AN OVERVIEW OF ENVIRONMENTAL ECONOMICS

INTRODUCTION:

Environmental Economics has emerged as an important branch of study over the last few decades or so. Many environmental goods were earlier thought to be abundantly available free gifts of nature and hence, outside the scope of Economics. (Economics is concerned with the use of limited resources at the disposal of individuals and the society to meet the unlimited human wants, and hence scarcity is typically at the heart of economic problems.) However, with the passage of time people started realizing that many of such goods have been increasingly becoming scarce. Accordingly, their use and allocation have increasingly attracted attention of the economists.

Within economics, environmental economics has emerged as a separate branch because the usual system in which the allocation of most of the economic goods take place does not work for environmental goods. In a market economy framework allocation of resources or as to how much of various ordinary economic goods and services such as rice, bikes, pens, computers etc. to be produced gets decided through the working of the price system. If, for instance, there is excess of supply of a particular good over its demand by the people then price will fall. On the other hand, in the opposite case of excess demand of a commodity over its supply the price will increase. This process of adjustment in prices will continue till the quantity supplied of the commodity concerned is exactly equal to its quantity demanded by the people. Except under certain exceptions, this system works more or less efficiently in a competitive economy. However, in case of environmental goods and services the price system fails to ensure their judicious use in the society. Many environmental goods despite being scarce do not command price because of certain factors to be discussed later. Even when price exists for them, the price fails to adequately reflect its proper value. Thus, the various issues related to the use of environmental goods and services by the society require specific treatment which is done in the branch of environmental economics.

Some of the main components of Environmental Economics are

- Inter-linkage between the Economy and the Environment
- Sources of Market Failure
- Pollution Control Policies
- Economics of Natural Resources
- Valuation of Environmental Amenity
- Development-Environment Interrelationship
- Sustainable Development
- Economic Aspects of Global Environmental Issues

The following is a brief outline of the contents of these components

INTER-LINKAGES BETWEEN THE ECONOMY AND THE ENVIRONMENT:

Most text books on Environmental Economics begin with a chapter dealing with the inter-linkages between the economy and the environment. Indeed, an understanding of such inter-linkages is useful for a better insight to the more complex issues of Environmental Economics.

The service of the environment to the economy is multidimensional. First of all, it provides resources (materials and energy) as inputs for production of consumable goods and services. The environment also supplies recreational amenity for the use of human beings. More vitally the environment provides the ecosystem for continuation of human and other life forms in the earth. Apart from this, the wastes generated in the process of human economic activities are largely absorbed and assimilated by the environment. It is, however, important to recognize that these different services of the environment to the economy are interlinked and there are important trade-offs between one role and the other. For instance, too much dumping of wastes into the environment impairs the capacity of its life support system. Similarly, increased extraction of environmental resources as inputs for economic activities can damage its recreational value. Accordingly, the optimal balancing of the different roles of the environment in the economy is the core issue underlying the subject of environmental economics.

MARKET FAILURE AND ITS COMMON SOURCES:

Market failure refers to a situation where the market mechanism (or price system) fails to ensure an efficient allocation of resources. Two main reasons why price system does not work properly in case of environmental goods are what economists call ‘externality’ and ‘non-excludability’.

Externalities are the effects of production or consumption by one on production and/or consumption opportunity of another which is not captured in prices in market transaction. For illustration, let us take the case of paper production. The production process involves use of various resources such as labour raw material, machinery etc. Owners of these resources are compensated by paying prices and hence the value of these resources enters the cost calculation of the producer. However the pollution generated in the production process, may cause losses to the society in a number of ways. These losses actually form a part of cost of producing paper. But so long as the producer does not have to compensate these losses, they cannot enter the process of determination of price of paper. Hence paper will be under priced resulting in its too much demand for paper and concomitantly too much pollution inflicted on the society. Thus the market fails to provide for social optimality.

'Non-excludability' is a situation where it is impossible or highly costly to exclude any one from using a particular good or service. Since people can use such goods and services without paying any price, no price can ordinarily be charged for them even though they are not abundantly available. Most environmental services have this non-excludability feature. For instance the waste disposal capacity of the environment is not unlimited. Yet the market cannot set a price for this service as it is ordinarily possible for people to use it without paying for it.

Addressing market failure in environmental goods is a major concern in Environmental Economics.

POLLUTION CONTROL POLICIES:

The illustration of paper manufacturing in the previous section clearly shows that market forces will not automatically lead to socially optimal level of output and pollution. (It is to be noted that zero pollution may not be consistent with socially optimal level because any type of economic activity involves some amount of pollution). Hence, one area of environmental economics focuses on the methods of controlling pollution. Such methods of controlling pollution can be broadly divided into two categories, viz., *command and control* and incentive based measures.

In case of command and control the regulator specifies certain steps and commands the polluters to follow them and act accordingly in order to control pollution. For example, the regulator may instruct the polluters to use particular pollution control equipment. An important advantage of this method is that it can assure with certainty as to how much pollution will result from the regulations, provided the polluters follow the guidelines of the authority. Moreover, monitoring of compliance with a regulation is simple. However, the major problem of this tool is that it is difficult and very costly to enforce it mainly due to informational constraints. Another significant problem with the command and control is that since the polluters have to comply with the regulation; they do not have the incentive to look for a better way of controlling pollution.

