BLOCK 5
VALUATION OF ENVIRONMENT

INTRODUCTION TO BLOCK 5

Block 5 is on Valuation of Environment. This block has three units (Units 10, 11 and 12). **Unit 10** is on Economic Value of Environmental Services. The unit first makes a distinction between the use-value and the non-use value of environmental services. It then explains three types of valuation techniques viz. (i) objective standard based valuation, (ii) objective preference based valuation and (iii) stated preference method. The concept of 'measurement of environmental services' is then explained in terms of (i) 'willingness to pay' versus the 'willingness to accept' approaches and (ii) the 'marginal willingness to pay' concept.

Unit 11 is on Non-Market Valuation of Environmental Services. The unit explains three methods of evaluating the non-market value of environmental services viz. (i) contingent valuation method, (ii) travel cost method and (iii) hedonic price method.

Unit 12 is on Green Accounting. The unit first explains the 'cost of depletion and damage of natural resources'. The earlier method of the 'system of national accounts' (SNA) is explained in terms of: (i) distinction between 'national income' (NI) at market price and factor cost, (ii) types of accounts under SNA and (iii) the requisite modifications required in SNA. The new 'system of environmental economic accounting' (SEEA) is then described in terms of (i) stock and flow concepts of economic assets and (ii) the two broad perspectives of environmental assets viz. (a) components having only material value and (b) the broader ecosystem services [consisting of both the biotic (living) and the abiotic (non-living) parts of environment].

UNIT 10 ECONOMIC VALUE OF ENVIRONMENTAL SERVICES*

Structure

10.0 OBJECTIVES

After reading this unit, you will be able to:

- distinguish between the use-value and non-use-value of environmental services;
- explain the concept of Marginal Willingness to Pay (MWTP);
- differentiate between the marginal willingness to pay and marginal willingness to accept;
- derive the marginal willingness to pay for environmental goods; and
- specify the conditions under which 'willingness to pay' (WTP) and 'willingness to accept' (WTA) converge or diverge respectively.

10.1 INTRODUCTION

Environment has myriad important functions. Apart from providing tangible resources such as coal, oil, etc. it provides many intangible benefits such as clean air and water. Many environmental aspects such as the ozone layer are crucial for the survival of mankind. By valuing the environment, we are not putting a price-tag to nature as it is simply priceless. However, since non-priced services are subject to over-exploitative usage with negative externalities to society, valuing/pricing the environmental services helps in streamlining its proper usage. Moreover, protecting the environment needs

* Ms. Priti Agarwal, Assistant Professor, CVS, DU, Delhi.

resources and allocation of resources is an economic decision involving trade-offs. Hence, valuation of the environment will help in deciding allocation of resources for environmental protection. Since environmental goods and services have no markets, its demand curve needs to be first drawn using the 'marginal willingness to pay approach' and then the same used to 'measure environmental benefits and damages'. Since environmental costs and benefits are two sides of the same coin, valued in monetary terms, the benefits from one less unit of pollution numerically equals the damages from one more unit of pollution. Thus, it basically implies that the 'willingness to pay' for reducing pollution and the 'willingness to accept' compensation for increase in pollution are equivalent. But this is not always the case. The unit discusses these issues and shows the conditions under which the 'willingness to pay' and the 'willingness to accept' would either converge or diverge. Clearly, an awareness of such conditions would provide the policy planner with the necessary knowledge for tackling the environmental issues in an optimal manner.

10.2 VALUING ENVIRONMENTAL SERVICES

Environmental goods can be classified in various ways. It can be classified on the basis of nature of pollution such as air quality, water quality, etc. It can also be classified on the basis of nature of injuries caused such as health damages to residents or damages to agricultural crops. An yet another way of classifying the environmental services is on the basis of people's perception. For instance, consumers not only derive utility from using the environmental resources (such as wood) but also from simply viewing the environment (like scenic beauty of the mountains). Based on these classifications, we can draw a distinction between several types of values attached to the environment. Broadly, there are two types.

10.2.1 Use Value

Recreational and commercial users derive benefits from activities such as swimming and fishing. These activities involve using the environmental resource directly. In other words, such benefits yield *direct use* value. On the other hand, some individuals may derive *indirect use value*. For instance, simply looking at a lake's beauty has aesthetic value. Here, the lake is not used directly as in case of swimming. Such use value can be of current use, expected use or possible use.

