercussions and it is now slowly being realised by many countries. It is very difficult to assess where trade interests stop and environmental interests begin.

Further, environmental issues can be major irritant in the country's relationship with its neighbours. As eco-system gets degraded, they can no longer support local populations. Poverty-induced migrations would start creating tensions between countries and regions. Migration from Bangladesh and Nepal into India is a case in point. The sharing of the *Ganga waters* with Bangladesh has had a long and contentious history. The conflicts are certainly going to get more accentuated as the years go by, both at the international and national levels. In India, even between the States of the national territory, as we had seen the bitter conflict between Tamilnadu and Karnataka in sharing Cauvery waters.

Environmental Economics and how it encompasses different aspects of theoretical and practical studies of our socio-economic cum political life.

Fig. 13
Multidimensions of Environmental Economics



INTEGRATION OF CONSERVATION AND DEVELOPMENT

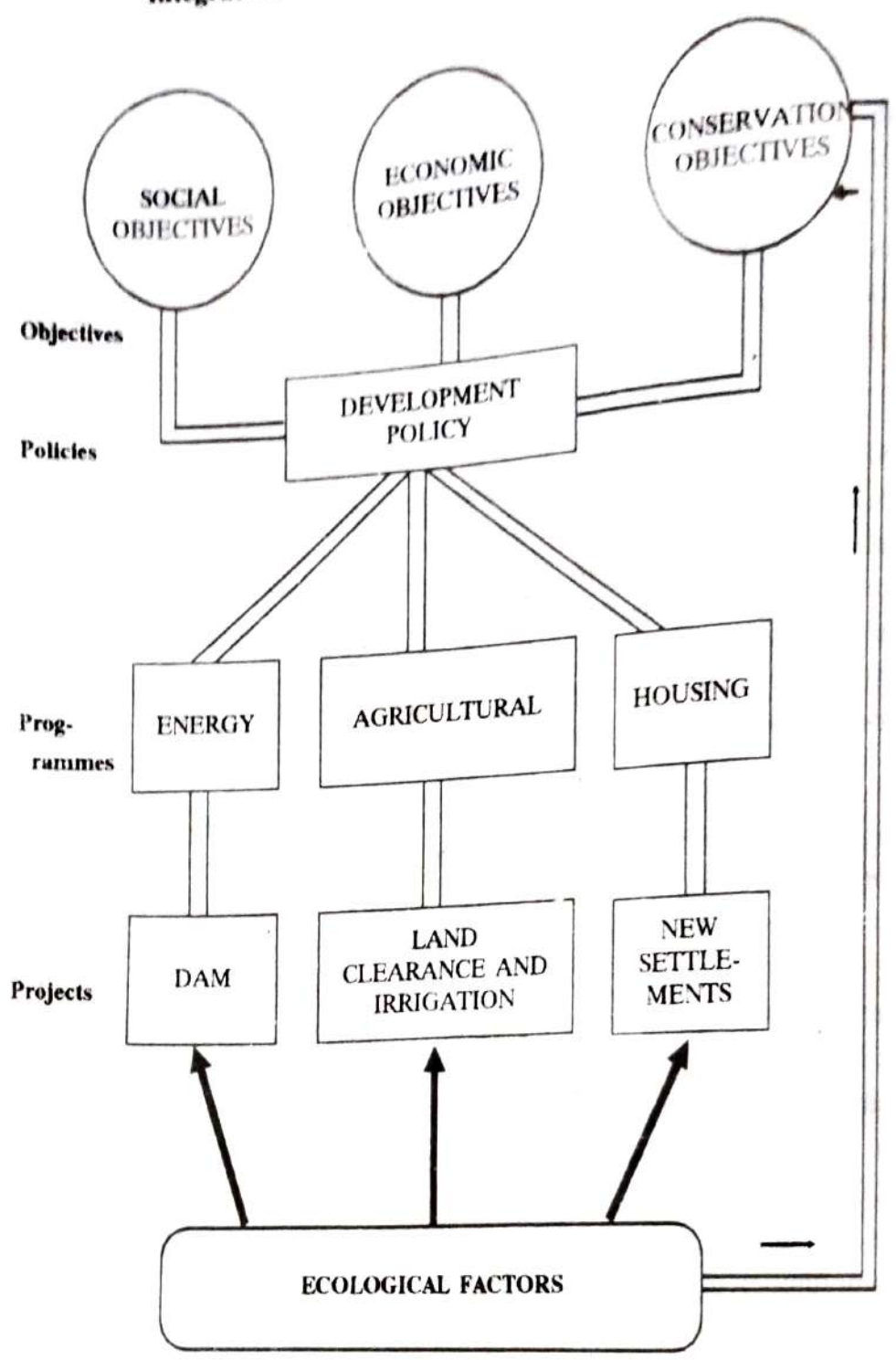
From the study of the dimensions of Environmental Economics, we can understand the need for integrating 'conservation of environment' with 'development efforts' by means of appropriate policies and adoption of controlling and distributive tools of the government, besides the responsibilities of citizens as producers and consumers.

