Institute of Distance and Open Learning
Gauhati University

MA/M.Sc in Economics

Fourth Semester

Optional: (C)
Environmental Economics

Contents:

Introduction:

(1)

Contributors:

Ms. Sanghamitra Baruah	:	Dept. of Economics Gauhati University

Course Coordination

Prof. P. J. Das	:	Director, i/c, G.U. IDOL
Dr. Ratul Mahanta	:	Asstt. Professor Deptt. of Economics Gauhati University
Dipankar Saikia	:	Editor, SLM

Editorial Team:

Dr. Ratul Mahanta	:	Asstt. Professor Deptt. of Economics Gauhati University
Dipankar Saikia	:	Editor, SLM, G.U. IDOL

Cover Page Designing :

Bhaskar Jyoti Goswami	:	IDOL, Gauhati University

Syllabus for MA/M.Sc Economics
Forth Semester
Optional: (C)
Environmental Economics

Unit –1: The Economy and the Environment

Interlinkings between the Economy and the Environment – The First two laws of Thermodynamics – Environment Degradation as Market Failure- Externality, Pigouvian Tax, Property Rights and Transaction Costs – Environmental Public Goods

Unit – 2: Economics of Natural Resources

Economic Issues relating to use of Non-renewable Resources, Optimal Depletion – Issues relating to Renewable resources, Sustainable exploitation – Common Property Resources – Open Access – The Tragedy of Commons

Unit –3: Valuation of Environmental Damages and Benefits

Use and Nonuse Values - Valuation Methods – Stated Preference Methods: Contingent Valuation – Revealed Preference Methods: Hedonic Pricing and Travel Cost Method – Environmental Impact Assessment.

Unit –4: Environment and Development

Environment Development Trade off – Poverty and Environment – Concept and Indicators of Sustainable Development: Environmental Accounting - Policies for Sustainable Development.

Unit –5: Political Economy of Global Environmental Issues

Climate Change, Loss of Biodiversity, Ozone Depletion, International Conventions and Protocols –Trade and Environment – Pollution Havens.

Paper Introduction:

This paper is basically designed to help the readers understand the concept of environmental economics and the various issues addressed within it.

The paper has the following five (5) units:—

Unit 1 : The Economy and the Environment

Unit 2 : Economics of Natural Resources

Unit 3 : Valuation of Environmental Damages and Benefits

Unit 4 : Environment and Development

Unit 5 : Political Economy Of Global Environmental Issues

In the Unit 1, a brief concept of the economy environment interlink age is given and how environmental degradation leads to market failure is discussed. The second Unit deals in the economics of natural resources—both renewable and no-renewable and stresses upon sustainable use. Besides the unit also discusses how open access to common property resources is a major cause of tragedy of commons. Unit 3 discusses the use and non-use values and its different valuation techniques and the various environmental impact assessment measures. The trade off between environment and development is discussed with the help of Environmental Skuznets Curve in Unit 4. Further the unit deals in the concepts and indicators of Sustainable Development and its various policy measures. Unit 5 discusses the various global environmental issues like climate change, loss of biodiversity, etc. and also discusses the functions of international conventions and protocols in preserving environment.

UNIT - 1
THE ECONOMY AND THE ENVIRONMENT

Contents :

1.0 Introduction

Environment Economics is a sub discipline of economics which is concerned with the efficient allocation of environment resources.

Many environment goods which were once abundant have now become scarce and we know that economics basically deals with the allocation of scarce resources among unlimited wants. So, environment resources come under the scope of economics.

Moreover, economics also deals with how the marks mechanism allocates the resources. But market failure is witnessed in case of environment goods. So their analysis requires special treatment.

1.1 Objectives

This unit is designed to help you understand the basic concept of environment economics and the linkage between economy and environment. After reading this unit, you will be able to –

- *understand* the interlinkage between economy and environment.
- *know* the first two laws of thermodynamics.
- *understand* market failure in case of environment goods.
- *know* about Pigouvian Tax.
- *understand* the need for property rights.

1.2 Interlinkings Between Economy and Environment

Economy basically refers to economic agents, the institutions they form and the interlinkages between the agents and institutions such as the market. The environment constitutes of all the abiotic components like land, water, mountains, mineral resources, climate etc. and biotic components like plants and animals.

The interlinkage between the economy and the environment can be explained with the help of the following figure –
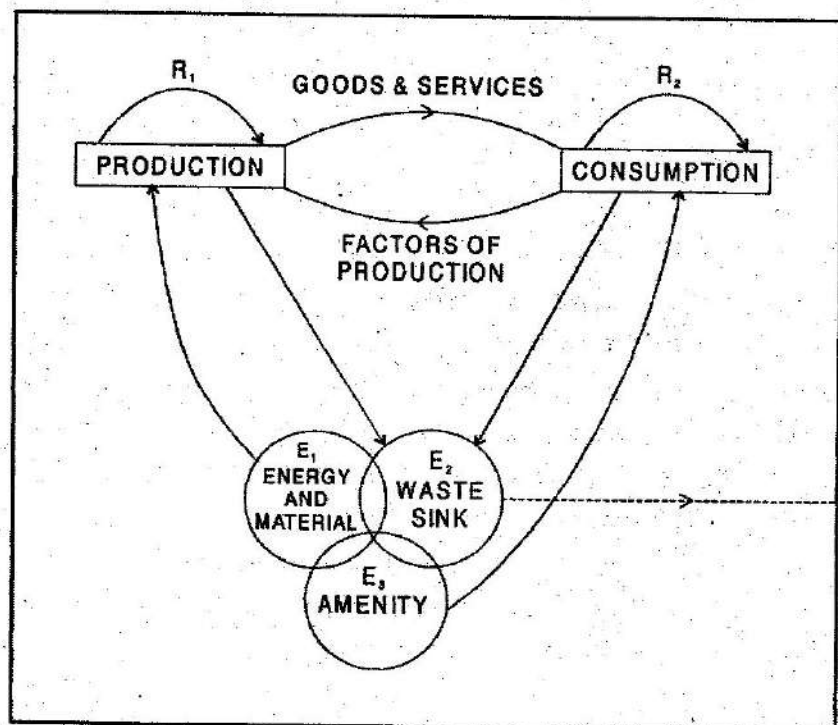
E$_4$ GLOBAL LIFE-SUPPORT SERVICE

Figure : 1.1 Economy-Environment Interaction

For the sake of simplification, let us assume that the economy consists of only two sectors – production sector and consumption sector. Exchange of goods and services and factors of production takes place between these two sectors.

In the above figure, environment is shown in 2 ways – as the three interlinked circles E1, E2 and E3 and the all encompassing boundary named E4. The production sector extracts energy and material resources from the environment and produces output, which are then supplied to the consumption sector. In the process of production, same waste products are also produced, a part of which is recycled within the production sector shown by the loop R1. Some recycling also takes place within the consumption sector as shown by R2.

Thus, the first role of the environment is to provide energy and material resources as shown by E1. The second role is that environment acts as a waste sink (E2). The next role of the environment is that it provides with a direct source of amenity (E3). The boundary E4 indicates the global life support services provided by the environment like maintenance of temperature, atmospheric composition, water and nutrient cycles etc. The dashed line between E2 and E4 indicates that waste emissions may affect the global life support services adversely.

The environment thus serves more than one function, using the environment for one purpose may reduce its ability to provide us with other services. eg. – disposing wastes in a river may eventually reduce its aesthetic value and also harm the habitat of fish and other organisms living in the river.

Thus, we see that the economy and the environment have a dynamic interlinkage. The way the economy is conducted has an impact on the environmentwhich in turn affects the economy.

1.3   First Two Laws of Thermodynamics

The first two laws of thermodynamics hold true in case of closed systems.

The first law of thermodynamics states that matter like energy can neither be created nor destroyed. It implies that matter can be converted into energy or energy can be transformed from one form to another. The implication of this law is that one cannot create

environment. We can only transform it from order to disorder as we go on using the environment, though the quantum will remain the same.

The second law of thermodynamics, also known as the entropy law, states that in a closed system, the use of matter – energy results in a one way flow from law entropy to high entropy ie. from order to disorder (since entropy is a measure of disorder). The implication of this law is that as we go on using the environment, it move from a state of order to disorder in the use environmental resources.

Stop to Consider:

The Gaia Hypothesis:

The Gaia Hypothesis was originally put forth by James Lovelock who is otherwise famous for his discovery of an analytical technique called the electron capture. Gaia is the name of the ancient Greek goddess 'Mother Earth'. The hypothesis, named after the goddess, simply believes that organisms do not simply adapt the physical environment but actively interract with it to modify the physical and chemical conditions of the biosphere. Lovelock studied many disciplines in order to pursue an interdisciplinary study for the purpose of testing the Gaia Hypothesis.

The Gaia hypothesis rests upon two observations:

1. The earth is a super-ecosystem with numerous interacting functions and feedback loops. These maintain life supporting temperature and the chemical composition of the atmosphere and oceans at a relatively stable level.

2. After life appeared on earth, organisms played an active role in modifying the ambient conditions on earth for the maintenance of life-supporting conditions.

1.4 Market Failure in Case of Environmental Goods– Externality

Most of the time environmental degradation occurs due to open access property right regimes and limited govt capacity to manage

the environment resources. Commodities supplied by the environment (like timber, minerals, game etc.) have a market price but the environment itself doesn't. So, it results in an increasing use of the commodities at the expense of the environment. Moreover absence of secure land tenure also leads to a lack of incentive among the present generation to protect the environment.

Market failure in case of environmental goods occurs mainly because the goods provided by the environment are non-rival and non-excludable. Eg. – air, everyone wishes for clean air but it is non-rival. If any one person consumes clean air, it doesn't reduce the availability of clean air for the others. Moreover, clean air is also non-excludable ie, no one can be excluded from consuming clean air. Environment is not exclusively defined. It doesn't have well defined property rights. Market failure occurs in case of environment more or less because of incomplete markets, due to which the environmental resources can't more to their highest valued use.

Externality: Externality arises when production or consumption decision of one agent affects production or consumption opportunity of another agent directly rather than through the price system. As this price system is side stepped, all the benefits and all the costs are not accounted for. There can be 2 types of externalities – posture externality and negative externality. Eg. – Beekeepers usually keep their beehives on farms since the nectar from the plants increases the production of honey. At the same time, the farmers are also benefitted as the bees aid pollination of plants.

Similarly, an eg of negative externality that can be cited is that of a factory which dumps its waste in the nearby river. This adversely affects the people who live by the riverside and use the river water for various purposes.