The incentive based measures relies on providing incentives in terms of rewards for the polluters to do what is perceived to be in the interest of the people. The incentive based measures or economic incentives in short, are basically of three types, viz., fees, liability and marketable permits. Pollution fees involve imposition of taxes per unit of pollution emitted. This is also referred to as Pigovian tax, named after the famous economist A.C. Pigou. When the polluter is required to pay for every unit of pollution emitted naturally it is in his interest to reduce emissions. The pollution fees may take the form of tax on a commodity generating pollution either through its production, consumption or through use of polluting inputs. (For more illustration see *Carbon Tax*.)

Carbon Tax:

A carbon tax is a charge levied on the fossil fuel which may vary within different types of fuels depending on their relative carbon content. It can be collected in several ways: as a tax on domestic fossil fuel output, as a tax on import of fuel output, as a tax on primary energy inputs etc. If the tax is higher than the cost of abating the additional unit of carbon (also known as Marginal Abatement Cost), the polluter would like to reduce the emission of carbon. On the other hand, if the tax is lower than Marginal Abatement Cost then he would like to emit and pay the tax. Thus, it is clear that the best solution for a polluter is to pollute up to that level where Marginal Abatement Cost is (MAC) equal to the tax. If all the polluters across sources behave in the same fashion, a situation will be attained where Marginal Abatement Cost of all sources is equal to the tax. This is the ideal or cost effective situation from society's point of view. This is the ideal or efficient solution because if this situation is attained then it is ensured that a specific emission reduction target is achieved with the minimum possible cost. This point can further be elaborated. Let us assume there are only two sources of carbon emissions. If the MAC of one source is higher than the other, then society can always save money by reallocating emission control responsibility away from the higher-MAC source and towards the lower-MAC source. Thus same amount of emission reduction can be achieved but at a lower cost. Once the MAC across sources becomes equal the scope of further reallocation of the emission control responsibility is no longer there. At that point whatever cost is incurred that is the minimum cost required to be spent to attain that particular level of emission reduction. Thus, it can be stated that the carbon-tax has the in-built-mechanism to attain the efficient solution.

A tax may result in several responses: different sources might reduce their tax liability by reducing emission, fossil fuel users will increase the energy efficiency, use less carbon intensive fuels and consume goods and services produced in carbon-saving ways. The major problem with tax, however, is that it is uncertain whether an emission reduction target will be attained or not.

An alternative to the Pigovian tax as suggested by D. H. Dales may be tradable or marketable pollution permits. The tradable pollution permits allows the polluters to buy and sell the 'right to pollute'. Let us take the example of air pollution. First the optimal level of pollution in a locality is determined and then this is divided into a number of permits and distributed among the polluting firms. Thus every firm enjoys the right to pollute according to their permits. Now cost of abetment is likely to differ across firms. While some firms can cut back pollution at a relatively small additional cost, for some others cutting down pollution level may be a much higher cost affair. Since pollution permits are tradable, the firms with low abatement costs will have the incentive to cut down pollution level and profit by selling surplus pollution permits in the market. The firms with high abetment cost would like to buy additional permits as that will spare them the high cost obligation of reducing pollution. In other words pollution will be reduced sharply in units where the cost of abatement is low and

permits will be concentrated in units where abetment cost is high. Thus, through buying and selling of the permits aggregate pollution will be kept within the prescribed level with minimum collective (social) cost of the firms. Markets for trading in carbon permits are already in operation. Carbon trade is slated to acquire a significant volume in India too.

The third type of incentive based measure is liability. Strong *liability law* is can help to minimize the risks of environmental disasters. Carelessness in storage, transportation and disposal of hazardous chemical or radioactive waste or other polluting agents can result in their leakage to the environment causing extensive damage to life and ecosystems. When agents dealing with use, storage and transportation such material are made severely liable for punishment and/or compensation for any such leakage, it creates the incentive to be careful to avoid such leakage. The incentive in turn reduces the probability of occurrence of environmental disasters like the Bhopal Tragedy.

ECONOMICS OF NATURAL RESOURCES:

Natural resources refer to the resources in the form of various goods and services provided by nature. For example, air, water, mineral, timber, solar energy and so on. Economics of natural resources is concerned with the principles regarding use, regulation and preservation of different types of natural resources.

Natural resources may be broadly categorized into two types, viz., renewable and non-renewable resources. The renewable resources are those which get regenerated through a biological process. Fisheries and forests are examples of renewable resources. On the other hand, non-renewable resources are not regenerated within a time horizon relevant to economic calculations of the human society. Minerals like coal, iron ore and hydro-carbon are prime examples. (The renewable resources like trees in a forest and the fish stock in a water body can regenerate within a reasonably short period of time whereas the resources like coal take million of years for their formation.)