The Figure 1.4 illustrates the need to integrate 'conservation' with 'development'. In this particular case, the construction of a dam as a development project has been considered. The dam is a key component of other associated projects, such as land clearance, irrigation and new settlements. These form part of the sectoral programmes relating to 'agriculture', 'energy' and 'housing'. Generally, ecological considerations are given their due weightage only at the project clearance stage; and afterwards these considerations are totally absent. Social objectives and economic considerations influence the development process, leading to ecological harm. Unless there is an explicit policy to achieve 'conservation objectives', the prospects of avoiding ecological harm and making the best of living natural resources are dim.

The figure indicates the extent of strain suffered by ecological factors by the construction of dam, clearing the land for irrigation, and creating new settlements for the uprooted people. The development policy of the government should be the synthesis of triple objectives viz., social objectives, economic objectives and conservation objectives, the last one should be given greater weightage than the first two objectives. This figure relating to one dam holds good for all dam projects round the world.

The world's governments are continually under intense pressure to bestow *immediate economic benefits* to their people, rather than *long-term benefits* of conservation to the people, despite their own awareness that this will create unthinkable misfortune on the descendants of those very people. This is something of a generalisation; because the immediate 'benefits' of exploitation are enjoyed by favoured sections of the population, than the population as a whole. A good example may be cited with reference to vast rain-forests of Sarawak, in Borneo. In the last century, these rain-forests were most splendid of their kind in South-East Asia. The loggers and their patrons became rich by utterly destroying the lives and cultures of the once-thriving tribal communities of those forests. However, this was defended as 'economic progress', a money-earner from the hardwoods, sold primarily to Japan for making 'chopsticks' to be thrown away after use.

Fig. 1.4
Integration of Conservation with Development



Review Questions

1. Explain the term 'Environment'
2. 'Economics and Ecology are conflicting disciplines' -- Do you agree with this statement?

Basic Theory of Environmental Economics

This chapter and succeeding chapters give some theoretical aspects of Environmental Economics. These are still in a stage of infancy and most of the treatment depends on microeconomic theory, based on hypothetical conditions and formulating theoretical hypotheses. The readers may find that the discussion to be too abstract to apply to the practical environment problems. However, a carefully worked out elementary theories are essential for understanding and also for further development of this Social Science, in order to make it scientific.

MARKET FAILURE AND EXTERNALITY

We have studied already that the environment performs three important functions to provide necessary comfortable living to humankind. They are : (i) supplying of natural commodities, like water, air, land and other material resources which are very essential for living; (ii) helping to produce many material and non-material things, as well as services for our comfortable living, by supplying adequate raw materials for the same. (iii) Thirdly, the environment assimilates all the by-products of our production and consumption. The environment is the natural receptacle or sink of unwanted materials, which are digested and assimilated by slow process of degradation and decomposition. Thus, the environment at the outset acts as a *supplier* of quality natural resources. It acts as a *producer* in the process of production; and finally acts as *waste assimilator*. By performing these essential functions, the environment sustains life in this planet. Not only this; by these processes, the environment enhances the welfare of human beings.

But, the real problem lies in the fact that the environment supplies all the "goods" needed "free of cost". This means that the environmental commodities have no market and as such no price; or we can call it "zero price". The first problem relating to environmental goods is the absence of commodity market and zero price of these commodities, though the true price of these commodities is positive.

This is called 'Market Failure' in Economics. In the environmental context, market failure refers to the difference or divergence between the price of resources and their price that would exist, if there were markets for them, and if they were supplied optimally. This market failure arises because of the *externality factor* in the process of production and consumption of goods relating to environmental commodities. In this context, *externality* means that the production or consumption of one individual's activity or an activity of the firm will affect the standard of living of another individual or firm, about which the former is not bothered, due to absence of market transaction between the former and the latter. This can be illustrated by saying that the smoke emitted by a factory in the atmosphere causes damage and reduces the quality of air used by the inhabitants, about which, the firm running the factory is not concerned for the annoyance created.

There are many services that the public desires, but for which it is difficult to charge an appropriate price. Goods and services supplied to one consumer may automatically get provided to many others. A classic example is pesticide spraying to destroy malaria-bearing mosquitoes in a particular locality. The benefit will accrue even beyond the targeted locality and it is very difficult to *exclude* non-purchasers of pesticide spray. In the case of malaria elimination, a pesticide spray company cannot charge individual residents, since all the non-payers in the region will also benefit from the spraying. For this reason, no private business firm will come forward to supply public health measures, elimination of crime in the city or any other services which can be considered public goods, as there are no ways to market such a good or service. In this context, it should be understood that economic activities will affect not only the welfare of the supplier and the purchaser of the product, but also unintentionally yield incidental benefits or cause incidental injuries to some third party or parties, not directly involved in the exchange. These unintended side effects are called *externalities* or *spillovers*. This means, these activities spill over upon persons outside the immediate transaction. In our discussion of externalities, we are interested primarily in the *adverse externalities* or spillovers that constitute the source of many of our environmental problems. This is called *negative externalities*. Air pollution is a good example of this. A factory that emits smoke into the atmosphere does not do so as an end in itself. It is only an incidental side effect in the process of production. However, this spillover effect constitutes health hazard to the people in the neighbourhood which is omitted entirely from the factory's calculation of its receipts and costs. The fact that the business firm running the factory causes adverse externality without paying any

There are different concepts of social welfare. Of these, the concept put forward by Vilfredo Pareto (1848 - 1923), the Italian Sociologist has become very popular. According to Paretian concept, social welfare is the collective welfare of all individuals in the society. Even if one individual is better off, without no one being worse-off, the social welfare is said to have been increased.