Option value is another type of use value. Here, individuals are willing to pay today in order to retain the option of using the environmental resource in future. Individuals value the option of retaining a good for the future even if they may not be using it currently. For instance, one may be willing to pay to preserve wildlife so that the option of visiting wildlife habitats in future remains open. Option value includes future direct and indirect use values.

When looking at the benefits from environmental resources, we must understand that environmental damages are negative environmental benefits. For instance, pollution has direct health impacts in the form of respiratory problems inflicted upon the population as well as indirect impacts such as thick smoke which reduces the visual appeal of the city. There are other negative impacts of pollution such as adverse impact on production process, damage to buildings calling for additional maintenance, etc. Pollution could thus disrupt ecosystem services which are sometimes critical for survival of humans.

10.2.2 Non-use Value

Non-use value refers to increase in the individual's utility without actually using the good. For instance, we may value an ecosystem existing far off in a remote area even though we may not frequently go and see it. Such non-use values are of three types: *existence value, altruistic value* and *bequest value.*

Existence Value: Sometimes, people derive benefits from simply knowing that some environmental resources exist and they are willing to pay to preserve such resources. For instance, individuals are willing to pay to protect the endangered species of plants and animals. Even though one may not be visiting to see such resources, mere knowledge of their existence provides satisfaction to individuals. Such a value is very abstract and it is called existence value of the environment. Existence value is in addition to the actual or potential use value.

Altruistic Value: Here, people value an environmental good because it provides benefits to others even though those beneficiaries are unknown to them. For instance, if my neighbour is happier when I clean the backyard and my neighbour's happiness makes me happy as well, I am being altruistic.

Bequest Value: People have a sense of obligation to preserve the environment for future generations. Thus, a person may derive bequest value in passing a beautiful garden to the next generation.

The point here is that many environmental assets have significant non-use values and less use values. One should be careful to include all these values as looking only at the use values, undermines the significance of the environmental asset. But, dissecting the components of value may be empirically difficult. For instance, knowing how much is altruistic value and how much is bequest value is difficult.

10.2.3 Valuation Techniques

The previous section presented the concept of total economic value of the environment. There are many valuation techniques for monetising environmental services. Table 10.1 presents an overview of these valuation techniques. These can be broadly classified under the following three heads:

- Objective Standard Based Valuation
- Subjective Preference Based Valuation
- Stated Preference Method

Objective Standard Based Valuation: This is a direct market valuation approach which uses data on actual markets. It is mostly used to obtain values for provisioning services of the environment such as production of food and other resources. Prices provide precise information on such values in well-functioning markets. There are two approaches under direct market valuation: *cost-based approach* and *production function based approach*. Under the cost-based approach, there are two methods viz. '*damage cost avoided*' method and '*replacement cost method*'. If people are willing to incur costs for avoiding damages caused by loss of ecosystem services or for replacing ecosystem services, then one can infer that those ecosystem services are worth at least what people paid to replace them. These methods are appropriate in situations where payment for avoidance of damage or replacement expenditures are actually undertaken or could be undertaken. Production function based approach analyses the effect of pollution externalities on production function i.e. here the environmental impact on inputs and ultimately on output is traced. For instance, say we are interested in finding the value of fertile soil. Although soil has no separate market, we can deduce its value using the production function approach wherein the impact of soil degradation can be seen from the loss in agricultural output.

Objective Preference Based Valuation: This is a revealed preference approach where people indirectly reveal their preferences for the environmental good through their choice of the marketed good. Two such approaches are the *hedonic pricing method* and the *travel cost method*. Under the hedonic pricing method, we measure the price of housing for different levels of air pollution and see how the housing price changes due to change in air pollution (keeping other things constant). This indirectly gives the price of air quality. Travel cost method is frequently used to value natural parks and recreation sites. The underlying logic behind travel cost method is that the value an individual attaches to a recreation site can be deduced from the effort he makes to visit the site (i.e. in terms of the time and money spent).

Stated Preference Method: Under this method, hypothetical markets are constructed and people are asked to state their willingness to pay for the environmental good. Two such methods are the *contingent valuation method* and the *contingent choice method*. In the contingent valuation method, the individual is posed a set of questions directly asking him to reveal his willingness to pay for the good. In the contingent choice method, people are asked to make choices based on a hypothetical scenario without directly asking them to specify monetary values/amounts that they would be willing to pay for the environmental good. For instance, two environmental characteristics with different costs may be presented to the respondent and he may be asked to make a choice between the two. Hence, the focus of this method is on trade-offs between alternate scenarios. The results may be used to rank options rather than attaching monetary values to them.