1.5   Pigouvian Tax

In the early part of the 20th century, A.C. Pigou suggested for imposition of taxes. to realise the socially optimum level of economic activity generating pollytion. As the social cost of

pollution is greater than the private cost, govt should try to make pollution costly by imposing taxes. this is the Pigouvian tax or Pigouvian fee. Pigouvian. Tax can be explained with the help of the following diagram–
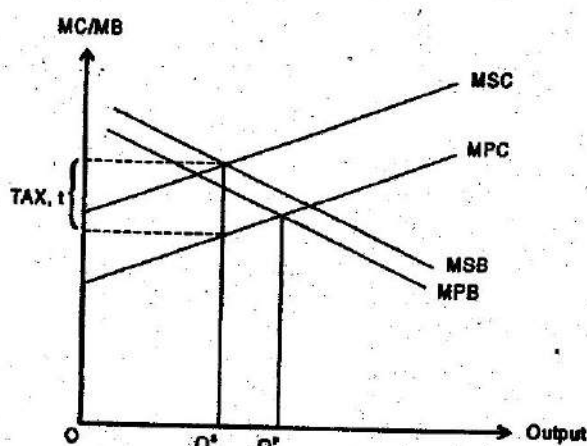
In the above diagram, MPC and MSC respectively represents marginal private cost and marginal social cost (MSC = MPC + MAC where MAC = marginal abatement cost). Similarly, MPB and MSB stands for marginal private benefit (marginal benefit from commodity produced) and marginal social benefits (marginal benefits + marginal benefit from reduced pollution) respectively.

Os and OP represent respectively the optimal level of output after pollution tax has been levied and the force market level of output. In the above diagram, t stands for the optimal tax which is equivalent to the difference marginal social between the marginal social cost and marginal private cost at the optimum.

Check Your Progress:
1. What is the interlinkage between economy and environment?
2. State and explain the second law of Thermodynamics.
3. Why does market failure occur in case of environmental goods?
4. What is Pigouvian Tax?

(10)

1.6 Property Rights, Transaction Costs

Market failure in respect of environmental goods is in some way linked to incomplete markets and markets are incomplete because of the absence of will defined property rights. For instance, lack of proper property right in case of clean air may result in market failure. This is because people in presence of pollution cannot demand for any compensation from the polluters and they cannot even demand for a stop in pollution.

Thus, it is seen that the absence of well defined property right necessitates the need for govt intervention. But Coase pointed out that if one ignores the transaction cost* then voluntary agreement between the concerned parties will result in a socially optimal level of output, regardless of which party is assigned the property right.

Transaction cost : If in carrying out a transaction a cost is involved, then that cost is called transaction cost. It hinders the efficient working of the market.

An institution should always try to confirm the property rights and reduce transaction cost.

If property rights are not well defined then transaction costs occur.

1.7 Summing Up

To sum up we can say that environment serves more than one use. The dynamic interlinkage between economy and environment affects each other. Besides the entropy level in the environment increases when we use too much of environmental goods causing environmental degradation. Besides environment being a public good is subject to the existence of externality as such it becomes difficult to determine the price for environment through market mechanisms. So, market failure is a common feature of environmental goods. However some corrections are suggested through Pigouvian taxes and allotment of property rights.

1.8   Additional Readings

1. Charles D. Kolstad – "Environmental Economics", Oxford University Press

2. Hanley, Shogren and White – "Environmental Economics", Macmillan.

3. R. Bhattacharjya – " Environmental Economics", Oxford University Press.

1.9   Exercise

1. How is the economy and environment interrelated to each other?

2. State and explain the two laws of Thermodynamics.

3. Why does market failure occur in case of environmental goods? How can it be prevented?

4. What are property rights?

*****

UNIT – 2
ECONOMICS OF NATURAL RESOURCES

Contents:

2.0 Introduction

Natural resources are those which occur naturally in the environment. This chapter 'economics of natural resources' is concerned with the principles regarding use, regulation and preservation of different types of natural resources. In this chapter we discuss about the economic issues related to non-renewable and renewable resources and also talk about the Tragedy of commons.

2.1 Objectives

This unit is designed with the objective to –

- *know* the economic issues related to non-renewable resources – the question of optimal depletion.
- *know* about the economic issued of renewable resources – the question of sustainable harvest.
- *understand* the concept of Tragedy of commons related to open access common resources.

2.2 Natural Resources

Natural resources refer to the resources in the form of various goods and services provided by nature. They can be either material resources like iron ore, fish stock in the ocean etc. or energy resources like coal, oil etc. But whether the resources are material or energy depends upon their use. For eg. – wood, it can be used both as material or for providing energy.

Natural resources are broadly classified into 2 types – renewable and non – renewable resources. Renewable resources are those resources which can naturally regenerate within a time frame meaningful for economic optimization. Eg – fish stock in the occan. On the other hand, non – renewable resources are those resources, which either can't regenerate at all or those which can't regenerate within a useful time frame Eg – fossil fuel.

2.3 Economic Issues Related to Non–Renewable Resources

The non – renewable resources, unlike the renewable resources, are not regenerated within a time frame meaningful for economic optimization. As the non – renewable resources are exhaustible in use, their stock is bound to deplete over time ie, the more we use, the resource, the less is the stock left for future use. The main issue therefore regarding the use of the non – renewable recourses is their optimal extraction and depletion over time. We should optimally distribute the resources rather we should optimally deplete the stock. Thus, the main issues can be outlined as the following –

* the issue of optimal depletion
* conditions for optimal depletion
* will competitive market lead to optimal depletion?
* time path of the price.

(1) Issue of Optimal Depletion :

Optimal depletion means to deplete the resources over time in such a way that the society's benefit is maximised. In case of non –

(14)

renewable resources, the more we use them today, less will be available for tomorrow.

Suppose, we have a total stock of resources,

$$\overline{Q} = Q_0 + Q_1 + Q_2 + \ldots\ldots$$

Where, Q_0 – quantity used in current period
          Q_1 – quantity used one period later
          Q_2 – quantity used two periods later etc.

Let the benefit from using Q_0 be $B(Q_0)$
Similarly, the benefit from using Q_1 be $B(Q_1)$
The benefit from using Q_2 be $B(Q_2)$ and so on.

Thus,

$$\text{Total benefit } (W) = B(Q_0) + \frac{B(Q_1)}{1+r} + \frac{B(Q_2)}{(1+r)^2} + \ldots\ldots$$

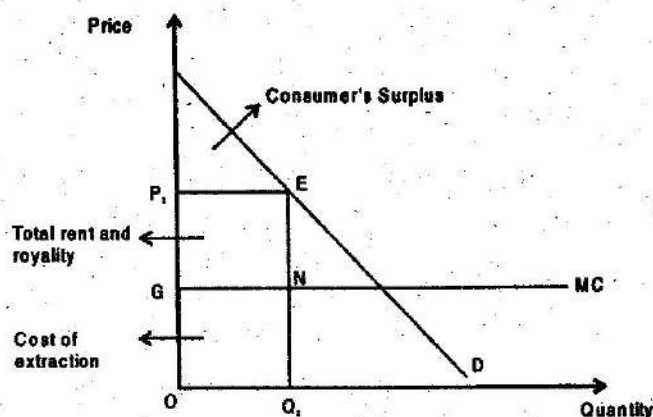Where r = social rate of discount.

The time path $Q_0, Q_1, Q_2, \ldots\ldots$ should be so selected that the total social benefit (W) from its use is maximum.

$$\therefore \text{Max} W = \sum_{t=0}^{\alpha} B(Q_t)/(1+r)^t$$

$$\text{s.t.} \sum_{t=0}^{\alpha} Q_t = \overline{Q}$$

This is a dynamic optimization and the result is a path or curve.
Now, let us find the benefit for a single period :-

(15)

In the figure, D represents the demand curve and MC represents the marginal cost of extraction.

We have,

Net benefit = Gross Benefit − cost of extraction

Total rent is a price of the opportunity cost of the resources. Suppose we are using Q_o quantity, then price = EQ_t

$$\Rightarrow P = EN + NQ_t$$
$$= \text{net price} + \text{marginal cost}$$
$$\therefore \text{Net price} = \text{Price} - \text{marginal cost}$$
$$= EQ_t - NQ_t$$
$$= EN$$

Thus, net price is defined as the value of an unit of the natural resource at its source.

So, given D, OQ_t will be extracted by a resource planner to allocate extraction efficiently over time.

Net price is also called rent or royalty. The royalty is generally appropriated by those who own the resources like mines, cost pits etc.

(2)   Conditions for Optimal Depletion :

The conditions for optimal depletion can be explained with the help of Hotelling rule. Hotelling Rule can be stated as − "For optimal depletion of non-renewable natural resources the net price must increase at the social rate of discount"

'OR'

"The present discounted value of the net price at each period should be equal."

This can be explained with the help of the following diagram −
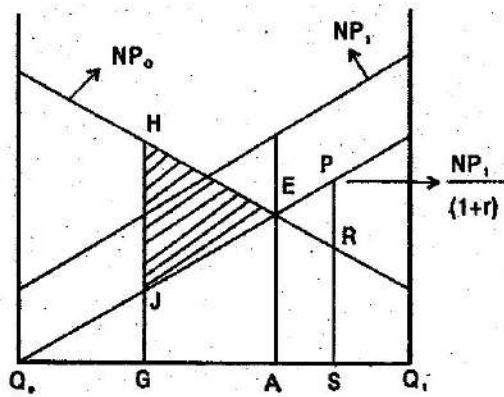
Let us consider two periods –   Period (O) = current
                                   Period (1) = Future

Let Q_o . Q_1 be the total quantity available. Now, if we use no quantity, the net price is very high.

Assuming the demand pattern to remain unchanged, the social is maximizing the total benefit, W ie,

$$W = B(Q_o) + \frac{B(Q_1)}{1+r}$$

Where $B(Q_o)$ – benefit from Q_o

$B(Q_1)$ – benefit from Q_1.

According to Hotelling rule, E is the equilibrium

Where $NP_o = \frac{NP_1}{1+r}$

$NP1 = NP0 (1 + r)$

The optimal allocation is –

Q0A – current allocation

AQ1 – future allocation

Now if $Q_oA > AQ1$. the quantity allocated in all future time periods will be smaller and smaller; the price however will be higher and higher.

In the diagram HEJ represent the area lost due to unnecessary reduction in present consumption (ie $Q_oG < Q_oA$) and PER is the area lost due to much use in present (ie, $Q_oS > Q_oA$).

(17)

(3) Will Competitive Market Lead to Optimal Depletion ?

If we are operating in a competitive market, we try to maximize our profits/returns, and we have two options for it

    (i) We can conserve for tomorrow $NP_1 = NP_0 (1+g)$

    (ii)   We can extract today & invest in financial market –
         $NP_0 (1+i)$

Now, $NP_1 = NP_0 (1+g)$

Where g = rate of increase in net price.

Whether we extract today or will conserve for tomorrow will depend on g and I (rate of interest).

Now, if g>i, people will conserve. If we conserve more and more, net price will reduce because future supplies are increasing. If all of us conserve, it will pull down the future price and raise the current price. While the present price will have a tendency to increase because of scarce present supply, g will converge to i.

If g < i, we extract today this will increase the net price in future thereby leading to an increase in g. There will be a fall in the current prices till againg converges to i.

    Thus, if the market is competitive, at equilibrivm – g =i

    But Hotelling rule requires

    g = r, where r is the social rate of discount.

But if a market is perfertly competitive and there are no imperfections then

    i= r

Thus, the rate of increase in net price (g)=social rate of discount (r)

Hance, Hotelling Rule is fulfilled and so, allocation will be efficient.