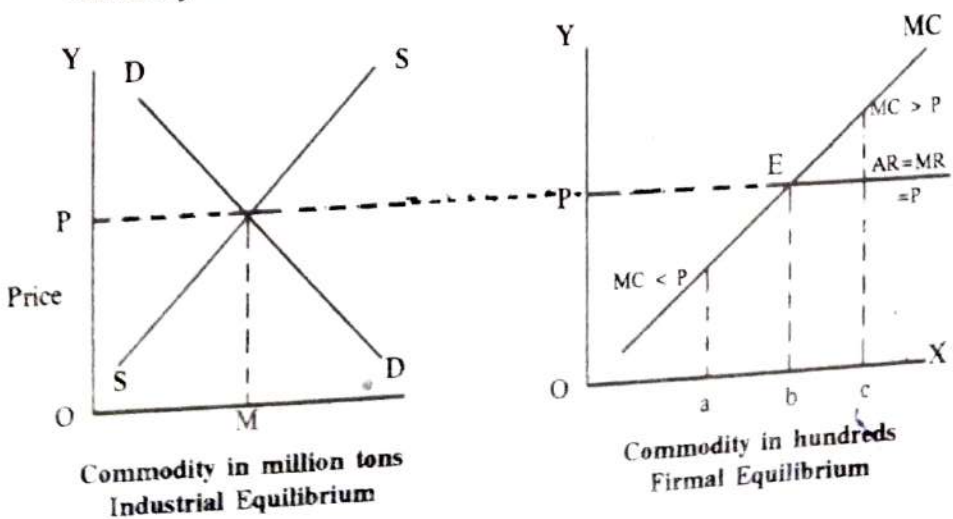
COMPETITIVE ECONOMY AND SOCIAL WELFARE

Efficiency And Perfect Competition:

Readers will be very familiar with elementary principles of economics relating to different types of marketing conditions in the economy and how do they come to equilibrium. In a perfectly competitive private market economy (which is rather hypothetical), the householders, otherwise called 'consumers' and firms, otherwise called 'producers' would be in large numbers and they take into account their individual welfares and decide their activities in the private competitive free market economy. The consumers will be guided by the utilities and satisfaction they derive in demanding and consuming the goods; while the producers (Firms) will be guided by the profits and losses in their ventures. In such a perfectly competitive market, no buyer or seller can affect the market price by changing the individual demand or supply in the market. In short, every operator in the market, whether consumer or supplier is only a *price-taker* and not price-maker. The general *equilibrium price* in such a market is determined by impersonal forces of market supply and demand. We assume that the level of technology, tastes, preferences and other factors remain constant without affecting the state of general equilibrium. This is depicted in the figure 4.1

Fig. 4.1

Industry and Firm: Equilibrium in Perfect Competition.



The left of the Figure 4.1 indicates the equilibrium of the perfectly competitive market arrived by the interaction of aggregate demand and aggregate supply. The price OP has been taken by the firm on the right side. The firm's demand curve is the straight horizontal line at P . At the price OP , the firm can produce and sell any quantity. But, how much the firm will sell? This depends on its marginal cost curve which cuts the price or revenue curve at E . If the firm decides to produce more than Ob units, it will incur loss, as MC is higher than the marginal revenue it gets for each unit sold. If it sells less than Ob units, it will reap profit. But maximisation of profit comes at the level Ob where MC is equal to MR .

In a perfectly competitive market, a firm will maximise its profit at a level of output where $P = MC$. Every firm will produce where $P = MC$. Here, the sellers group gets maximum benefit by making $P = MC$. The total market supply is equal to total market demand and in this sense all consumers are satisfied, as they get the quantity what they demand.

What is Efficiency ?