From the above discussion on valuation techniques, it is clear that for estimating the use-value of any environmental service, actual market based valuation techniques like *objective standard based valuation* and *subjective preference based valuation* can be used. For estimating the non-use value, stated preference method is used. The choice of valuation techniques essentially depends upon whether actual markets or suitable proxy markets are available. For use values, we observe that direct market interactions are suitable proxy markets. But for non-use value (such as existence value), there are no markets or proxy markets. Hence, one has to apply *stated preference method*.

Table 10.1: Valuation Techniques

Valuation Technique	Approach
1. Objective Standard Based Valuation	Restoration Cost
	Cost of Illness Method
	Replacement Cost
	Productivity Loss Estimates
2. Subjective Preference Based Valuation	Hedonic Pricing
	Travel Cost Method
3. Stated Preference Method	Contingent Valuation
	Contingent Choice Method

Check Your Progress 1 [answer within the space given in about 50-100 words]

1) Why is it important to evaluate environmental resources?

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

2) Distinguish between the 'direct use value' and the 'indirect use value' of environment with illustrations.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

3) What is meant by an 'option value'? Give an example.

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

………………………………………………………………………………

4) In what way 'environmental damage' amounts to negative environmental benefit?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

5) State the three types of non-use-value of environmental resources with illustration.

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

10.3 MEASUREMENT OF ENVIRONMENTAL SERVICES

We are aware from microeconomics that consumer surplus is measured by the area under the demand curve where the demand curve shows the marginal value placed by the individual consumer on the good in question at different levels of consumption. While this is about conventional goods, whether for environmental goods (such as water quality, air quality) OR environmental bads (such as air pollution and water pollution) also similar measurement techniques applies is the question we have to consider here. Just like any other good, we can also draw the demand curve for environmental goods but the major difference is that, since such goods have no markets, we cannot observe how much is consumed at different prices. However, we can represent the underlying preferences for an environmental good using a demand curve. Since protecting the environment requires (i.e. demands) financial resources, we can ask how much an individual is 'willing to pay' for protecting an environmental good. Since such decisions involve trade-offs, they can be put into the framework of consumer theory as follows. Let us assume we have to derive the demand curve for clean air. The willingness to pay for each additional unit of air quality is relatively more at lower levels of air quality i.e. when the air quality is fairly good; the willingness to pay for each additional unit of air quality is relatively less. Such an approach can be used to derive the demand function for clean air. Once we have drawn the demand curve for the environmental good, we can measure the environmental benefits/loss by applying the theory of consumer surplus.

In case of environmental goods having no market, price is equivalent to the *marginal willingness to pay* (MWTP) with consumer surplus being equivalent to the total willingness to pay. The concept of MWTP becomes clear with a Figure (Fig. 10.1) where the marginal willingness to pay (say for reduction of nitrogen oxide emission) for three households having different income levels is shown. We can see that consumers are willing to pay a negative amount i.e. they have to be compensated for having been forced to consume pollution for each additional unit of NO_x they are forced to bear with. Higher the pollution, greater the compensation. Hence, the demand curves are downward sloping in the fourth quadrant (i.e. NO_x is positive but MWTP is negative). Moreover, as incomes increase, the MWTP increases i.e. higher income households have to be compensated by higher amounts for the same level of pollution.