(4)   Time Path of Price:

Let us consider a two period case. Hotelling Rule requires that –

$$NP_0 = \frac{NP_1}{1+r} \Rightarrow NP_1 = NP_0 (1+r)$$

If we generalize Hotelling Rule, then we get – $NP_0 = \dfrac{NP_t}{(1+r)^t}$

$\Rightarrow NP_t = NP_0 (1+r)^t$, where $t = 1, 2, \ldots\ldots$

$\Rightarrow P_t - MC = NP_0 (1+r)^t \quad [\because NP_t = P_t - MC]$

$\Rightarrow P_t = MC + NP_0 (1+r)^t$

Price will increase with time exponentially. If $t = 0$, $P0 = MC + NP_0$. The ceiling of price Pt is set by the MC of a backstop. Backstop is a resource / technology which provides the same service as a non-renewable resource but is currently not in use because of its high cost. The current net price (ie, NP0) is also influenced by the MC of the backstop.
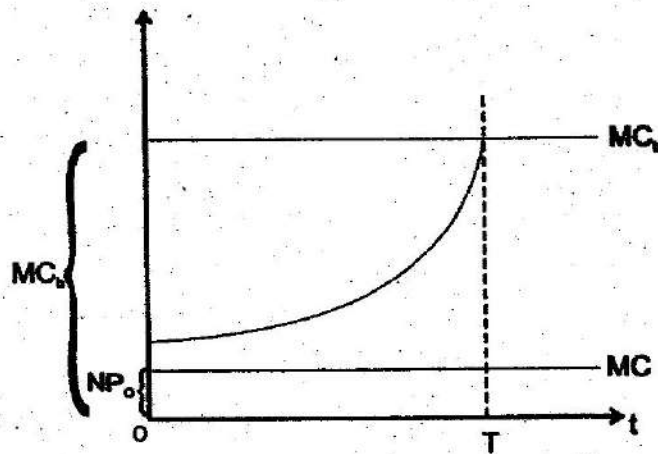
Let T be the period by which the backstop becomes operational.

$$MC_b = P_T = MC_o + NP_o (1+r)^T$$

$$\therefore NP_O = \dfrac{MC_b - MC_o}{(1+r)^T}$$

Thus, we see that the current net price or royalty positively relates to how expensive is the backstop and negatively relates to the time period in which the backstop becomes operational.

(19)

2.4 Economics of Renewable Natural Resources– Efficiency and Sustainable Harvest

Renewable resources are those which can naturally regenerate within a time frame meaningful for economic optimization. These resources are also interactive resources because their stock depends on –

(i) biological reproduction

(ii) human activity.

Eg of renewable resources are -- trees in a forest, fish stock in a water body etc.

But these resources should not be exploited indiscriminately else it would lead to extinction of some of the renewable resources. So, we should go for sustainable exploitation so that the stock of the renewable resources remain unreplenished. So, one needs to give importance to the concept of sustainable harvest.
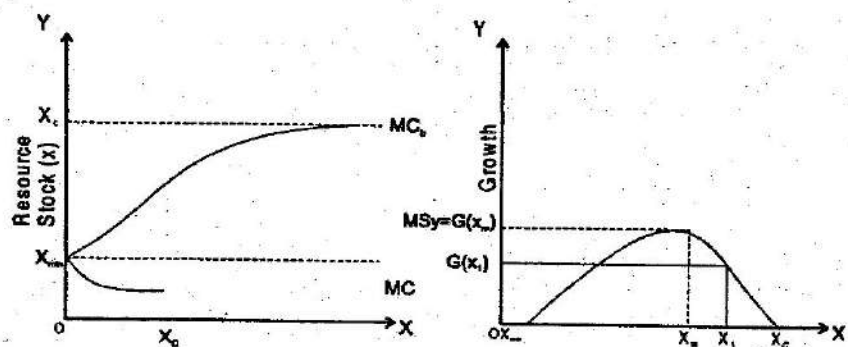
The figures above illustrate the population dynamics of a renewable resource say fish stock. The stock of fish is supposed to fellow growth through time as shown in figure 1. This shows the cumulative growth of the stock at low level of stock the fish continues to multiply but gradually as they begin to compete for food the rate of growth declines and the stock eventually converges to some maximum level, Xc in figure 1. The cumulative curve thus takes the shape of a logistic curve with successively larger increments initially and them gradually smaller ones. In the figure, Xmin is the critical minimum level of population of the stock and if it falls below this level then the species is in the process of extinction (X0).

In figure 2 the growth of the stock of fish is measured along Y – axis and the resource stock along X – axis. With human intervention, when the yield is equal to the growth of the stock it is known as sustainable yield. In the figure G (X1) is the sustainable yield for resource stock X1. But the maximum sustainable yield occurs at a point where the growth of the resource is maximum. In the figure, Xm represents maximum growth of the resource and correspondingly G (Xm) represents the maximum sustainable yield of the stock.

Now if we harvest the yield in such a way that we take the maximum sustainable yield (MSY) from the stock, the resource is able to re-generate itself and we will be able to get MSY in succeeding periods also. Thus, MSY is the optimum harvest from the resource which allows it to maintain its sustainability without reducing the stock in the long run. This is sustainable harvesting which allows the stock of resources to remain unreplenished.

Cheek Your Progress :
1. What are natural resources ?
2. What are the types of natural resources ?
3. What is optimal depletion ?
4. State Hotelling's Rule.
5. What is net price ?

---

6. What sets the ceiling of price, Pt ?
7. What is a backstop ?
8. What is meant by maximum sustainable yield (MSY) ?

2.5 Common Property Resources

Common property resources refer to those resources on which the rights of an exclusive group of people are well established. These resources have the characteristic of a public good ie, it is non-excludable for the members of a group but excludable for others.

Commons are extensive areas containing natural resources. Some examples of common property resources are grazing ground, water bodies, forests etc.

There are certain characteristic features of these resources. They are –

(i)   they are extensive areas of resource stock.

(ii)   a well defined group has the exclusive right on the use of the resource. However, no single individual on the group has any exclusive property rights on those resources.

(iii) the use of these resources by any user would reduce the welfare of the ether members of the group.

2.6 Tragedy of Commons

Garret Hardin, a great environmentalist, used the term 'Tragedy of Commons' in 1968 in order to express the environmental problems. Environment is a commonly held resource which cannot be handed over to private ownership. These resources are supplied at zero cost and there is no restriction on their use so, these resources are over exploited and misused which eventually leads to environmental degradation. Hardin describes this as the phenomenon of 'Tragedy of Commons'.

Thus, 'tragedy of common' spells doom for everyone. Economic analysis show that if rights over the resources are clearly defined

(22)

then market forces can ensure sustainable use of the renewable resources. But the main problem arises when the property rights are not well defined and it becomes an open access common resource. Open access resource refers to a resource which has no enforceable property rights and is open to exploitation by all the members of a group. An example can be cited in this context –

Suppose there is a common grazing ground in a village which is open for all the villagers. Now if each person in the village aims to maximize his individual gain then he can add more and more cattle to the field. The person will definitely gain from adding one more cattle but with the addition of one more cattle damage will occur as the grazing ground becames rowded. But the benefit derived by the person exceeds the loss from adding one more cattle. If all the villagers think in similar manner and act similarly then the total no of cattle will exceed the carrying capacity of the grazing ground and as a result everybody will lose. So over exploitation of common resource leads to their destruction.

Since the problem of 'Tragedy of commons basically arises because of the absence of well defined property rights so, solution to the problem lies in the assignment of private property rights or through common property rights regime, which lays down rules to limit the entitlement of individual members to common resources of the community.

2.7   Summing Up

In this unit we have thus seen that economic of natural resources is concerned with the use, regulation and preservation of different types of natural resources. Non-Renewal resources if not used judiciously will exhaust up and can never be replaced. So such resources need to be exploited in a sustainable manner because the replacement has its own pace and such resources as well cannot be replaced beyond a certain limit. Property rights are not clearly defined in case of natural resources. Such unambiguity in property rights leads to the depletion of common property resources which ultimately leads to the tragedy of commons.

2.8   Additional Readings

1. Charles D. Kelstad – "Environmental Economics", Oxford university Press.
2. Hanley, Shogren and White – "Environmental Economics", Macmillan.
3. U. Shankar – "Environmental Economics", Oxford University Press.
4. R. Bhattacharjya – "Environmental Economics", Oxford University Press.

2.9   Exercise

1. What are natural resources? What are its different types?
2. What are the economic issues related to non-renewable resources?
3. What is optimal depletion? What are the conditions for optimal depletion?
4. What are the economic issues related to renewable resources?
5. What is meant by sustainable harvest?
6. What do you mean by common property resources?
7. What is 'Tragedy of commons'? Why does it occur?
8. How can the 'Tragedy of commons' problem be solved?

*****

UNIT - 3
VALUATION OF ENVIRONMENTAL
DAMAGES AND BENEFITS

Contents:

3.0 Introduction

Environmental goods are non-rival and non-excludable so they do not have value in exchange and supply price. But they provide us with both use and non use value. The necessity of valuation of environmental good arises because of non-excludability and absence of well defined property rights. Moreover, environmental goods are to be preserved and conserved but their conservation involves a cost. All these things are to be valued to find out what amount is socially justifiable. In this chapter, we try to discuss the different methods that are used for the valuation of environment.

3.1 Objectives

The main objective of this unit is to—

- *identify* the use and non-use value of environment.
- *discuss* the different methods of valuation of environment.
- *understand* the need for environmental impact assessment in case of a project.

3.2 Use and Non-Use Values

Value of an environmental good is defined as the price or expenditure that we are willing to incur for the additional beautification of the environment good.

The environment pronides us with different goods and services and the value of these goods and services can be broadly categorised into use and non-use value.

In case of environmental goods, there is no value-in-exchange but it has use value. Use value arises when one directly benefits from an environmental good or service. Eg - the environment provides raw materials and other resources which can be used for either consumption or production purpose and the value derived from this is thus called use value.

The environment also has a non-use-value. This is because the environment has a value even if we don't use it, it is called the Existence value. Sometimes we may value the environment because we may think that our future generation will use it. Such value is called Bequeath value. Again, if someone somewhere uses the environment then it has philantrophic or altruistic value. All these non use values can be clubbed together to be called optional value.

3.3 Valuation Methods- Stated Preference Method and Revealed Preference Method

We can measure the use and non-use value of environment by different valuation methods -

(i) **Stated Preference Method :** This is the direct method for valuation of environmental good. In this method, we ask the respondents directly for what they are willing to pay for the use of environmental good.

Eg : contingent valuation method is a direct/stated preference method for environmental valuation.

(ii) **Revealed Preference Method :** This is also called the indirect method for valuation of environmental goods. In case of this method, we observe the revealed behaviour of

(26)

the respondents and find out what value they attach to the environmental good.

Eg : Travel cost method and Hedonic Pricing method are egs of indirect or revealed preferance method.

3.4　Contingent Valuation Method

The contingent valuation method for the valuation of environmental goods was proposed by Davis (1963). This is a direct method for environmental valuation in which people are asked to state either their maximum willingness to pay (WTP) for an increase in the quality of the environment or their minimum willingness to accept compensation (WTAC) to forego such an increase. In this method, we go for direct estimation of the marginal willingness to pay and then by aggregating these responses, the total value curve is obtained.