Since the non-renewable resources are exhaustible in use, their stock is bound to deplete with the passage of time and growing demand for them. Therefore, the main issue regarding the management of such resources should focus on their optimal extraction and depletion over time. The management of non-renewable resources is concerned with the optimal allocation of resources between present and future. Here price system can play an important role. The price of such a resource increases with increase in its scarcity, which provides an incentive for economization in use and also for looking for substitutes. For example, the scarcity and higher price of non-renewable energy resources such as mineral oil, coal etc. has encouraged people to focus on other substitutes like solar energy and nuclear energy as alternative energy sources. Moreover, the existence of monopolies and cartels may also slow down the rate of depletion of non-renewable resources. For example, the Organization of

Petroleum Exporting Countries (OPEC) may reduce the supply of oil in the market leading to increase in the price and thereby reduce the depletion of crude oil.

The case of renewable resources is quite different from that of the non-renewable ones as the former may be prevented from its exhaustion unlike the later. However, their indiscriminate extraction should be avoided. For instance, over harvesting reduces the stock of fish, which in turn reduces the natural regeneration of fish population. Sometimes, it may even lead to the extinction of otherwise renewable resources as is now with the case of many endangered species. Hence, we should go for sustainable exploitation along with necessary steps to facilitate their regeneration so that the stock of the resources remains un-replenished.

Economic analysis has shown that if rights over the resources are firmly and clearly defined then market forces can ensure sustainable use of the renewable resources. However, the main problem arises when property right is not well defined and it becomes an open access common resource. Open access resource signifies a situation where there are no enforceable property rights over the use of the resource and it is open to exploitation by all members of a group. It may lead to 'tragedy of commons'.

The Tragedy of Commons:
Let us take an example of a common grazing land in a village which is open to all the villagers. Each villager in the pursuit of maximizing individual gain adds more and more cattle to the grazing field. He gets the full benefits of adding one more animal to the field. His personal gain from adding one more animal exceeds his personal loss from the damage done to the field (since the loss done by one more animal is to be shared by all as opposed to the gain which accrues fully to him). All villagers think the same way and act accordingly to maximize personal gains. Eventually the total number of cattle exceeds the carrying capacity of the grazing land and everybody loses from the damage of the land. Thus, in the absence of appropriate regulation, overexploitation of resources leads to their destruction. Such tragedy may also occur in case of common fishery in the villages.

Since the problem originates from laxity in defining and enforcement of property right over the commons, the usual solution suggested is assignment of property rights either in the form of private property rights or through establishing *common property rights* regime, which lays down rules to limit entitlement of individual members to common resources of the community

'Prisoner's Dilemma':
A popular analysis of the 'Tragedy of Commons' takes the form of a game known as the '*prisoner's dilemma'*. To explain this concept let us assume that two persons, Haren and Bittu have been arrested on the charges of theft. They have been kept separate so that no communication is possible between them. The options in front of them are: if one confesses but the other does not, the former will be set free while

the later will receive punishment of 5 years in jail; if both confess then they will get a modest punishment, say of 2 years; and if neither confesses his crime they will be freed after 3 months due to lack of evidence. This is depicted in Table 1. Now Haren thinks that if Bittu does not confess his best option is to confess and secondly if Bittu does not confess, then again his best option would be to confess. Because if he does not confess and Bittu confesses, he will get a severe punishment of five years and there is no way for him to know what the decision of the later would be . On the other hand, Bittu thinks the same way and decides to confess. Thus the likely outcome is that both will confess and get a punishment of 2 years each. However, it is interesting to note that if both could come to contact and cooperate then they could have got only 3 moths punishment simply by denying the charges against them. But since they have been kept separate cooperation is not possible. The essence of 'prisoner's dilemma' is that lack of cooperation among the parties deprives them of the best of all the outcomes.

Table 1: The 'Prisoner's Dilemma'

Bittu	Haren	
	Confess	Don't confess
Confess	2 years, 2 years	free, 5 years
Don't confess	5 years, free	3 months, 3months

Thus, 'prisoner's dilemma' refers to a situation where each participant receives a comparatively lower return as a result of non-cooperation than what they would have received if there were cooperation between them.

The same sort of 'prisoner's dilemma' can be observed in case of the commons. Let us now take the example of common grazing land used while discussing 'tragedy of commons'. It was found that the desperate use by all the herdsmen lead to degradation of grazing land. For the sake of simplicity let us assume that there are only two herdsmen Haren and Bittu. The different options open to each one of them are shown in Table 2. As clear from the table when one cooperates in the judicious use of the land but the other does not, the later is the gainer in terms of returns from his livestock as he will be putting more and more cattle on the land. If neither of them cooperates and uses the grazing land indiscriminately then each gets a low return of 20. The best action, however, would have been to cooperate and appropriate a larger return of 50 each. But their individual rational choices lead to non-cooperation.

Table 2: Common Grazing Land and 'Prisoner's Dilemma'

	Haren

Bittu	Cooperate	Don't cooperate
Cooperate	50,50	10,30
Don't cooperate	30,10	20,20

However, this undesirable solution may be avoided in a 'repeated game' framework. Suppose the players, Haren and Bittu in our example, go through the dilemma repeatedly. Once repeatations come into calculation, the players are likely to realize the mutual gain from cooperation, and their choice of action may be different from what that will be in a one-off game. There are ample empirical instances when members of a community get together to form rules to self regulate the use of their commons and thereby manage to avoid the 'tragedy of commons'.