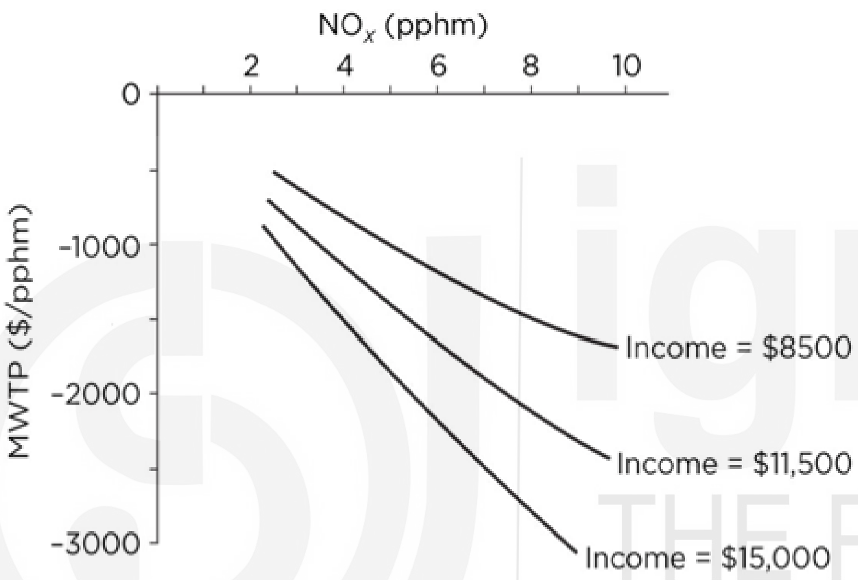
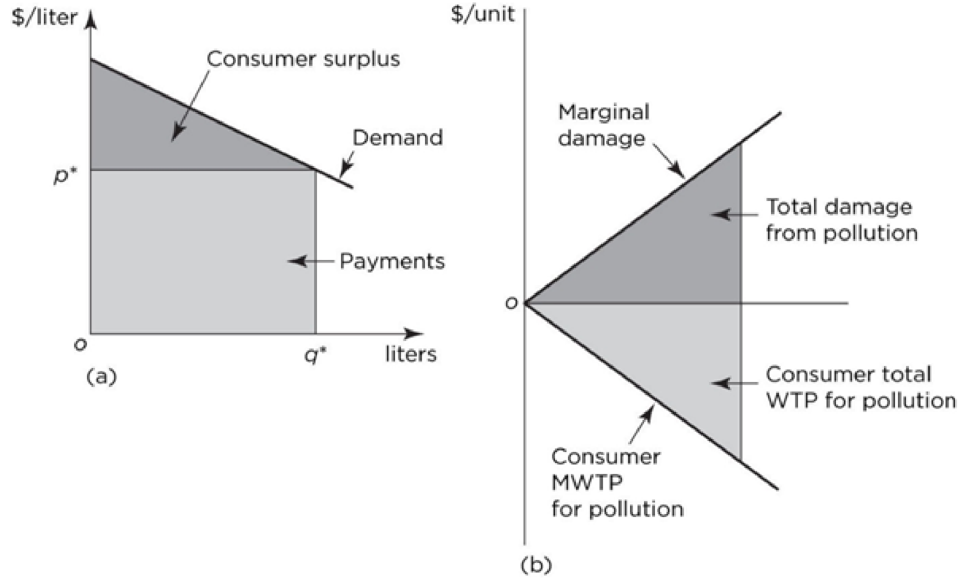


Fig. 10.1: MWTP for NO_x Households with Three Different Income Levels

Source: Harrison & Rubinfeld, 1978.

Benefits of less pollution, and damages from more pollution, are therefore opposite sides of the same coin i.e. when we express these in money terms, the benefits become 'willingness to pay' (positive) and damages become 'willingness to accept' (i.e. negative willingness to pay). Viewed from this angle, WTP for pollution decreases is equivalent to saying 'willingness to accept compensation' for pollution increases. We can understand more by comparing a demand curve (and the consumer surplus associated with it) with a normal good with that of a 'negative environmental good' i.e. environmental 'bad' (Fig. 10.2). For air pollution, the 'marginal damage curve' and the 'MWTP for pollution' curve are mirror images– one being negative of the other. Area under the marginal damage curve gives the total damage from pollution. The total amount that has to be paid to the consumer as compensation should be equal to the total damages from pollution. Area under the MWTP curve gives the total willingness to pay for pollution (which in this case is negative). It is the consumer surplus, which since being negative, represents the total willingness to accept compensation.



10.2 (a): A Normal Good **10.2 (b): An Environmental Bad (i.e. Pollution Damage)**

Fig. 10.2: Demand Curve for a Normal Good and Air Pollution

10.3.1 Willingness to Pay Vs Willingness to Accept

In the previous section, we have seen that the Marginal Willingness to Pay is equivalent to the Marginal Willingness to Accept (MWTA) compensation. This is true in most contexts but not always. Consider the demand for a normal good such as gasoline. Here, the individual values an additional unit of gasoline at 1$ per litre. That is, the MWTP for one more litre of gasoline approximately equals the MWTA compensation for one less litre of gasoline. In this instance, there is hardly any difference between MWTP and MWTA. Now consider an environmental good such as clean air. How much an individual would be willing to pay to reduce CO_2 emissions by one unit? How much compensation an individual would be willing to receive to allow CO_2 emissions to increase by one unit. We may think that $MWTA \gg MWTP$. This is because WTP is limited by the income of the individual whereas WTA is not subject to any such constraint. Taking another instance, an individual's WTP to avoid flood may not be equal to the WTA compensation after floods. Hence, for environmental goods, WTP and WTA may not be the same. Knowledge about this divergence is essential because we need to know whether WTP or WTA should be used in the context of demand for environmental goods.