This method basically consists of the following stages -

     (i)   setting up the hypothetical market.
     (ii)   obtaining bids.
     (iii)   estimating mean WTP/WTAC.
     (iv)   estimating the bid curve.
     (v)   aggregating data.

(i)　Setting up the hypothetical market :-

The first step is to set up a hypothetical market for the environmental goods and services. To construct a hypothetical market, the respondents must first be provided information on the existing state, proposed state and the impact of such an improvement in the environment. Next the respondents should be convinced that they are working through a market and make them understand why they need to pay. After stating the reason for payment, we have to tell them about the bid vehicle ie, how the payment is to be made.

(ii)　Obtaining the bids :-

This can be done either by telephonic interview or mail or by face to face interview. Telephonic surveys are least preferred because conveying information about a good over the telephone is slightly

(27)

difficult as it is subjected to a limited attention time span. Mail surveys again suffer from non-response bias and low response bias, so personal interview is the best method for data collection. The bidding can be derived in several ways -

(a) **as a bidding game** : In this method higher bids are suggested to the respondents until their maximum WTP is reached.

(b) **as a payment card** : Here one writes different values in the payment card and ask the respondents to choose the value that they are willing to pay.

(c) **as an open ended question** : The respondents are asked to state their maximum willingness to pay with no value being suggested to them.

(d) **as a close ended referendum** : A value P is suggested to the people and they have to pay whether they are willing to pay or not, ie, yes or not. These responses are called dichotomous choice (DC) response. If the response is yes, the investigator knows that $P \leq$ maximum WTP of the respondents; if no then $P \geq$ maximum WTP. But here one cannot know about the exact amount that people are willing to pay.

There is another method called the double bounded referendum where people not only say yes or no but they also suggest the value they are willing to pay.

(iii)   Estimating mean or average WTP/WTAC:

Since exact information is available about the maximum WTP in case of an open ended bid, so the average is calculated by using either arithmetic mean or median.

But in case of the close ended bidding, the consumer knows his preference completely but it is not observable to the researcher. So this poses a problem to the estimation process.

(iv) Estimation bid curve :

A bid curve can be estimated for open ended bidding, by taking WTP/WTAC as the dependant variable and a host of independent variable like income, education and other sovo economic factors

$$WTP_i = f(Y_i, E_i, A_i, Q_i)$$

In the above eq^n, Y_i stands for income,

E -- education,

A -- age

and Q stands for some variable measuring the quantity of environmental quality being bid for.

(v) Aggregating Data :

After estimating the bid curves next step is aggregating the data.

After aggregating the data we have to compare it with the information that we have from experience.

Although this is the most widely used method, it has certain limitations which we briefly state below—

(a) There may be a strategic bias in response. The respendent may sometimes try to act as a free-rider if he presumes that the money will be collected from him at a future date, so he may understate his preferences. On the other hand, if he feels that he doesn't have to play then to enjoy higher moral satisfaction, he would everstate his preferences.

(b) This method suffers from hypothetical bias. The values in this method are hypothetical. We know that there is no budget constraint in case of a hypothetical survey and without a budget constraint, the choices are meaningless. This bias is called hypothetical bias.

(c) There can also be investigator bias. Since two parties are involved—respondent and the researcher. There can be bias not only from the respondent but also from the researcher.

3.5 Hedonic Pricing Method

Hedonic price is basically the price paid for pleasure where the pleasure refers to that which is derived from the environmental

characteristic of a good. Hedonic price theory states that goods are valued for their utility bearing attributes or characteristics. So hedonic prices are defined as the implicit prices of attributes. This approach can be explained with respect to the housing market, where the demand for house in a particular area depends upon a no. of characteristics like crime rate in that area, accessibility of public utilities, environmental factors like quality of air, drinking water and so on determine how much money is available for the house, $\theta (Y, Z, \hat{U})$. This is called the bid function of the consumer because it represents the amount of money the consumer may bid for the house.

Let us now consider a single homogenous area such as a city or part of a city which can be considered to be a single market from the viewpoint of our good (say, house). Let us assume that each house is characterised by a single variable say Z, which suppose represents the quality of air. Thereafter, we determine how the price of a house varies with the quality of air, ie, pollution level. We now try to find out the house price as a function of air quality levels, $P(Z)$.

We first look into the consumer side and producer side and then the market equilibrium is sought to be determined.

*The consumer :

Let us suppose that a consumer has a utility function U and an income Y. Let us also assume that the consumer buys exactly one house. Now the consumer has to decide how he will allocate his income between the house and other goods, denoted by X. Thus, the problem can be framed as --

$$\text{Max } U (x^2) \text{ ----- (1)}$$
$$\text{subjected to } x + P (Z) = Y \text{ ----- (2)}$$

Eq^n (1) indicates that the consumer should chose that level of X and Z which maximises his utility.

Eq^n (2) indicates that while the consumer tries to maximise his utility he should keep his expenditure on the house and other goods equal to his income.

Afternatively, this problem can be viewed as how to determine for a particular value of Z, the amount of X that needs to be consumed to achieve a particular level of utility, U and for which how much he is ready to pay for X. After spending for X, how much is available for Z. Here the problem is fixing Z. Once Z is fixed, we can solve for the value of X that satisfies $U(X, Z) = \hat{U}$. This defines a particular amount available for the house, $y - x = \theta$. The next problem is to find θ that satisfies $U(y - \theta Z) = \hat{U}$.

For given value of Z, Y and $\hat{U}$, we can and Q stands for some variable measuring the quantity of environmental quality being bid for.
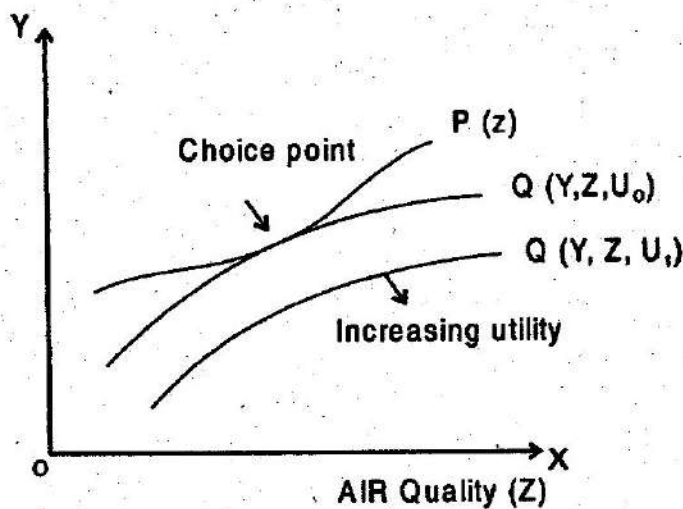
In the above diagram, we show for a single consumer two bid functions for two different levels of utility. The lower bid function is associated with higher level of utility. P (Z) represents the Hedonic price function, determined by the market. The consumer's problem is the choose that level of Z which maximises his utility. The choice point is the point at which the bid function is just tangent to the price function, P (Z). This provides the maximum utility.

(31)

The producer : Let us consider a particular producer with a given cost structure. Let us assume that there are constant returns to scale. Now suppose the producer faces input prices r, then unit costs can be given by C (r, Z), If the producer offers a price, then profit per house is given by -

$$\pi = \phi - C\,(r, Z)$$

This is called the offer function because it indicates the price at which the producer will offer the house to obtain a particular profit level, π, given a particular value of input prices, r and a particular value of Z.
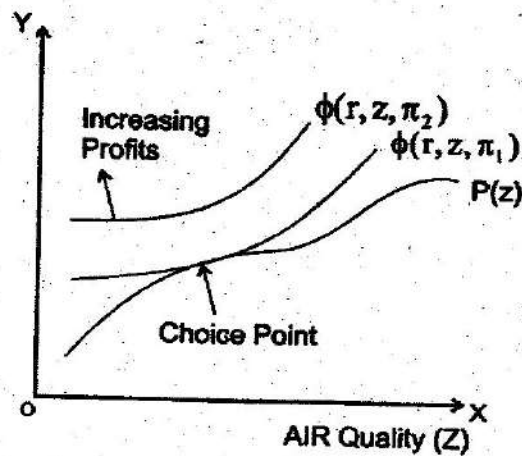
In the above figure, we show for some particular firm two offer curves, associated with the profit levels π_1, and π_2 respectively. The higher curve is associated with higher profit. The Hedonic price function is shown by P(Z). The choice point of Z is the one at which an offer curve is tangent to the hedonic price line.

Market Equilibrium :

As there are many consumers in the market and producers so, there will be different sets of bid and offer curves. The Hedonic price function can be thus obtained as the locus of the tangency point between bid and offer curve. This is explained with the help of the following diagram -

(32)

AIR Quality (Z)
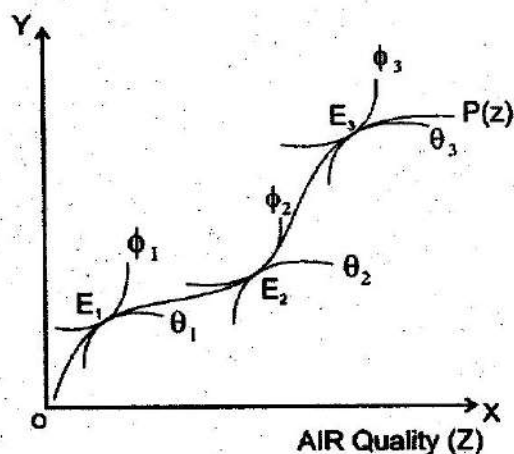
In the above diagram, we have shown 3 pairs of consumers and producers each with their bid curves and offer curves. Thus at each point along the hedonic price function P (Z), there is tangency between the bid curve and the offer curve. This tangency implies that the slope of the bid curve is equal to the slope of the offer curve which in turn is equal to the slope of the Hedonic price function. This implies that the consumer, producer and the market - all have the same valuation of a unit of the given characteristic.

Now, there are certain problems associated with the Hedonic Pricing method which are mentioned below --

(i) **Omitted variable bias** : This method is generally applicable to the housing market. Now we know that the demand for a house depends upon a no. of characteristics but if some variable which significantly affects the house price is omitted from the hedonic price eq but is suppose correlated with one of the included variables then the coefficient of this included variable will be biased.

(ii) **Multicollinearity bias** : There maybe some variables which maybe higher collinear. To estimate them one may need separate equations, otherwise it will be difficult to disentangle the implicit prices.

(iii) **Choice of functional form** : Economic theory does not specify which functional form should be used for the

(33)

hedonic price eq^n. The choice of the functional form will influence the value that the implicit prices take.

(iv) Expected versus actual level : The difference between the actual and expected attitudes also affect prices. Eg : house sale maybe a function of expected future environmental conditions besides current observed conditions.

(v) Attitude towards risk : The application of hedonic price to evaluate the changes in risky environmental assets are likely to produce biased estimates of consumer benefits from avoiding or reducing such risk.

Despite these problems, hedonic price function can also be applied to choose one's career. It is also used for measuring values of statistical life, estimating wage differences in the hazardous job, it also gives us a clue why prices may differ in different parts of the city or in different city.