VALUATION OF ENVIRONMENTAL AMENITY:

Why is the valuation of environmental amenity needed? The answer depends on the values that the society puts on the environmental amenities. Since the society puts value on such amenities, it is desirable that they should be preserved and conserved. As preservation and conservation involve costs, hence decision has to be taken regarding the amount that is socially justified. The valuation tools have now been extended to heritage sites and monuments also. Before going to discuss the valuation techniques it is necessary to highlight upon the values the society puts on environmental goods.

The environment provides different types of goods and services. The values that the society puts on such goods and services are broadly categorized into use value and non-use value.

Use value arises when one derives benefits from an environmental good or service by directly participating in its use. For example, the environment provides raw materials and other resources which are used directly in the production and consumption activities. Another example of this is sightseeing where an individual is directly engaged in viewing the beautiful scenery.

On the other hand, in case of non-use value an individual derives satisfaction without directly using the goods or services. One may feel happy simply by knowing that the one-horned rhino is found in Kaziranga National Park in the state of Assam. The non-use value may, however, be of different types, viz., option value, existence value and bequest value. An option value is the value placed on the option for using a good in future. An example of option value is preservation of biodiversity. Preservation of some of the endangered species may be desired as many people may wish to have enjoyment from seeing them in future. Existence value refers to the value attached to knowing something exists. An example is the one-horned rhino mentioned earlier. Bequest value arises when one intends to pass a good or service on to the future generation.

Non-market Valuation Techniques:

The value or price of the ordinary goods that we use in our day–to-day life such as pen, rice, computer, clothes etc. are determined through the market on the basis of their demand and supply as mentioned earlier. The problem, however, arises in case of environmental goods most of which do not command any price notwithstanding their great importance and scarcity. Therefore, the usual valuation techniques based on the market forces cannot be applied for such goods or services. In simple words, market does not exist for such goods. Hence, for valuation purposes certain techniques popularly known as 'non-market valuation techniques' are used in this regard. This is perhaps one of the biggest contributions of environmental economics. The two major groups of non-market valuation techniques are - Stated Preference Method and Revealed Preference Method. They are briefly discussed below.

Stated Preference Method:

In this method people are asked to state their preference in terms of willingness to pay (WTP) or willingness to accept (WTA) for certain hypothetical changes in the environmental quality. For example, they may be asked what they would be willing to pay for an improvement in the air quality or what they would be willing to accept as compensation for any deterioration in the air quality, if there were a market for it. Since market doest not exist for air quality, say for instance, this method is based on the existence of a hypothetical market. One popular form that has been extensively used in the empirical researches is the *contingent valuation method*. In the contingent valuation method the respondents constituting a sample of population are asked to state what they would be willing to pay (or accept) for a hypothetical increase (or decrease) in the environmental quality. However, the major limitation of this method is that the respondents may overstate their willingness to pay if they believe that they will not actually be required to pay whereas they may have a tendency to understate their willingness to pay if they think that their response may influence how much they would actually be charged.

Revealed Preference Method:

In this method attempt is made to estimate the value that people place on environmental goods from their observed behaviour in terms of expenditure on a closely related ordinary good. Unlike the stated preference method in the revealed preference method we make use of people's actual behaviour rather than their intentions (in terms of WTP of WTA). There are two approaches to this method: *hedonic pricing method* and *travel cost method*.

The hedonic pricing method starts with the assumption that variations in the presence (or absence) of environmental qualities cause differences in the prices of ordinary goods and this information can be used to infer the value of the environmental qualities concerned. This approach is generally used in case of housing markets. For example, a house contains different attributes like number of rooms, age of the house, open space outside of it, its location form the main town

etc. and also environmental characteristics like air quality, noise level, sunlight, scenic views and so on. Now, other things being equal, a house with a better air quality or in a quieter environment may fetch a higher price (or rent) than a similar house with a relatively poorer air quality or noisier part of the city. The hedonic pricing method seeks to infer the implicit value of the environmental attributes (like air quality in the above example) from the amount people are willing to pay for the ordinary goods like houses.

The travel cost method is associated with the valuation of environmental goods such as outdoor recreational sites. The method uses travel cost (time cost as well as money cost) as a proxy for the value of visiting such sites. A statistical relationship between observed visits and cost of visiting is derived and this relationship may be used to infer the value that the visitors enjoy.

DEVELOPMENT-ENVIRONMENT INTERRELATIONSHIP:

Development and Environment Trade-off?

The relation between the development process of a country and its environmental quality has attracted the attention of a number of economists. Some of them have found that environmental pollution has a relation with the development process which is of the shape of an inverted U. That is, the pollution levels first tend to increase as development process takes off. But as the process crosses a certain threshold and attains a fairly high level the pollution levels tend to decline with further advancement of development. The explanation for such relationship is given in the following lines. At low level of development economic activities, by and large, are subsistence in nature. Hence, the quantity and intensity of resource use being limited and wastes being mostly biodegradable, environmental degradation remains low. But as economic development accelerates agriculture gets intensified, resource extractions acquire larger scale and industrialization takes off. As a result, resource exploitation and waste generation increase in quantity and toxicity. At higher levels of development, however, the structure of the economy becomes more service oriented, environmental awareness increases and demand for cleaner environment expands with rising income levels. Consequently, environmental regulations are enforced and better technology and higher expenditures are applied for limiting pollutions. Such factors contribute to leveling of and gradual decline of environmental degradation.