What is the meaning of the term 'efficiency' for the whole society in this context? An individual is said to be efficient when the person maximises the consumption with the available resources or income. To put it in the other way, an individual is said to be efficient, if the person makes minimum expenditure to attain a particular level of consumption. In the same way, a firm is said to be efficient, if it produces maximum output with available resources or investment; or minimum investment or expenditure to achieve a particular level of output. To put it shortly, efficiency connotes maximum output with very minimum resources or maximum consumption with minimum income. In the same manner we can say that an economy is said to be very efficient if it can maximise the satisfaction of the society with minimum resources; assuming that we can make some aggregation of satisfaction of all households in the economy. This aggregation of satisfaction is not in any way physical measurement like tons or metres, but by subjective values attributed to different goods and services by individual consumer units. The maximisation of satisfaction for the entire society as a whole is termed maximum social welfare with minimum social cost. This can also be expressed in a different way. Economic efficiency of a society is identical with maximum social welfare which means that it would not be possible to make any change in the economy's consumption or production arrangements, without reducing the welfare of any other household. Maximum social welfare is a situation in the society where it would

Firms Equilibrium in Production

The above analysis will help to show that only in a perfectly competitive economy, the firm can maximise profit to maximise welfare. We had already discussed that in a perfectly competitive market, the firm will produce at a level where $P = MC$. This means that every firm in the economy produces its output to a point where price is equal to marginal cost. The price of X is the marginal cost of X. This means $P_x = MC_x$. In the same way $P_y = MC_y$ and $P_z = MC_z...$ etc. It follows that relative prices will be exactly equal to relative marginal costs for all products and services, i.e., $\frac{P_x}{P_y} = \frac{MC_x}{MC_y}$.

This connotes that relative prices of all goods measures the relative marginal costs of all goods in a perfectly competitive economy in equilibrium. All these go to show that there will be *maximum efficiency in a perfectly competitive economy* in equilibrium, and all the people (households and firms) will attain maximum satisfaction and Pareto's maximum social welfare (MXSW) could be obtained.

POLLUTION EXTERNALITY AND ECONOMIC EFFICIENCY

Maximum efficiency of markets under perfect competition and the consequent achievement of MXSW discussed above holds good *only in the absence of externalities*. In our discussions above, we had not considered the social cost involved due to pollution externalities. Hence, we have to analyse the market efficiency under perfect competition when pollution externality is present.

In the beginning of this chapter, an indication has been made about the problem of externality and market failure. Let us discuss those points elaborately, so as to have a purview of economic efficiency under perfect market when there is pollution externality.

According to economists, the private market system produces undesirable effects on the environment in the form of obnoxious pollutants which involve some social cost and which are not reflected in the cost of production and market price of the product. This is called as we have studied earlier, "spill over" effect or "spill over" costs. According to A.C. Pigou, the term "spill over" indicates that the full effects of production or consumption are not confined to the firms or households directly involved, but *spill over* on to third parties. Such spill over effects may be in the form of smoke polluting the environment, or discharging of effluents into the water bodies by industrial plants.

This spill over results in the deterioration of environmental quality, which is an output by the firm quite distinct from the final marketed product of the firm. The firm does not and could not sell this extra output which are external to the product produced by the firm for product which are external to the households and also firms affected output which are external, the households, if they could either market. On the contrary, the firms are willing to pay a cost, if they could either by the spill over would be willing activities. Thus, any costs that are end or lessen the firm's polluting activities. The total social costs can be defined additional to the costs resulting from the production outlays of the firm are *external cost or spill over cost*. The total social costs can be defined as the sum of the private costs of the firm and any external costs. The expression 'external' implies that this cost does not accrue to the firm producing the commodity, but imposed on the society which suffers such costs are outside the market system and are not reflected in relative market prices.

In modern industrial economy, many instances can be cited to illustrate the concept of external cost. A paper mill or an oil refinery, polluting the river nearby, by discharging their effluents and destroying the game fish population impose external costs on fishermen, boaters and swimmers. A leather tanning unit discharging its effluents in the nearby canal or river and make the water unfit for irrigation purposes, imposes external cost on the peasants in the nearby region, using the water body for irrigation. Similarly, a cement factory emitting smoke and dust particles, creating many lung diseases to the people in the locality and making them inefficient in their respective workspots, imposes external cost on this segment of the society.

The Economics of Externalities

The economic effects of an external diseconomy can be illustrated by means of an hypothetical example. Suppose there exists a small river valley ecosystem in which the land on the upper portion is unfit for cultivation and hence lies idle and the land downstream is fit for cultivation and it is owned by a single farmer who uses the river water for irrigating his land and producing corn. The farmer gets an average return sufficient for him to keep in the occupation. Now, suppose a leather tanning firm acquires the idle land in the upstream, constructs a big tannery and discharges the effluents into the river. The water becomes useless for irrigation and the corn yield of the farmer in the downstream will have less productivity and he may be even forced to go out of his farming business.

This is a case of external diseconomy of production in a private market economy. Though this illustration is hypothetical, it is not far

Basic Theory of Environmental Economics

In fact, the farmers in North Arcot Ambedkar district of Tamilnadu on the banks of the river *Palar* have been facing a similar situation, due to the tanneries discharging their effluents into the river, making irrigation and cultivation of land absolutely impossible and many farmers have left agricultural operations.