3.6 Travel Cost Method

This is another example of revealed preference method (indirect method) of valuing environmental good. This method uses travel cost as a proxy for the price of visiting outdoor recreational cites. We are also willing to pay a higher price for the place when it has additional environment characteristics.

There are certain issues which need to be analysed -
* Value that one attaches to the environmental good.
* no of trips to a particular site.
* an increase in value if there is an improvement in environmental quality of the good.

Let us explain it with the help of the following diagram -
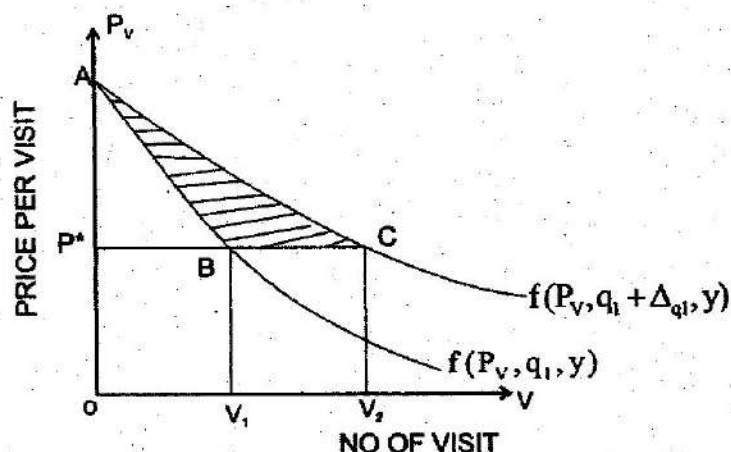
In the above diagram, we measure the no. of visits (v) along the horizontal axis and the price per visit (P_v) along the vertical axis.

In the above diagram -

> y stands for income
>
> q stands for quality of the environment
>
> p* stands for the actual price paid

ABC represent the gain due to improved environmental quality.

In the above diagram, $f(P_v, q_1, y)$ is an inverse demand function. Now suppose that there is an improvement in quality of the environment (ie, $q_1 + \Delta q_1$) the demand is then represented by $f(P_v, q_1 + \Delta q_1, y)$ and ABC represents the increased environmental quality. But if the price remains the same (P*) after the increase in environmental quality, then the person gets a surplus. We also notice that the no. of visits also increase with an increase in the quality of the environment.

We can also represent the above problem with the help of the following eqⁿ -

> Maximise $U(x, v, q)$ ----- (1)
>
> subject to $wl = x + pv$ ----- (2)

Where; X -- other goods

> L ---- no. of hours that a person works
>
> w ---- wage rate
>
> p --- price per visit
>
> x --- income spent on other goods

(35)

Eq^n (1) indicates that the consumer should adjust the no. of visit that he makes to a perticular site and the other goods that he consumers so as to maximise his utility.

Eq^n (2) indicates that the amount that a person spends on visiting a particular palce and on the consumption of other goods must be equal to the amount that he earns (ie, WL).

Now, L has to be divided into 3 parts –

    (i) Time needed for travelling.
    (ii) Time within the park.
    (iii) Time for work.

Now, the time budget constraint can be expressed as –

$$T = L + (t_t + t_v) V$$

where t_t - travel time

       t_v - time spent in the site

       V - no. of visits

       L - no. of hours that a person works.

$$T = L + (t_t + t_v) V$$
$$\therefore wT = wL + w(t_t + t_v) V \quad \text{[from eq}^n \text{ (2)]}$$
$$= x + p_v + w(t_t + t_v) V$$
$$= x + [p + w(t_t + t_v)]V$$

$\therefore$ Maximise $U(X, V, q)$

subject to

$$wT = x + [p + w(t_t + t_v)]V$$
$$\therefore wT = x + P_v V$$

where $P_v = p + w(t_t + t_v)$,

p is the out of pocket expenses,

$w(t_t + t_v)$ is the opportunity cost of travelling by foregoing wages.

This Travel cost method is one of the oldest methods forth for the valuation of environmental goods. This method was proposed by Harold Hoteling in a letter that he sent to the US Forset service in the 1930s. This method has been widely in use in both the USA and the UK for the valuation of recreation especially that which is associated with national parks, forests etc.

(36)

In the above we had discussed about the individual Travel cost emthod. But it takes more time as each and every visitor is to be approached. But we also have the zonal travel cost method.

Zonal Travel Cost Method:

Here we take about the visitation rate which is the no of visitors per 1000 population. It is denoted by --

$$v_z = (g \, \pi_x + f, y_z, w_z) \text{ ---- (1)}$$

Where z denotes a particular zone.

$\pi_z \rightarrow$ travel cost for that particular zone

$f \rightarrow$ fee

$\therefore$ Total travel cost $= \pi_z + f$

$y_z \rightarrow$ average income in a particular zone.

$w_z \rightarrow$ percentage of demographic characteristics

The demand function for park visits is given by –

$$q(f) = \Sigma_z p_z v_z$$

$$\therefore q(f) = \Sigma_z p_z g(\pi_z + f, y_z, w_z) \text{ [from eq}^n \text{ (1)]}$$

Where, $p_z \rightarrow$ total population of the zone

$q(f) \rightarrow$ aggregate demand curve for the park.

But the aggregate income may not always show a true picture, so, the Zonal travel cost method is limited in scope. Hence we generally resort to the Individual Travel cost method even though we have to approach each and every individual.

One limitation attached with the Travel Cost method is that people may attach more importance to pleasure derived from travelling than from the opportunity cost of foregone wages.

3.7 Environmental Impact

Assessment :

Environmental ompact assessment (EIA) is a process undertaken to test the viability of any priject or major activity. While taking up any project, one not only requires to analyse the need for such a project, the costs and benefits involved in it but also the impact of such a project on the environment.

With the help of an EIA, a project can be granted environmental clearance because an EIA helps to identify the potential beneficial and harmful effects of the project. Moreover, an EIA helps to identify the adverse effects of a project, if any, and helps to address, them at an early stage.

In recent years, many projects have faced severe difficulties in their implementation because —

(i) proper account has not been taken about their relationship with the environment.

(ii) some projects were unsustainable due to resource depletion.

(iii) some projects were abandoned due to public opposition, disastrous accidents etc.

Thus, from the past experiences it is seen that without first taking into account the environmental consequences, it is difficult to approve a project.

EIA Process in India :

In India until the 1980, the development projects were undertaken with very little or no environmental clearance at all. Till 1980, the issues of environment and forest were the responsibility of the Dept. of science and Technology and Ministry of Agriculture. These issues were later on attended by the Ministry of Environment and Forests.

In 1994, an important legislative measure was issued under the Environment protection Act, 1986 called the "Environment Impact Assessment Notification 1994."

While obtaining environmental clearance, the first step is to determine what statutory legislation apply to a project. The MOEF has put forward different notifications restricting the setting up of industries in certain areas. But this environmental clearance can be obtained either at the state level or the central level depending on certain characteristics of the project.

(38)

EIA Process :

In an EIA process, there are two 'tiers' of assessment - screening and preliminary assessment. For obtaining environmental clearance for a project, the project proponent needs to conduct an EIA of the project. To carry out the EIA, the project proponent appoints an environmental consultant, who then prepares the EIA report by incorporating data from all the four seasons of the year. Such an EIA is called "Comprehensive EIA". But sometimes data may be collected from a single seson, but that should not be during the monsoon season. Such an EIA report is called "Rapid EIA".

Screening : The first step in the process of project evaluation is screening. Screening helps in clearing those projects which from past eaperience are not likely to cause any damage to the environment.

Drawback in the Indian System :

Some industrial set up may not require EIA as per the noums but they may involve such technologies which harm the environment. Again, screening a project on the basis of its investment is not acceptable because mostly it is seen that it is the small scale project which cause more pollution.

Preliminary Assessment : If a project is not cleared by screening, then the project proponent have to undertake a preliminary assessment which involves identifying the impact of the project on the environment, predicting the extent of these impacts etc.

Formation of an EIA Team : If after the preliminary assessment, need is felt for a full EIA then the next step will be to prepare the EIA report.

This involves appointing an independant co-ordinator and an expert team, identifying the people who will finance, permit, plan and control the proposed project, determining how the EIA findings will be communicated etc. Expert team should include people from diverse backgrounds so as to arrive at an appropriate EIA report.

(39)

Drawback in the Indian System :

In the context of India, the expert team lacks expertise in variour fields.

Scoping : The aim of scoping is to ensure that the study encompasses all the important fields of study.

Drawbacks in the Indian System :
  (i) In India there is a lack of exhaustive ecological and socio-economic indicators for assessing the impact on the environment.
  (ii) Moreover, piblic opinion is not taken into account which often brings in conflict in the later stages of project approval.

Main EIA : After scoping, the main EIA begins. The EIA basically attempts to answer certain questions like --
  (i) What will happen due to the project?
  (ii) What will the extent of changes, if any?
  (iii)Do these changes matter?
  (iv) What can be done about these changes?
  (v) How will the desision makers be informed of what needs to be done?

Identification :

This process basically tries to answer the first question ie, "what will happen due to the project". In the identification phase one basically attempts to find out the key impacts of the project (like change in the quality of environment, wild life habitats, species diversity etc.). It also helps to identify all the sources of impacts.

Drawback in the Indian system:
  (i) The primary data collected by the data collector is not credible.
  (ii) The secondary data is also not reliable.
  (iii)Tha data collectors don't pay heed to the advice of the local people.

(40)

Prediction :

The next phase - 'prediction' attempts to answer the second question "what will be the extent of changes, if there are any." Prediction tries to find out the extent of these changes by laking the help of mathematical models physical models, socio-cultural models, economic models, experiments or expert judgements. But the predictions involve some degree of uncertainty also. So the study team should try to quantity the prediction uncertainty in terms of probabilities or margins of error.

Drawback in the Indian System :

The method that is used for the prediction and evaluation of the project is not mentioned in the report.

Evaluation :

The third question ie "do the changes matter" is tried to be answered in the next phase which is - 'Evaluation'. In this phase, an attempt is made to evaluate the adverse impact of a project so as to decide if they require mitigation.

Mitigation :

In this phase, various measures are undertaken to prevent, reduce or compensate for the adverse impacts of a project. The different mitigation measures that can be undertaken are --

(i) Change the project sites, operating methods, processing raw materials, disposal methods etc.

(ii) introducing programmes of pollution control, waste treatment, social services, personal training etc.

(iii) Providing compensation for the damage resources.

All the mitigation measures cost something. The various measures are compared, a trade off is obtained between the alternative methods and finally the EIA team proposes the action plan, usually combining a no. of measures.

Drawbacke in the Indian System:

(i) The information regarding the implementation and effectiveness of the various mitigation measures are after not provided.

(ii) For strategic industries like nuclear energy, the mitigation measures adopted are usually kept as a secret for various reasons.

(iii) The emergency plans are also not discussed in advance in details among the communities.

Documentation :

The last question ie, "how the desision makers will be informed of what needs to be done" is answered in this phase. In documentation, the key decision makers are identified, the questions that they ought to ask and the answers for every interpretation are provided to them. An EIA report should include the following -

(i) an exeutive summary of the EIA findings.