Empirical evidence in support of such an inverted U-shaped relationship is not fully conclusive. Even if such a relationship exists, leaving environmental degradation unattended in the development process with the hope of the process itself taking care of the environment at a later stage is not an advisable approach. For, once environmental degradation crosses some threshold the damages may become irreversible. Hence, environmental economists call for the sustainable development (to be discussed later) approach rather than leaving development process to take care of environmental degradation merely through its inherent dynamics.

Poverty and Environmental Degradation:
All over the world poor people usually live near the dirty factories or waste dumps or other degraded locations which the better off choose to avoid. Accordingly the poor people, almost always, bear the burnt of environmental degradation. Most of the people who die from air and water pollution every year are poor.

Poverty and environmental degradation are often caught in a mutually reinforcing downward spiral. The poor are usually more critically dependent on common resources such as forests and water bodies for their day to day living than those who possess greater private wealth. Because of the pressure of growing population and in absence of other resources to fall back upon in difficult times, poor people are forced to exploit such resources more extensively than before. This puts further pressure on the environment. Environmental degradation, in turn, makes their living conditions even more precarious forcing them squeeze the already degraded environmental resources. If the spiral is to be arrested, purely environment oriented policy obviously will not be adequate. Addressing poverty will be equally important.

Indeed, for appropriate policy formulation it is necessary to examine the causality between poverty and environmental degradation. Addressing poverty supported by a programme of environmental restoration should be adequate only if the downward spiral is triggered off by poverty. However, the poor usually do not possess the means and power to damage the environment to the point that will unleash the spiral. On the contrary, there are ample evidence to show that greed and rent seeking by the rich and the powerful initiate the degradation of the environment and common resources in a scale that endanger the livelihood of the commons-dependent poor pushing them degrade the very resources on which they are critically dependent. Under such a situation merely addressing poverty can at best have only some temporary impact. More permanent solution will require correcting market and institutional failures that allowed plundering of environmental resources.

SUSTAINABLE DEVELOPMENT:

Definition and Interpretation:
Energy crisis of 1970s and some other events in the same period heighten concern about depleting natural resources and degrading environment all over the globe. Some thinkers even call for slowing down of economic growth so as to avoid/postpone environmental and natural resource crisis. On the other hand, existence of wide spread poverty and deprivation in the less developed countries necessitated enhanced level of economic activities in these countries so as to eliminate poverty and underdevelopment expeditiously. To find out a way of reconciling the apparently conflicting goals of speeding development process on one hand and conserving resources and environment on the other, the United Nations instituted the World Commission on Environment and Development under the chairmanship of Mr. Bruntland, the then prime minister of Norway. The commission

in its report ‘Our Common Future’ published in 1983, articulated sustainable development as “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

While the concept of ‘sustainable development’ as given by the Bruntland Commission sounds appealing at the first instance, an attempt at putting the idea in practice is confronted with ambiguity. The ambiguities arise from the fact that the definition is based on needs of present and future generations. The need of the future generation is particularly difficult to foresee and hence it is difficult to comprehend the course of action that will pass sustainability criterion. For practical application of the idea, a more distinct interpretation of it becomes necessary.

Economists led by Nobel laureate Robert M. Solow finds that the idea of sustainability resonates with Economists’ conceptualization of INCOME, i.e., maximum consumption one can have in a period while remaining as well off in the end as in the beginning of the period. In that light sustainability has been interpreted as an obligation to conduct ourselves so that we leave to the future the option or capacity to be as well off as we are. The emphasis is on keeping the stock of asset undiminished so that the flow of production of goods and services for consumption is maintained. Accordingly, sustainability requires that the stock of capital-manufactured, human and natural, is left undiminished. This in turn needs restricting consumption to save resources for asset creation and conservation and protection of the environment.

Environmentally Adjusted National Income:

Conventionally while computing national income the wear and tear of manufactured capital is deducted from the gross value of annual production. This is necessary to provide for replacement of depreciation of the capital stock so that the production capacity of the economy is maintained. However, till recently, national income accountants were oblivious of the fact that even the stock of natural capital and the quality of environment also takes a beating in the process of production and consumption in the economy. Environmental economists have driven home the point that provision should be made for the depletion of natural resources and damage caused to the environment also from the gross value of a country’s production to obtain its income. Accordingly they define ‘genuine income’ of a country as its Gross National Product less (a) depreciation of man made manufactured capital, (b) depletion of the stock of natural capital and (c) the value of damage caused to the environment in course of producing and using that GNP. Countries where total consumption is within the limit of such environmentally adjusted income can be regarded as adhering to a broad sustainability norm.

ECONOMIC ASPECTS OF GLOBAL ENVIRONMENTAL ISSUES:

These issues can be broadly divided into two categories. One set of issues arises from the consequences of differences in environmental regulations across countries. The other set of issues is concerned with management of global environmental public good.