In the economics of externalities, the society gains on the one hand and loses on the other. The net social gain from the tannery in our example is the excess of the value of tannery products over the value of the factors of production used by the tannery firm, in their best alternative uses. The net social loss associated with tannery production is equal to the decrease in the value of the corn crop, net of the value of the land and the farmer's labour in their best alternative uses. If the farmer is driven out of farm business and becomes unemployed and the land also becomes valueless, then the value of the loss is identical to the full value of the corn crop. Thus, the external diseconomy of the tannery production (i.e., spill over effect) is measured in terms of farmer's net income loss. The possibility that the switch from corn production to tannery production resulting in a net social loss is a form of (potential) market failure. Such a possibility would not arise, if the corn farm and the tannery plant are owned by the same profit-maximising firm. But our assumption is that two independent units (two firms or firm versus household) are considered in their welfare maximisation activity. The competitive marketing system cannot allocate the resources most efficiently in the presence of externalities. The implicit assumption is that there is no market for the sale and purchase of water rights and the farmer cannot contract with the tannery firm *not* to pollute; and the tannery firm has no incentive to include in its cost and profit calculations the amount of external costs it imposes on the farmer.

With this preliminary ground about external diseconomies, we shall proceed to discuss the price and quantity of external diseconomies.

Economists have identified different types of externalities, such as marginal unidirectional, marginal reciprocal, infra-marginal reciprocal, pecuniary and non-pecuniary externalities. But, we are concerned with only two types of externalities, viz., pecuniary externality and non-pecuniary externality which may also be called technology externality.

Pecuniary Externalities

This is not a big problem, as this type of externality (as the name itself suggests) gets reflected in the market prices of goods and there will not be much of divergence between marginal private cost and

marginal social costs. The pecuniary externality can be illustrated in the following cases:- (i) An increase in demand for a commodity results in the increase in output and selling the commodity at a higher price due to increase in cost of production. This increase in price is the result of society's decision to have more of the commodity and hence this is called pecuniary externality; to be very precise 'pecuniary external diseconomy to consumers'. On the other hand, if the price of the commodity is caused to fall by the decisions of the society, then it is called pecuniary economy to consumers. It should be noted that pecuniary diseconomies to consumers are pecuniary economies to producers; and pecuniary economies of consumers are pecuniary diseconomies to producers. Thus, this type of externality causes no problem and the market price reflects such externalities and there will not be any distortions from optimality.

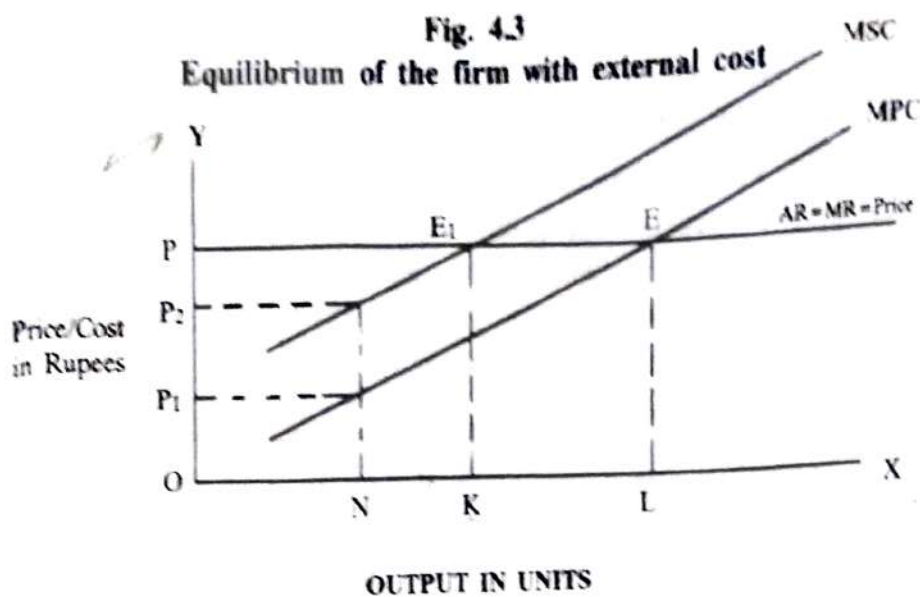
Non-pecuniary or Technological Externality

It is only this that would cause distortions and prevent the smooth functioning of the market efficiently. This will result in wide divergence between marginal private cost and marginal social cost.

Already we have seen that the equality between price and marginal cost of the firm is essential for obtaining maximum social welfare in a competitive market. All costs borne by the firm is termed private costs and the marginal costs incurred by the firm may be called *marginal private cost* (MPC). In the absence of any externalities, the firm will have output level by equating MPC with price curve. Suppose, the firm imposes an additional cost to the society due to pollution created by smoke or discharging effluents, this pollution cost is not included in the MPC schedule of the firm. So we have to conceive another marginal cost schedule that includes all the costs of the firm's production, both private and external. This means that the marginal cost will include external cost also and we call this *Marginal Social Cost Schedule*.

In the figure 4.3, MPC denotes marginal private cost curve of the firm and MSC, marginal social cost which includes, external costs as well. P is the price line. The vertical distance between MPC and MSC schedules at any given quantity measures the *external cost* (that is net loss to the society) per extra unit of output by the firm. For example, the MPC of producing ON^{th} unit of the commodity is OP_1 rupees; but the MSC of this unit is OP_2 rupees. The difference i.e., $P_2 - P_1$ rupees is the marginal external cost of producing the ON^{th} unit of the commodity of the firm. The marginal external cost of

production is a constant per unit of output and it does not depend on the level of output.