(ii) a report describing the proposed development project

(iii) the important environmental and natural resource issues connected with the project.

(iv) the various impacts of the project on the environment.

(v) a description of the various mitigating measures, that are available.

(vi) a summary of the EIA for the general public.

Once the EIA report is prepared, the proponent needs to submit 20 reepies of the executive summary to the SPCB (stat pollution control board) for getting the NOC. After receiving the required documents, the SPCB needs to conduct the public heaving. After the public hearing is carried out, the proponents need to submit their report to the MOEF for obtaining environmental clearance.

(42)

Drawback in the Indian System:

Some important drawbacks associated with the EIA process are --

(i) The EIA reports are generally incomplete and contains false data.

(ii) Most of the times the EIA report is based on single reason data and so, they are not fit to determine whether environmentalm clearance should be provided or not.

(iii) Again, the EIA is generally carried by an individual or an agency whose primary objective is to obtain environmental clearance for their project so there is every possibility that the final assessment may be biased.

(iv) The EIA report is bulky and very technical which is very difficult to understand.

(v) Sometimes it is seen that the agency which is engaged in the EIA process is not even specialised in that particular area.

(vi) There is no centralised baseline data bank where the data can be ctosschecked before use.

Hence, these are some of the drawbacks associated with the EIA process.

3.8 Summing Up

In this chapter we learnt that environment has both use and non-use value. Use value refers to the benefits derived by direct use of environment, whereas non-use value refers to the benefits derived through existence and option value of environmental goods. To measure the use value the revealed preference based valuation technique is used which include Travel Cost Method (TCM) and Hedonic pricing (HP). On the other hand to measure non user value the stated preference method of Contingent Valuation Method (CVM) is used. Further, Environment Impact Assessment process is discussed, which is a process undertaken to test the viability of any project or major activity.

3.9 Additional Readings

1. Charles D. Kolsted - "Environmental Economics", Oxford University Press

2. Hanley, Shogren and White - "Environmental Economics", Macmillan.

3. U. Shankar - "Environmental Economics", Oxford University Press.

4. R. Bhattacharjya - "Environmental Economics", Oxford University Press.

3.10 Exercise

1. What are the different methods for the evaluation of environmebt?

2. How is the contingent valuation method used for the valuation of environmental goods?

3. Discuss about the revealed preference methods for the valuation of environmental goods?

4. Why is Environmental Impact Assessment required?

5. What are the different phases involved in the environmental impact assessment process?

*****

UNIT – 4
ENVIRONMENT AND DEVELOPMENT

Contents:

4.0   Introduction

In this chapter we discuss about the link between environment and development. We also talk about the dependance of the poor people on environmental resources. We discuss about sustainable development and the need for environmental accounting for sustainable development.

4.1   Objectives

This unit basically attempts to fulfil the following objectives –

- *it* helps to identify the trade off between environment and development.

- *understand* the dependance of the poor on the environment.

- *understand* the concept of sustainable development.

- *know* about the need for environmental accounting, its types- system of national account (SNA); system of environmental economic accounts (SEEA)

(45)

4.2 Environment and Development Trade Off

There is a trade off between environment and development which can be understood from the Environmental Kuznets Curve (EKC).

While the original Kuznets curve depicts the change in inequality over time during the process of econimic development, the Environmantal Kuznets curve basically talks above the change in environmental quality due to economic development.
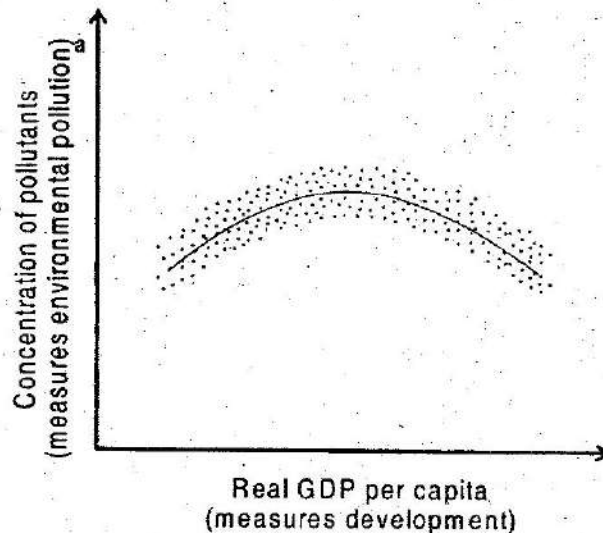
Fig : Environmental Kuznets Curve. capita (measures development)

According to the Environmental Kuznets curve, in the early stage of development we generally have good environmental quality. Moraover, in the early stage, the consumption level is also low so consumption wastes are not high and even then these wastes are biodeyradable ie, the volume of wastes is low. But as the development process progresses further and furder, industrialisation also increase, Rapid increase in industrialisation leads to pollution of air, water, land etc. thereby degrading the environment. Again, with increase in development, agriculture also becopmes commercialised. The consumption wastes also increases gradually. These wastes are intensive in chemicals so they are not degradable. Thus, we see that as economic development progresses

(46)

environmental degradation also increases ie, the progress of development would reduce environmental quality.

But the turning point occurs in the latter stages of the development process. In the latter stages, the income levels of the people increase. At higher levels of income, they demand for a higher environmental quality. Moreover, once the people are rich they can afford higher technology for a cleaner environment.

Now if this is true, then naturally the question arise as regards to the policy relevance of the Environmental Kuznets curve. According to the Evironmental Kuznets curve, we need to take up development and not worry about the environment. But this is something we can't do. If we degrade the environment beyond the threshold level, the damage will be irreversible, we may reach the Tipping Point. So, we can say that the Environmental Kuznets curve is not favourable from policy point of view.

Development and environment are two conflicting issues. If we go for development we have to sue more resources, there will be more industrialisation, more pollution. But to curb pollution and to keep the environmental quality, we cannot forsake development as it is very important for any country's progress.

4.3 Poverty and Environment

Environmental degradation affects the society as a whole. However, such degradation affect the poor section the most - they generally have to bear the brunt of environmental degradation. This is because the environmental degradation. This is bacause the poor are dependant on the environmental resources. So, destruction of these resources seriously affect the lives of the poor. The UNDP human Development reports describe 'poverty as the greatest polluter'. For instance, the poor generally extract fuelwood from the forests which degrade the forests and also may result in erosion of the top soil. But this is just again a single instance. There are also the type of properly rights like open access which can also be a cause of environmental degradation.

(47)

Contrariwise, there is also evidence that environmental degradation hurts the poor. For eg, shortage of drinking water or fuelwood affects the poor more than the rich.

To deal with the nexus between poverty and environmental degradation, policy measures need to be adopted. But for framing such policy, one needs to distinguish between exogenous poverty and endogenous poverty. In case of factors other than environmental degradation. In case of 'exegenous property', poverty in caused by factors other them envioronmental degradation. In such cases, addressing the root cause of poverty such as inequality of income and wealth etc. can help to mitigate the adverse impact of poverty on env·onmental degradation.

However, there is another type of poverty called 'endogenous poverty' where poverty is caused by environmental degradation, which results from market failure, institutional failures, failure to have groper Property right etc. In such case, degradation jeopardise the poor who have no option but to fallback upon the environment which degrades it further. In such situation, the anti poverty programme has to be implimented in combination with the policy for addressing the market and institutional failures.

Sometimes it may so happen that environmental degradation arising from other sources may affect the poverty environment nexus. For eg - if forests are depleted, than the poor people will not get the firewood for fuel so, they may switch to other sources like cowdung which can be used as fuel. But the use of cowdung as fuel may reduce its availability as-manure for the soil. This can further reduce the productivity of land which will in turn affect the poor farmers.

4.4   Sustainable Development

Sustainable development or sustainability according to Solow, is an obligation to conduct ourselves in such a way so that we leave to the future the option or capacity to be as welt off as we are.

A widely accepted definition of sustainable development is from the Report of the "World Commission on Environment and Development" also known as the Brundtland Commission of 1987. According to the Commission - "sustainable development is development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs."

Here needs basically refer to food, clothing shelter, jobs etc. This whole thing has resonance with Hicksian definition of income which ststes that income is the maximum consumption one can have within a period while remaining as well off at the end of the period as one was at the beginning of it.

Strong and Weak Sustainability :

Generally, there are 3 types of capital - man-made capital (Km), human capital (Kh) and natural capital (Kn). With these 3 types of capital, two different definitions of sustainability can be considered. The first approach called weak sustainability' requires that the total capital stock should not decline. This approach assumes that we can aggregate Km, Kh and Kn in the same units and that they are substitutes of each other.

Strong sustainability - this approach maintains that sustainable development requires us to keep the stock natural capital (Kn) intact. According to this view, the function performed by natural capital cannot be duplicated by manufactured and human capital.

Strong sustainability is the idea that there are certain function that the environment performs that cannot be duplicated by humans. Eg : the azone layer is such a thing which cannot be dupilcated by men.

Indicators of Sustainable Development :

(i) **Solow - Hartwick Rule :** According to this rule, one needs to maintain an undeiminished stock of capital. In another similar article, Hartwick shows that as long as the profits of the extracted

(49)

non-renewable resources are re-invested on either human capital formation or on regenerating renewable resources, the stream of consumption flows would remain constant for generations. Such a development process according to him is sustainable.

But this rule suffers from certain limitations -

 (a) it does not consider the non use velue of the environment.

 (b) natural capital may not be substituted by manufactured capital.

(ii) London school Approach : A gropu of economists from the London School of Economics designed a rule to rectify the shortcoming of the Hartwick Rule. According to this approach, the society should identify all the critical non-substitutable natural resources and must resolue to preserve them. In short, these economics opioned for non-deeling natural capital stock.

(iii) Safe Minimum standards : This approach is closely linked to the non-declining natural capital stock. The rule is to prevent reductions in the natural capital stock below a safe minimum standard identified for each component of this stock, unless the social opportunity cost of doing so is unacceptably large.

(iv) Daly's operational principle : Daly provides some rules for operationalizing sustainability -

 (a) The human scale is to be limited to a level, which if not optimal is atleast within the carrying capacity and these sustainable.

 (b) Technological progress for sustainable development should represent an increase in effiriency.

 (c) Harvest rates should not excees regeneration rates and wast emissions should not exceed the renewable assimilative capicity of the environment.

 (d) Non-renewable resources should be exploited at a rate equal to the creation of renewable substitutes.

Daly thus hints at population control and implementing the Hartwick rule simultaneously.

Stop to Consider:

Paradigms of Development

Growth	Development	Social Development	Sustainable Development

Included Notions

Growth	Development	Social Development	Sustainable Development
Efficiency	Efficiency	Efficiency	Efficiency
	Equity	Equity	Equity
		Proper Valuation	Proper Valuation
			Resource Stock Recognition
			Resilience

Non-included Notions

Equity	Proper Valuation	Resource Stock Recognition
Valuation	Resilience	Resilience
Resource Stock Recognition	Resource Stock Recognition	
Resilience		

4.5 Environmental Accounting

The national accounts method uses different indicators to determine the trend of economic growth. But with tncreasing importance on sustainable development particularly after the Earth Summit, the United Nations Conference on Environment and Development in Rio de Joneiro, 1992 stresses on the need for a broader measure of economic growth.