Trade and Environment:

International trade helps a country to specialize in the production of those commodities in which it has comparatively a lower cost (i.e., comparative cost advantage) as compared to other countries and import those commodities from others in which it has a comparative cost disadvantage. The relative endowments of different types of natural resources, among other things, play an important role in determining the pattern (i.e., composition of the goods and services to be traded) and volume of trade. On the other hand, the pattern and volume of trade, through changes in the spatial distribution of production and consumption, affects the environment nationally and globally. This issue assumes greater significance particularly in the context of the move towards liberalization and globalization by almost all the countries.

As suggested by the standard theories, the two sources of international trade determining the comparative cost advantage of different countries are differences in the labour productivity and relative availability of factors of production including the natural resources. However, apart from these two sources the differential environmental standards or regulations across countries may also affect the pattern and spatial distribution of trade, and thereby the environment. International trade facilitates greater production and consumption, which in turn lead to different types of environmental problems like loss of forests and bio-diversity, pollution of water and air etc. These are important costs that the society has to bear, but remain uncovered in the cost calculations of the individual producers. As mentioned earlier (under section on ‘Market Failure and its Common Sources’) in such cases of negative externalities private costs underestimate social cost and hence, the price set is lower than the costs that the society bears as a whole. Consequently, more output is produced than the socially optimal level. The appropriate regulations may, however, prove useful to make the polluters curtail output to the socially optimal level when they are compelled to bear the cost of such pollution.

The above point needs a little bit elaboration. Let us take two countries --- one developed and the other developing. The environmental regulations are generally stricter in the former as compared to the later. Suppose the two countries are identical with respect to factor endowments, prices of factors and technology; except the differences in their environmental regulations. In the developed countries the stringent regulations force the producer to set prices at the level of social costs. On the other hand, the absence of such environmental regulations in the developing countries enables their producers to sell the products at a low price (which is equal to private cost rather than the social cost). Thus, the developing countries appear to

enjoy a comparative advantage, though this is not a genuine comparative advantage.

Thus the developed countries are forced to go for producing and exporting those commodities and use those methods of production which are less polluting in nature; otherwise they will have to bear the cost done to the environment because of stringent environmental regulations. On the other hand, due to apparent comparative advantage the developing countries would specialize and export the environmentally intensive goods which are more polluting in nature. Secondly, they cannot afford to produce less polluting goods as it requires investment on 'clean technology'. If this is the reality then international trade between the developed and developing countries will turn the later into 'pollution havens' where all the 'dirty industries' or heavily polluting industries would get concentrated.

Empirical evidence however provides little support for the 'pollution haven' hypothesis. Obvious explanation for why the phenomenon has not manifested in any significant scale is that there are costs of relocating an industry which often outweigh the advantage of less stringent environmental regulation.

Global Public Goods and Bads:

Public goods are those which are non-rival and non-excludable in nature. Non-rivalry means the use of the good by one person does not make it less available to others. Non-excludability means it is impossible or highly costly to exclude any one from having the benefits of the good or service concerned. Similarly, public bads affect all the people in a locality adversely and no one can be excluded from its effects. These public goods and bads may be local as well as global. One example of global public good is ozone layer. The good effects of the ozone layer is not exclusive to any country irrespective of whether the country has or has not taken steps to conserve it. Similarly an example of global public bad is a green house gas, since a country cannot exclude itself from its adverse impact.

Because of the non-excludable feature of global public goods and bads individual countries on their own may not have enough incentives to take necessary measures for conserving the goods and limiting the bads. Indeed, a country might try to free-ride on other countries hoping that others would, in any case, take necessary actions. However, if each country thinks in this line enough actions will not be taken and the 'tragedy of commons' will repeat itself. Thus for dealing with such global environmental goods and bads, cooperation among countries around the globe is essential. The realization of the need for such cooperation is the foundation for discussions and negotiations of different international protocols such as the Kyoto Protocol, the Montreal Protocol etc. on global environmental issues.

LINKS

Command and Control:

The command and control measure is one of the dominant forms of environmental regulation in the world today. The essence of the method is that the regulator commands the specific steps that the individual polluters have to take to solve a particular problem which he decides upon after collecting the necessary information. The best analogy for command control is the system of central planning that existed in the former Soviet Union to manage its economy. The method may take several forms. One way of conveying the command and control may be by example. The authority may set off an act which fixes the minimum pollution control performance of an individual polluter. This may require the authority to study each and every category of polluters and fix separately the minimum requirement of different categories of them. The regulator might, in some cases, specify the use of particular pollution control equipment. Command and control may in fact be combined with significant fines and penalties associated with non-compliance. However, such incentives to comply with a command and control regulation should not be confused with an economic incentive to abate pollution. There are two key features that differentiate command and control from economic incentives: 1) choice regarding the means to meet an environmental target is restricted in command and control measure and 2) Command and control lacks a mechanism to equalize the marginal control costs across polluters whereas the economic incentives have it. One major advantage of this approach is whereas it is unclear how a polluter might respond to an economic incentive, command and control gives greater certainty on how much pollution will result from regulations. Another advantage of command and control is that the monitoring of compliance with a regulation is simple. If the authority commands the use a specific type of pollution control equipment, monitoring involves simply verifying if that equipment has been used. There are, however, certain disadvantages of command and control. Informational requirements are very high for command and control method. Hence, such a regulatory system can be very costly to administer. Moreover, there is potential for fundamental information problems. Very often, the regulator needs to rely on information regarding either the level of pollution or the cost of control provided by the polluters who may distort the information. A very significant problem with the command and control is since the polluter must have to comply with the regulation; he does not have the incentive to find out a better way of controlling pollution. The biggest problem, however, is the difficulty in implementing the equimarginal principle which has already been mentioned while referring to the differences between the command and control and the economic incentives. The final problem of command and control is that the polluter pays only for pollution control and not for the damaged caused by the pollution that is being still emitted even after the regulation is in place.