Since we have assumed perfectly competitive condition in the market, the firm has to take the market price OP . The management of the firm does not take into account of the external cost and as such maximises profit by equating MPC with price. So in the figure the firm produces OL units of the commodity, as at this level of output $MPC = P$ and point of equilibrium is E . But from society's point of view, all cost should be taken into consideration and the equilibrium point should be at E_1 where the firm would be producing only OK units of the commodity and where price = MSC . In an ideal condition, the firm should have $P = MSC$ and production level should stop at OK units. Private optimal level of production is OL units; but social optimal level of production should be OK units. The difference between the two levels of production ($OL - OK = KL$) represents *over production* by the firm. Society would be better off with OK than with OL units, because the resource used to produce KL units have greater net productive value in other employments. The same logic may be applied that in some other goods, production may be below the social optimum level. Thus, we can come to the conclusion that in an ideal competitive market system, external diseconomy distorts the optimal allocation of resources; some goods may be over produced and some in lesser quantities; or they may not be produced at all.

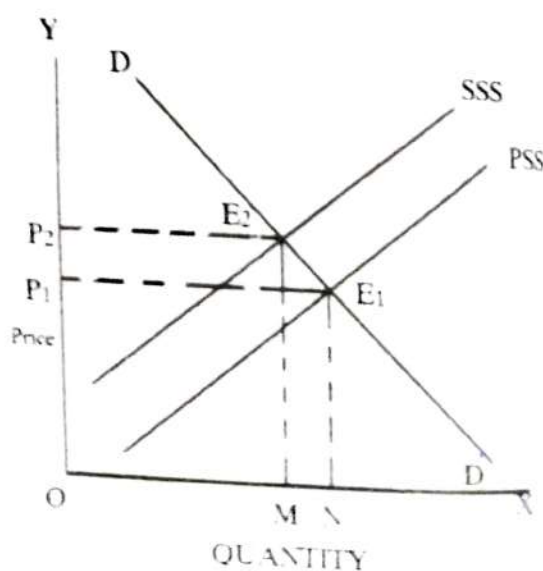
Externality and Industrial Output

The analysis given above relating to firm's output in a competitive economy with external diseconomies can be further extended to the

level of industrial output. We extend the analysis by assuming that all firms of the industry in the economy have more or less similar external diseconomies. Then the aggregate of all MPC schedule of firms will become the supply schedule of the industry which can be called PSS (Private Supply Schedule). The summation of all MSC will become Social Supply Schedule which may be called SSS. Evidently, the SSS will lie above PSS showing that the industry will supply less due to the adding of external cost, which is the difference between MPC and MSC. In the figure 4.4 showing SSS PSS, we can introduce the demand curve for the industry's product which may be called DD to find out the exact implication of the equilibrium condition.

According to the figure 4.4, the demand curve for the industrial product cuts the private supply curve at E_1 , indicating the total supply as ON units at a price OP_1 . The total industrial output ON is the sum of all firms' output in the industry. But, in this equilibrium point, we have not included the social cost accrued to the society due to the external diseconomies. Only SSS depicts the real supply curve in which social cost has been included. The SSS cuts the DD at E_2 where the production is OM units and the price OP_2 . From this we can conclude that private market system produces larger quantities (ON units) at a low price OP_1 . Over production is to the extent of $(ON - OM)$ MN units and the price is less by $(OP_2 - OP_1)$ P_2P_1 . This implies that some other industries are precluded from producing enough or they may not be producing at all. The ideal situation would be if the industry produces at the equilibrium E_2 where it produces OM units and sells at a price OP_2 . The society would be better off, if all the firms behaved, as if SSS is the supply curve and not PSS. At an output level OM , pollution costs are reduced to a socially optimum level, though it may not be at zero level. In the absence of governmental intervention, the external diseconomies will be larger and the pollution will be more conspicuous and also burdensome social cost. If any individual firm exhibits social concern and attempts to pay the

Fig. 4.4
Externality and Industrial output



external cost imposed on others, it would be placing itself at a disadvantageous position in the competitive market; and the firm will be answerable to the shareholders for poor dividends.

Thus, in the presence of externalities, the private market mechanism fails to allocate resources efficiently so as to achieve MXSW by the society.