So, this called for a modification of the conventional system of national account (SNA). This system suffered grom some limitation which we highlight below -

(i) The scarcities of natural resources which threaten the sustained productivity of the economy ; and

(ii) The degradation of environmental quality mainly from pollution and its consequences on health and welfare.

System of National Accounts (SNA) :

The SNA is compossed of two accounts -- supply & use account and asset account. The supply and use account is a flow account while the asset account is a stock account. The supply and use account and asset account of the SNA can be structured as below –

The supply account of SNA = Domestic Production + Imports from the rest of the world.

The use account of SNA = Intermediate Consumption (IC) + Fixed consumption (FC) + Gross consumption (GC) + Exports (X).

Now, Total Consumption – Intermediate Consumption = Gross Value Added

If we do this for all the industries, we get the GDP (Gross Domestic Product) of the whole economy.

There is alos the consumption of fixed capital (CFC) which is due to the wear and tear of the products during the production process.

Now, if we substract CFC grom the GVA we get the net value added ie,

$$GVA - CFC \quad = \quad \text{Net Value Added}$$
$$= \quad \text{Net domestic product}$$
$$= \quad \text{Domestic Income}$$

But environmental economists are of the opining that this is not the domestic income because it doesn't take into account the aspect of environmental degradation.

The asset account of SNA on the other hand is a stock account which consists of the opening stock, changes during the year and the closing stock.

Thus, the balances are defined as –

Closing stocks $=$ opening stocks + gross capital formation - consumption of fined capital+ other changes in volume of assets + holding gains/losses on assets.

There is another method for accounting, it is called the system of Integrated Environmental and Economic Accounting (SEEA)

System of Integrated Enuironmental and

Economic Accounting (SEEA) :-

SEEA has emerged from the awareness about the need for sustainable development. Sustainability requires that the stock of capital, manufactured (Km) human capital (Kh) and natural (Kn) should be kept undiminished for the future generations. But the conventional system of National Accounts takes into account only the manufactured capital. The SEEA is an extended system which takes into account the natural capital. The SEEA has many accounts which we briefly discuss below -

(i) supply and use account.
(ii) asset accouint.
(iii) Pollutionh and material flow account.
(iv) Environment protection and resource management account.
(v) Macroeconomic aggregates.

(i) **Supply and Use Account :**

The supply side can be structured as--

P R O D U C T S		Industry	Household	Rest of the world	Envoronment
	Natural Resources	-	×	-	✓
	Products	✓	×	✓	×
	Residue	✓	✓	✓	×

(53)

From the above table we see that industry supplies both products and residue. The household sector supplies only the product. The rest of the world also supplies products and some amount of residue. But it is the environment which supplies the natural resources.

The use account of SEEA is represented in the following tabular form—

	Industry	Household/ Govt	Accumulation	Rest of the world	Environment
Natural Resources	✓	-		-	-
Products	Intermediate consumption	Final consumption	Gross capital formation	Exports	
Residue	For treatment	-	✓	✓	✓

From the above table it is seen that the industry uses natural resources, the intermediate products of the industries and also some residue after treatment. The household or the government sector uses the final products for consumption. Similarly, for accumulation we have the gross capital formation. The rest of the world uses exports. The environment acts as a sink for the waste materials/residue.

(ii) Asset Account :

The asset account of SEEA consists of the opening stock, changes during the year and closing stock.

The opening stock includes various types of natural capital. The changes during the year include depletion/depreciation, gross capital formation, consumption of fixed capital and other value changes. Depletion is measured in two ways -- depletion of non-renewable natural resources, which measures the extraction value at net price and depletion of renewable resources, which measures harvest in excess of re-generation. Then there is the closing stock.

(iii) Pollution and Material Flow Account:

The damage caused to the envoronment can be estimated by 2 methods --

(1) Damage Control Method :

In this method, we try to estimate economic losses due to pollution. The losses may be

(a) loss of agricultural productivity.

(b) loss of income and other assets.

(c) accelerated corrosion of structure.

(d) Damage to human health.

(2) Maintenance/Avoidance Cost Method :

In the method, we --

(a) set acceptable pollution norms.

(b) estimate the amount of resources necessary to bring pollution level to the set standards,

(c) estimate the cost of resources required to achieve these norms.

(iv) Environment Protection and Resource Management Account :

This accouints tries to monitor efforts towards conservation and maintenance of the envoronment. It is like a satellite account, it doesn't give any information but it takes out from other accounts the efforts used by industries etc.

(v) Macroeconomic Aggregates :

Envoronmentally adjusted NDP = GVA - CFC - DNR - Damage to the envorioment.

Where GVA - gross value added

CFC - consumption of fixed capital

DNR - depletion of natural resources.

If domestic consumption ≤ environmentally adjusted NDP,

we have weak sustainability situation.

There is another supporting indictor --

Genuine sauing = Gross domestic saving - CFC

$$- DNR - damage \ to \ the \ environment.$$

Positive genuine savings means that the weak sustainability norm is fulfilled and nagative genuine savings implies that the society's practices are not sustainable.

4.6 Summing Up

This unit briefly deals with the trade off between environment and development with the help of environmental Kuznets Curve, which talks about the change in environmental quality due to economic development. Further, this unit speaks of the cause and effect relationship between poverty and environment, and also the concept and indicators of sustainable development. Besides the unit discuss some need for environmental accounting and its various types as–system of national account (SNA) and system of environmental economic accounts (SEEA).

4.7 Additional Readings

1. Charles D. Kolstad: *Environmental Economics*, Oxford University Press.

2. Hanley, Shogren and White: *Environmental Economics*, Macmillan.

3. U. Shankar: *Environmental Economics*, Oxford University Press.

4. R. Bhattacharjya: *Environmental Economics*, Oxford University Press.

4.8 Exercise

1. Explain the environment development trade off.

2. What is the relation between poverty and environment?

3. What is sustainable development? What are its indicators?

4. What is environmental accounting?

5. How is SEEA different from SNA?

6. What are the different accounts under SEEA?

*****

UNIT - 5
POLITICAL ECONOMY OF GLOBAL ENVIRONMENTAL ISSUES

Contents:

5.0   Introduction

Environmental goods and services provide both use and non –use values. But there are certain environmental issues which affect the entire world. Most of the time environmental externalities are in the form of local or global public bads. So, govt intervention is required to solve these environmental problems. Infact with the process of globalizations and various natural process the local problems are transformed into international problems and almost every nation is adversely affected by the global environmental problems like depletion of ozone layer, acid rain, biodiversity loss, greenhouse gas emissions, global warning etc.

These global environmental problems may sometimes arise when pollution from one country crosses borders and harms the people of another country. Again sometimes it is seen that there are some resources like tropical rain forests, endangered species etc., which may be present in certain countries but they provide non use values

(58)

to people living in other countries. Now if these resources are destroyed then they will bring about an adverse affect in the other countries as well where they are not even present. Moreover, the issue of global public bads may also arise when countries share global environmental resources like accans, atmosphere etc. In this chapter we try to discuss some important issues like climate change, biodiversity loss, ozone layer depletion and the various international conventions and protocols that have taken place around the world for environmental preservation. We also discuss issues like trade and environment and pollution havens.

5.1 Objectives

This unit is designed to serve the following objectives–

- *to understand* the various environmental issues affecting globally.

- *to know* about the impacts of climate change.

- *to understand* the concept of biodiversity loss, ozone depletion, global warming etc.

- *to disscuss* about the various international conventions and protocols.

- *to know* about trade and environment and pollution havens.

5.2 Issues Related to Climate Change

Climate change refers to long term (typically decades or more) changes in climate including changes in the surface temperature of the earth and relative changes temperature of the earth and relative changes in the geographical distribution and chemical quality of rain. The greenhouse gases (GHGs) play a very inportant role in regulating the climate on earth. These gases have the ability to be transparent to the incoming visible light from the sun but they are opaque to the energy radiated from the earth. This is called the greenhouse effect as these gases (ie GHG) trap heat in the same manner as the greenhouse's transparent covering traps heat.

(59)

Without these greenhouse gases the earth's temperature would have been for below freezing but then again an increase in the GHGs would result in an increase in trapped heat and would cause the global temperatures to rise.

But there has been a gradual change in earth's climate which has raised concerns globally. Global warming is an important issue related to climate change. Human activities are considered to have the potential to disturb the balance in the climate and bring about some irreversible adverse impacts.

5.3 Global Warming

Global Warming refers to the rise in the temperature of the earth which is perceived to have been caused by increase in the heat trapped in the atmosphere as a result of a rise in the concentration and accoumulation of the green house gases (GHGs) like carbon dioxide, water vapour, nitrous oxide, methane etc. From the early part of the 20th century, earth's mean surface temperature has inereased by about $0.8^0 C$ $(1.4^0 F)$.

The adverse effects of global warming include rising sea levels, decreased snow cover,decrease in forest biomass, decrease in agriculture production and a change in the amount and pattern of precipitation. It is experted that warming would be strongest in the arctic with the gradual shifting and metting of glaciers. There would be damages due to coastal inundation caused by rising sea levels.Agriculture production is also likely to fall as the surface temperature of the earth increases. Other effects of global warming inculde extreme weather like heat waves, droughts, heavy rainfall, species, extinction etc.

The genesis of this issue lies in the ever increasing energy demand in the last two centuries. One thing which causes global warming is electrical pollution. In some cases fossil feels (coal,oil and natural gas) are burnt to generate electricity. Now many pollutants are producted when the fossil fuels are burnt. One such pollutant is carbon dioxide which is a greenhouse gas. Moreover , this burning of fossil fuel consequent upon an increasing demand for energy

results in a depletion of the exhanstible resources like coal, oil, natural gas etc. Another important factor causing global warming is cutting down of trees. Generally, trees and other plants absorb CO_2. Plants collect CO_2 (carbon dioxide) and give out O_2 (oxygen). But with less trees and plants, less oxygen is available for us and more greenhouse gases are present in the atmosphere. This makes the earth warmer.Thus it is very much important to understand the concern for global warming and the need for mitigating it....

5.4   Ozone Depletion

Ozone layer is present in the straresphere several miles above the surface of the earth. Although ozone is present in a small amount in the atmosphere, it plays a very important role by shielding human beings and other life forms from the harmful ultraviolet radiation of the sun.

Ozone depletion thus refers to the destruction of this ozone layer. In the last several decades, human activities have been found to be producing some ozone depleting subtance (ODS) like chlorofluorocarbon (CFCs) halons etc which react at the high attitude of the atmosphere and destroy the ozone molecules. The depletion of the ozone layer is feared to cause a no. of dreadful diseases like skin cancer and cataracts; damage of plants , reduction of planktion population in the oceans etc.

The academic claim of the ozone breaking potential of the CFC s was made for the first time in 1974 but these apprehensions eventually proved correct when a hole was discovered in the ozone layer above Antarctica. Since then various international agreements were signed to limit such emissions , one such agreement being the Montreal protocal that was signed to reduce the ozone depleting substances.