Common Property Resource (CPR):

A property or resource owned collectively by a group or community is called a common property resource. Some of the familiar common property resources are village grazing ground, common fishery, forest etc. All the common property resources in general have two characteristics: 1) everyone in the group has right on

the use of the property but no one has excusive right on it and 2) use of the resource by one member makes it less available for another member. Within the group, some sort of rules and regulations are developed so as to share the property. The group can put restriction on the use of the property by the outsiders. Due to the second characteristic, each member of the group usually has an incentive to exploit the resource before somebody else uses it resulting ultimately in over-exploitation of it. This is the reason why the community very often finds difficulty in devising a way of sharing the benefits from the common property.

Contingent Valuation Method (CVM):

CVM involves surveying a group of people and asking them to state directly their willingness to pay (WTP) or willingness to accept compensation (WTAC) for a specific level of environmental up gradation or degradation. People should be informed before they state their WTP/ WTAC as to why they will have to pay or how they will pay so that they can make an informed judgment. The mode of payment should appear to be practical. For example- people should be asked to pay an entry fee rather than a general tax for the up gradation of a park. The surveyor can give different options to the respondent through which he/she can express his/her willingness. It may be an open ended question where the respondent can say any amount; may be a dichotomous choice or may be any other version. Once the responses about WTP/WTAC are collected, mean WTP/WTAC of the group can be calculated. It may be possible that somebody states zero WTP. This may happen if the good for which one is asked to pay is completely irrelevant for the person. On the other hand, somebody's WTAC for some good may be zero if nothing can compensate for the destruction of the good. These kinds of responses are to be separated from the positive responses before calculating the sample mean WTP/WTAC. The next stage involves tracing the effect of other factors like education, income etc of the study group on WTP/WTAC. For example, other things being equal, people having higher level of income may be willing to pay more. The final stage of CVM is to obtain the social valuation of the environmental change from the sample mean WTP/WTAC.

Major advantages of this method are: 1) it can be applied for a wide range of situations, 2) the questionnaires can be designed in such a way that the researcher can gain some insights into why people value the environmental good and how the valuation changes if the uncertainty surrounding the supply of the environmental good changes. The method, however, is criticized on the following grounds: 1) CVM works with what people state, but what they actually do may be different from what they say. For example, if they feel that their responses may influence what they actually get charged to pay, respondents will understate their WTP. On the other hand, if they feel that their responses might influence the possibility of the supply of the good and not what they will have to pay, they will overstate their WTP. 2) All the WTP responses may not be effective. Usually respondents do not keep a part of their budget or income separately for the environmental goods. Hence there is possibility that the total amounts that they state as are willing to pay may be more

than what they actually keep for such environmental good in a mental accounting process. Thus, all the WTP responses can not be effective. To guard against this problem, CVM surveys these days also ask which expenditure will be reduced to make money available for the payment for environmental change. 3) Another weakness of CVM is that the responses of the respondents depend heavily on the information provided to them. There fore determining the right amount of information to be provided is a major issue in CVM. 4) Whether to work with the responses of the ill-informed respondents or to let the experts work alone, especially in the context of making policy is another debating issue in CVM.

Hedonic Pricing Method:

The essence of the hedonic pricing method (HPM) is that the valuation of an environmental good is done in the market for an associated private good (usually houses). It is assumed that people value the private good on the basis of the attributes it possesses of which environmental characteristics is one. For exampleThe value of a house depends on several attributes, such as - 1) site characteristics (S_i) which might include the number of rooms, the age of the house, the size of the garden etc.; 2) nieghbourhood characteristics (N_i) like how many miles away it is from the bus station, how good is the local school etc.; and finally 3) environmental characteristics (E_i), such as, the noise level, air quality etc. Environmental characteristic may be an important determinant of the price of a house. For example - if somebody values peace and quite and wants to pay a premium for that then she will pay more for a house in a quieter part of the town than for a similar house in a noisier part of the town.

The HPM, in this context, proceeds by collecting data on house prices along with data on S_i, N_i and E_i. These data can be used to apply suitable statistical technique which finds out the effect of change in environmental quality on the price of house whiling keeping other things (attributes) constant. This might give us the result that a 5 per cent improvement in the air quality raises the price of the house by 2 percent on average, which can then be used to work out the implied WTP in money for the air quality improvement. In this manner, money values can be placed on environmental attributes that are linked to house prices.