IMPERFECT MARKET

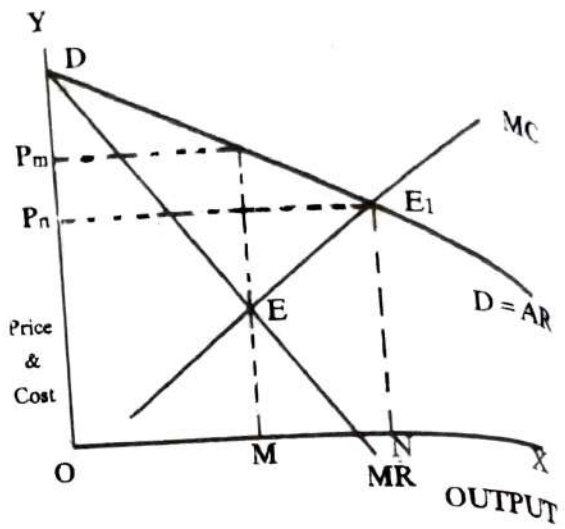
Externality and Efficiency

We shall proceed with the discussion of externalities and efficiency in an imperfect market condition. We are very familiar with imperfect market, as this represents the practical market conditions prevailing in the economy.

What are the essential differences between a perfect market discussed above and an imperfect market? (i) In a perfect market, the firm, i.e., the seller will have no power to fix the selling price. He is only a *price-taker* and not price maker. But, in an imperfect market, the firm will have *some powers* to affect the market price. The extreme form of imperfection is monopoly. The powers of the firms in imperfect markets are only matters of degree. (ii) In a perfectly competitive market, the firm can sell any quantity at the market price, i.e., the demand curve of the firm will be horizontal and elastic. But in an imperfect market, the firm cannot sell any quantity at the same price. Larger quantities can be sold only at a lesser price. This is to say that the demand curve of the firm will be a descending curve, showing that larger quantities could be sold only at a lesser price. (iii) In perfect market, the price will be equal to marginal cost. But in the case of firm under imperfect market, the selling price will be higher than the marginal cost of production. (iv) In perfect market, the firm will be producing the maximum and the price (market price) will be minimum. But in imperfect market, the production will be less and the price will be higher than the competitive price.

Whatever be the type of market, the motivating force behind will be maximisation of profit which will be achieved by equating MC to MR ($MC = MR$). For sake of simplicity, we shall discuss the extreme case of imperfection, i.e., monopoly which sells the commodity, assuming there is no externality.

Fig. 4.5
Equilibrium of the Monopolist



The figure 4.5 depicts the equilibrium position of a monopolist. DD curve is the descending demand curve of the monopolist which is equal to AR i.e., Average Revenue or price. MR curve will lie below the demand curve (AR). MC curve denotes the marginal cost of the monopolist. The equilibrium point is E where marginal cost is equal to marginal revenue ($MR = MC$) and the level of production is OM units. But at this level of production the monopolist can sell at a price OP_m and make maximum profit.

The monopolist will not produce at a level of ON where $MC = \text{price}$, as in the case of perfect competition. By so doing, the monopolist will spoil his market, as at that level his marginal revenue will be less than the marginal cost and he will incur loss. The revenue will also go negative, as at that level the $MR = 0$. For every unit produced by the monopolist beyond OM level of production, MC is greater than MR and the firm will incur loss on each additional unit of production. So, the monopolist will restrict production at OM and sell at a rate of OP_m which is the most advantageous position. In imperfect competition, as a general rule, P will not be equal to MC. It will be more than MC as the firm has some monopolistic control, over the price. With this ground we shall discuss about externality and efficiency in an imperfect market, that is 'monopoly' taken for illustration.

Monopoly and Externalities : The Problem of Second Best

Now, we have come across two sets of problems distorting the efficiency of the market. The first one relating to perfect competition in which the external costs cause price to fall below the true marginal social cost of production and the resulting level of output is too high compared to the level where all costs are paid by the firm. That is, under perfect competition, the firms produce more at a lesser price. On the other hand, in the case of monopoly, the firm produces less and prices at a higher level, i.e., more than the marginal cost. These two effects work in opposite directions and will tend to offset each other. Any one of these two effects may dominate. It will be very difficult to determine theoretically which effect is stronger, as it is an empirical problem.

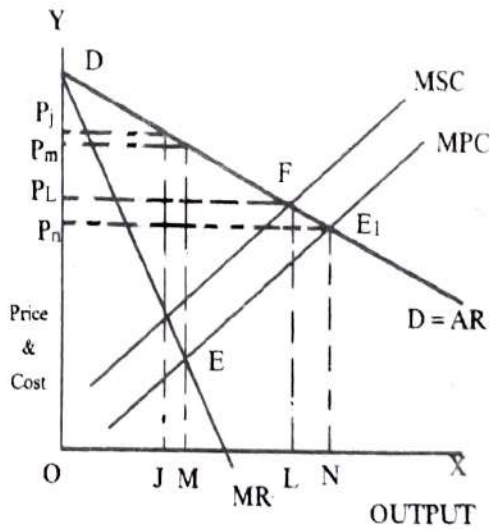
Next, we shall take up the consideration of externality in a monopolistic firm. Suppose, the monopoly firm generates pollution and imposes external costs on the society. Based on maximising behaviour without considering the externality, the monopolist will produce OM units selling at a price OP_m as shown in the figure 4.6. The marginal cost curve will become the marginal private cost (MPC) and the marginal social cost curve (MSC) will lie above MPC at a distance of pollution cost for every unit produced. The equilibrium point 'F' which is socially advantageous is shown in the figure.