5.5   Loss of Biodiversity

The term biological diversity, often referred to as biodiversity refers to the variety and differences among the living organisms from

(61)

different sources, viz terrestrial , aquatic ecosystems etc. Biodiversity refers to the degree of variability among the different living organisms within a given species, ecosystem etc. So, accordingly we have "species diversity", "genetic diversity" and "ecosystem diversity." Variability among species in terms of their uniqueness is called "species diversity" while the variability in terms of habitats, biotic cammunities etc. is referred to as ecosystem diversity. On the other hand, variation in terms of the genes contained in the organisms is called "genetic diversity".

Thus we find that biodiversity is a crucial life support system for human life as well as all other forms of life.Thus it becomes extremly necessary to preserue the biodiversity so as to maintain the physical, social and economic life of human beings.

Biodiversity provides us with both use and non use values. The use value can be categorised into direct use value and indirect use value. The direct use value are food, biomass , recreation and tourism. The indirect use value are biodiversity provides a sink for wastes, for recycling nutrients, watershed protection and preservation of soil quality. On the other hand, the non-use values provided by the biodiversity are the life support services like climate regulation, laurbon fixing, providing a habitat for living organisms etc.

In the past few years it has been observed that there has been a gradual degradation of biodiversity owing to a lot of factors, mainly human induced factors. Forests and natural habitats of the liying organisms have been put to different other uses that has resulted in a total deterioration of biodiversity. This has raised global concern for the preservation of biodiversity.

The erosion of biodiversity can be attributed to the difference between private and social costs and benefits of biodiversity. Market failure occurs because market fails to account for the non use values. There is the absence of well defined property nights, lack of institutional mechanisms and proper policies to manage the natural resources. Deforestation, pollution, overharvesting, overgrazing etc. have alos been responsible for the gradual destruction of biodiversity.

India is one of the mega biodiversity centres in the world. Its huge reserves of forests, grasslands, wetlands, mountains, marine ecosystems etc. are subjected to pressures of rapid increase in population, conversion of land for other commercial purpose, encroachment, illegal trade of wildlife and other factors. Various policy intiatives have been taken in this regard to preserve the biodiversity. Thus, bioviversity unless preserved will pose a threat to the total nub of life.

5.6 International Conventions and Protocols

The importance of environment is felt in every sphere of life as it provides the basic life support services basides various other uses. But in the past several decades the process of environmental degradation was so rapid that it demanded international co-operation to mitigate such environmental issues. As a result, various international conventions and protocols were undertaken to ensure sustainability of the environment.

Prior to the Stockholm conference of 1972, international co-operation on conservation. It is a comprehensive action that is to be taken globally, nationally and locally by organisations of the UN, the governments and major group in every area.

* Kyoto Protocol :

In December 1997, parties to the FCCC made an international climate policy regime under the kyoto Protocol. The main elements of this Protocol are --

    (i)   commitments made by the (Annes I parties) OECD countries, Eastern Europe and former Soviet Union to limit or reduce the aggregate GHG emissions by an average of 5.2 % below 1990 levels by the period of 2008 - 21.

    (ii) commitment by the above mentioned countries to show the progress in this regard by 2005.

(iii) commitments made by the same countries to the preparation of inventories of GHG emissions and reporting national plans to the FCCC.

(iv) this protocol introduced four flexible mechanisms

    (a) Joint Implementation.

    (b) Bubble.

    (c) International Emission Trading.

    (d) Clean Development Mechanism

These mechanisms will allow emission reduction beyond the geographical boundaries of the committed countries.

(v) No commitment was made by the rest of the world (non-Annex I parties)

For a successful implementation of these mechanisms, reliable data on GHG envissions are required. It is also important.

* Rio conferme 1992 :

The United Nations Conference on Environment and Development (UNCED) also known as the Rio summit, Rio conference or the Earth summit was held in Rio de Janeiro in 1992. The various issues addressed in this conference included :

(i) Study of patterns of production, partucularly the production of toxic components such as lead in gasoline, radioactive chemicals etc.

(ii) alternative sources of energy to replace the use of fossil fuels.

(iii) reliance on public transportation system in order to reduce vehicle emissions, congestion in cities and health problem carred by polluted air and smog.

(iv) the growing scarcity of water.

An important achievement of this conference was an agreement on the climate change Convention, which in turn led to the Kypto

Protocol. Moreover, the Convention on Biological Diversity was opened for signature at the Earth Summit.

The Rio conference included a special "Agenda 21" with regards to sustainable development. It is a program run by the United Nations (UN) related to sustainable development and the conference was the planet's first summit to discuss issues relating to global warming. The main aim of the Agende 21 is to bring together the various components of balanced development with the objective of economic development, social equity and resource environmental issues were mainly confined to few treaties and agreements on matters like pollution of rivers, use of nuclear power etc. As per the Stockholm Declaration states were required to ensure that activities within their jurisdiction do not cause any environmental damage to areas beyond their national territory. Moreover, with the establishment of the United Nations Environment Programme (UNEP), various UN organisations were required to include environmental considerations in their operations.

The main international conventions and protocols on environmental issues are briefly discussed below

Montreal Protocol :

The Vienna Convention on the protection of the ozone layer was signed in 1985. This treaty is considered to be the precursor to the Montreal Protocol. The Montreal Protocol on substances that deplete the ozone layer was opened for signature on september 16, 1987 and entered into force on January 1, 1989. The main aim of this Protocol is to protect the ozone layer by phasing out the production of the ozone depleting substances (ODS) which are believed to be responsible for ozone depletion ODS is a global bad. ODS include chlorfluorocarbons (CFC s) and halons which are used in refrigerators, airconditioning, feam, aeresol sprays, etc.

According to the world Development Report, 1992 the adoption

and implementation of this Protocol was relatively easier because—

   (i)   there was evidence for ozone depletion.

   (ii)   the no. of ODS producers was small.

   (iii) substitutes for ODS were found and were present with the producers of ODS.

India become a signatory to the Montreal Protocol in 1992. In 1993 India prepared a country wide programme to phase out ODS. The Protocol in this respect has made an important contribution by providing financial support to Indian firms to purchase machines and technologies that help to reduce the use of ODS.

Due to its widespread adoption and implementation the Montreal Protocol has been hailed as an example of exceptional international co-operation.

Convention on Climate Change :

The UNEP and the World Meteorlogical Office established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The objective of the framework Convention on Climate Change (FCCC) is to achierve stsbilisation of Greenhouse gases (GHG s) in the atmosphere. There were certain guiding principles of FCCC some of them are --

*   the need to protect the climate system on the basis of equity and common but differentiated responsibilities.

*   the need for precautionary measures in the absence of full scientific security.

*   parties should co-operate to promote a supportive and open international system, etc. to calculate the net emission reduction of a project. There are other proposals as well for reducing emission of GHGs. This include an international carbon tax reginne, financial transfers from developed to developing countries and voluntary agreements.

(66)

* Rio + 20 summit :

It was the 3rd international conference on sustainable development with the basic aim of reconcealing the economic and environmental goals of the global community. This summit was hosted by Brazil.

This conference had 3 basic objectives --

(i) securing political commitment for sustainable development

(ii) assessing the progress and implementation gaps in meeting previous commitments.

(iii) addressing new and emerging challenges.

The basic theme of this summit was to build a "Green Economy" to achieve sustainable development and life people out of poverty and allow them to find a green path for development. It also stressed to improve international co-ordination for sustainable development.

Check Your Progress:

1. What happens as a result of climate change?

2. What is global warming ?

3. What is ozone depletion ?

4. Mane some ODS.

5. What is meant by biodiversity ?

6. What is the Kyoto Protocol ?

7. What is "Agenda 21" ?

8. What are the objectives of Rio + 20 summit ?

5.7   Trade and Environment

Trade is considered to be the engine of economic growth. Each country can hope to specialise in the production of those commodities where it has a comparative advantage only the presence of free trade. The commodities traded mainly consists

of primary commodities and certain labour intensive manufactured goods. The primary products are mainly natural resources inyensive whereas the manufactured goods are production of the industrial sector. These manufactured goods generates negative externalities because of inefficient technologies used and low environmental standards. The free flow of such manufactured goods due to trade liberalisation may result in environmental degradation.

The developed countries formulated certain policies to overcome these trade related environmental issues, which includes --

(a)　a ban on imports.

(b)　imposition of anti-dumping duties on products.

(c)　pledge for harmonisation of environmental standards and multilateral agreement on investments.

The negative externalities within a national territory come under the category of local public bad or national bad whereas the externalities beyond boundaries come under the category of global public bad. Examples of global public bads are ozone depletion, greenhouse gas emission etc. To counter such global public bads some international policies and mechanisms are needed to be undertaken by international organisations with mutual collaborations.

But the supporters of free trade argue that environmental considerations should not influence trade policies. Accodding to them, environmental problems should be tackled with the help of environmental policies and not through trade policies. If trade policies were indircetly used to address these issues it might lead to a decrease in the trade of commodities among different nations which may stagnate the process of industrial growth. But since environmental issues are not only national but also international in nature, therefore, the preservation of environment is very much important through not only environmental policies but also other such measures available such as trade policies.

5.8 Pollution Havens

A country that, because of its weak or poorly enforced environmental regulations, attracts industries that pollute the environment is called a pollution haven. In other words, in a developing economy it is seen that there is either absence of any environmental regulation or the existence of very weak regulation. The industries of developed nations took this advantage of the absence of such kind of regulations and establishes their pollution intensive industries in such countries. Thus, the developing nation becomes the pollution haven for the developed nations.

The pollution haven hypothesis argues that highly polluting industries migrate to the developing countries and recent estimate also support the above hypothesis. The environmental concerns of developed nations cause them to enact some strict environmental regulations that restrict the setting up of pollution causing industries. On the other hand, the developing countries are devoid of such strict environmental regulations which attracts rhese industries.

Recent study focussed on pollution haven hypothesis revealed that as the dirtiness of the industries increase the exports also increase correspondingly. This provides some evidence for the pollution haven hypothesis -

5.9 Summing Up

In this unit we have seen that excessive use of environment leads to various environmental problems like ozone layer depletion, loss of biodiversity, global warming etc. As such government intervention is required to solve these issues. Various international conventions and protocols are observed and together the entire world is working for the optimal use of environment and lowering of environmental bads.

5.10 Additional Readings

1. Charles D. Kolstad: *Enviriomental Economics*, Oxford University Press.
2. U. Shankar: *Enviriomental Economics*, Oxford University Press.
3. R. Bhattacharjya: *Enviriomental Economics*, Oxford University Press.
4. Hanley, Shogren and White: *Enviriomental Economics*, Macmillan.

5.11 Exercise

1. ˮ/hat is climate change ? What are the issues related with climate change ?
2. What are the effects of global warming ?
3. What is ozone layer depletion?
4. Which protocol was signed to reduce the use of ODS ?
5. What are the different conventions and protocols undertaken for environment preservation ?
6. What were the issue taken up in the Rio conference 1992 ?
7. What were the conventions undertaken for preventing climate change ?
8. Discuss the importance of the Kypto Protocol.
9. What is the inter-relationship between trade and environment.
10. What is meant by Pollution Haven ?

* * *