The HPM has been widely used to study the implicit prices of environmental attributes like the changes in air quality, noise, and proximity to waste sites. The technique, however, has a number of drawbacks. They are:

1) For those environmental goods which are not linked to housing market, HPM won't work. Even for those goods which are so linked, the method provides only an indication of partial value. For example- air quality improvement benefits the visitors to a city, but only the house owners' values are picked up.

2) The method assumes that for every attribute, house-buyers are able to locate a house for which the marginal value for each environmental attribute is equal to the marginal cost.

3) It is also assumed that the buyers and the sellers are well informed about how environmental attributes very spatially across the area being studies. This assumption is unrealistic.

4) Investment on housing being a long-term investment, expectation plays a crucial role. Not only the current level of environmental quality but the expectation of changes in the level of environmental quality also affects the price of a house. The role of expectation can not be captured by this method.

Liability law:

This is a type of economic incentive to control pollution or environmental degradation. The basic idea is that if I perform an activity which may cause damages to the society, I shall be responsible or liable for the damages and have to pay compensation for that. Government does not dictate me as to how to perform the activity or how to reduce damages. The fact that I shall be liable for the damages makes me consider the potential damages while taking the decision as to how to perform the activity. This works as an incentive for me to take the necessary precaution to prevent the damages, which the society wants me to do.

Prisoner's Dilemma:

It is the most widely used game-theoretic concept in environmental economics. The concept is used to represent the idea: often a socially warranted situation can not be attained because of distrust or lack of co-operation among the individuals. The original prisoner's dilemma has the following form. Two persons are caught by the police suspected of conducting some illegal activity. Police, however, does not have sufficient evidence to convict them and will be sure about their involvement only if they confess. In other words, the crime can not be proved if none of them confess and then both of them will go free. Both of the persons are kept in two separate rooms and are being interrogated. Police offers the following outcomes to each of them: if they both confess they will both get two years in prison; if one confesses, he will go free while the other will get the maximum sentence of ten years. Aloof in the room with no knowledge about the other person's response and faced with these possibilities, each of them considers his options: if the other person does not confess then his best option is to confess and go free, whilst if the other person confesses, then also his best option is to confess and get lesser punishment. Thus the first person concludes that his best option is to confess. The other person will also take the same decision. Consequently, both of them end up confessing to the crime. While the best option would have been not to confess and go free, but both of them end up with an inferior outcome. This situation is termed as *tragedy of commons*. This happens because they could not communicate and arrive at an agreement before they make the decision. They could not even trust each other that none of them will confess. They thought of their individual benefits resulting in the tragedy of both. The original prisoner's dilemma can be applied in environmental economics to explain similar type of situations. In environmental economics, prisoner's dilemma can be seen especially in case of common property resources. For example: common property fishery shared by fishermen. The quantity of fishes in the fishery although is limited at a particular point of time, the total stock can be

maintained if not over-exploited. Fishes will get reproduced overtime. Hence the best thing is to catch the fish in such a way so that the total stock does not deplete. But the fact that total quantity is limited at appoint of time and hence catch by one fisherman will make fish less available by the same amount for another fisherman encourages each fisherman to catch more fishes before somebody else fishes. Since all the fishermen think similarly, they ultimately over-fish the fishery. The results are: the depletion of the stock, no more fishes for the fishermen and hence losses for all of them. While the best course of action would have been to conserve the fish and get the benefits shared among them for a long period of time, the fisher men end up with no fishes. This happens because they can not trust or cooperate with each other to make it certain that none of them will over fish.

Travel Cost Method (TCM):

TCM is associated with the valuation of environmental goods such as outdoor recreational sites. It involves collecting data on the total number of visits to a site from one zone and the total visitor population of that zone. Then dividing the number of visits by the total visitor population, the visitation rate is defined. This visitation rate is assumed to be dependent on the cost of visiting the site and other socio-economic characteristics. The total cost of visiting the site includes both the direct expenditure during the trip and the value of the time spent. Value of time is also considered as a component of expenditure because instead of making the trip had the visitor worked he would have earned his wage. The fact that the visitation rate depends on the visiting cost and other socioeconomic factors implies that if there is any variation or change in the visitation rate that is due to some variations or changes either in the visiting cost or in other factors. Using suitable econometric technique and controlling for the other factors, i.e. considering as if there is no change in other factors, the effect of change in the visiting cost on the visitation rate can be found out. This might give us a result which shows that 1 percent increase in the visiting cost reduces the visitation rate by 5 percent. The TCM usually assumes that the increase in the visiting cost is equivalent to an increase in the admission fee to the site. The result, thus obtained can be considered as a proxy for the demand for the site which then is used to find the value of the site.

The technique has certain limitations: 1) while estimating the value of or demand for a site, problems arise with multipurpose trips. It may be necessary to make a distinction between meanderers and purposeful visitors. For those who are visiting different sites on a single trip, only a part of their total travel cost is to be attributed to a particular site. 2) TCM infers values of a site from the expenditure made on visiting or use of the site. Therefore, if there is any non-use values associated with the site, it can not pick up such values. 3) Calculating the monetary value of travel time is a real challenge.