When the external cost is internalised by the firm, the level of output will be OL and the price will be OP_L as shown in the figure 4.6. Now the situation presents two distortions; the existence of monopoly and the existence of external cost. Correction of both problems is necessary to obtain the socially efficient outcome. Economists call such a situation, the problem of *Second Best*. If only one of these two distortions alone is set right, the society will not necessarily be better off. In terms of efficiency, the situation remains unchanged.

Suppose by starting a tirade either socially, politically or legally against the monopoly firm and the situation is brought to the level of perfect competition without internalising the external cost, then the output will expand to the level of ON and the price will fall to OP_n . This correction is rather unwarranted, as the output will expand far beyond the socially optimum level. Whether output OM is more efficient or output ON is more efficient relative to the socially optimum level of output OL is rather very difficult to judge by theory, as it becomes an empirical study. It is better to leave the monopoly alone which will be more efficient, than bringing about a situation of competition.

Suppose in our illustration the government imposes a tax on the monopolist to curb his production activities to neutralise the pollution or external cost. The amount of the tax per unit of production cannot be more than the external cost of pollution per unit. In that case, monopolist will behave as if the MSC is his MPC , as tax (wh

Fig. 4.6
Polluting Monopolist



Environmental Ecology

Knowledge of environmental ecology is essential for students of Environmental Economics to understand the concepts, structure and dynamics of the ecosystem. This will help the students to assess the extent of dependence, or rather interdependence of living things on earth and non-living things around.

Environmental segments

The environment may be broadly divided into following segments:
(a) Lithosphere (b) Hydrosphere (c) Biosphere and (d) Atmosphere

(a) **Lithosphere:** This is actually the earth's crust consisting of the mantle rocks and the soil covering the earth and rocks which result from physical, chemical and biological process during weathering. The soil consists of complex mixture of organic and inorganic matter and water. The inorganic minerals include mixture of silicates of sodium, potassium, aluminium and iron, oxides and carbonates. The organic matter which forms 5 per cent of the soil determines the productivity of the soil.

(b) **Hydrosphere:** This includes all surface and ground water resources present on the earth's crust. These include oceans, seas, rivers, lakes, streams, reservoirs, glaciers, polar icecaps, ground water and water locked in the interior of the earth. Earth is called blue planet, as more than 75 per cent of earth's crust is covered by water. However, more than 95 per cent of earth's water is saline, unpotable and useless, locked up in the oceans and seas. Only one per cent of the total world's water resources is available for exploitation for domestic, agricultural and industrial purposes.

(c) **Biosphere:** This is the region where life exists on the earth. This is roughly a global girdle extending from about 10,000 metres below sea-level to 6,000 metres above sea-level. (The biosphere is the realm of all living things (plants, animals of all kinds) and their interactions with the other sections of the environment, namely, lithosphere, hydrosphere and atmosphere. To be precise, biosphere is the region covering lithosphere, hydrosphere and atmosphere.

(d) **Atmosphere:** This extends upto 500 kms above the surface of the earth. The atmosphere comprises of a mixture of gases like nitrogen, oxygen, carbon dioxide, etc. A constant exchange of matter takes place between this atmosphere, biosphere and hydrosphere. The atmosphere is like a gaseous insulation surrounding the earth for 500 Kms thickness, protecting the earth from dangerous cosmic radiations from outer space and helps in sustaining life on the earth. The atmosphere screens the dangerous ultra- violet radiation from the sun. Further, it plays a vital role in maintaining the heat balance on the earth by absorbing the infra- red radiation received from the sun and remitted by the earth. This phenomenon is called "Green House Effect" which keeps the earth warm enough to sustain life on it. Besides, the gaseous constituents, viz., oxygen, nitrogen, carbondioxide play vital roles in sustaining life on this earth. Oxygen is essential for living. Nitrogen is essential for plants and carbondioxide is essential for photosynthetic activity in plants. Above all, the atmosphere performs the most essential and fundamental function of carrying water from oceans to land in the form of clouds, which is very vital for hydrological cycle.

Any major disturbances in the atmospheric composition may lead to disastrous consequences and may even endanger the very survival of life on earth.

✓ ECOLOGY AND ECOSYSTEM

The term 'Ecology' has its origin in Greek words 'Oikos' which means 'habitation' and 'logos' which means 'study'. Thus the term refers to the study of habitation of organisms and their habitats. A.G. Tansley, the British ecologist used this term first in 1935 and also said that ecosystem consists of basic functional units of ecology. According to him, the basic functional unit of ecology consists of the study of biotic communities and their relation with surrounding biotic and abiotic communities. This means that living organisms (biotic) have to live in the midst of other types of living organisms and also non-living (abiotic) things.

According to Ernest Haekol, ecology studies "the relation of animal to its organic as well as inorganic environments, particularly, its friendly or hostile relations to those animals or plants with which it comes into contact." To put it more easily, ecology can be defined as "the study of relation of organism or groups of organisms to their environment; of interrelations between living organisms and their environment together with the biotic