Fig. 10.3 illustrates as to why environmental goods mainly witness such a divergence. Consider two goods: a numeraire good which is a representative of all market goods priced at unity (say 'x' i.e. a good with price equal to unity) which is representative of all market goods and an environmental good 'q' (a non-priced good whose quantity consumed can only be measured and is indicated by levels of q on the X-axis. The diagram shows indifference curves with the vertical axis representing 'x' and the horizontal axis representing 'q'. Consumption basket (x_0, q_0) has utility U_0. Another consumption basket (x_0, q_1) has higher utility U_1 and higher level of environmental good consumption. Now, we can consider the following two questions viz.

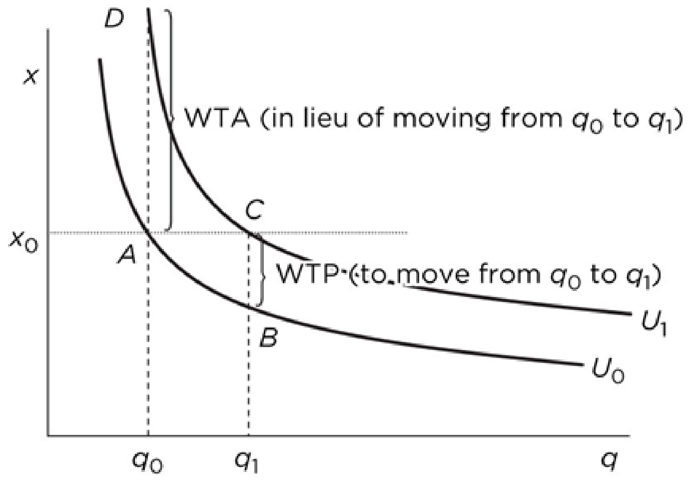


Fig. 10.3: WTP versus WTA for a Change in Quantity of an Environmental Good

Source: Kolstad (2011).

- What is the WTP to move from q_0 to q_1, if we start at q_0.
- What is the WTA to move to q_0, if we start at q_1.

Note that if we are considering an environmental 'good' like scenic beauty, the consumer may be expected to 'pay', whereas if we are talking of an environmental 'bad' (like pollution), the consumer has to receive compensation. In this example, since we are taking 'environmental good' on X-axis and not 'environmental bad', we can interpret that for movement from q_0 to q_1, the consumer pays, whereas for movement from q_1 to q_0, the consumer accepts compensation [because in the first instance he is consuming more of environmental good to increase his utility and in the second instance he is sacrificing the consumption of a 'bad' environmental good]. We are measuring WTP and WTA in terms of units of 'x' since 'x' is priced at unity. Starting at q_0, when the individual moves to q_1, his utility increases to U_1 keeping 'x' at x_0. But, he has to sacrifice some 'x' in order to get more 'q'. Thus, he will try to at least keep his utility at the original level U_0. Hence, he will only give up as much 'x' so as to maintain utility at U_0. Hence, he will give up BC. Thus, the WTP to move from q_0 to q_1 is BC as shown in the Fig. 10.3. Starting at q_1, when the individual moves to q_0, his utility decreases to U_0 keeping 'x' at x_0. But, he can gain some 'x' by sacrificing 'q'. He will try to at least keep his utility at the original level U_1. Hence, he will gain only as much 'x' so as to maintain utility at U_1. Hence, he will gain AD. Thus, the WTA to move from q_1 to q_0 is AD as shown in the Fig. 10.3. Since AD > BC, we can say that WTA > WTP. However, such a figure cannot completely substantiate the argument. What if the indifference curves are parallel straight lines? In that case, WTP = WTA. Two cases can result in linear indifference curves:

1) If 'x' and 'q' are perfect substitutes. This is possible if one could offset one more unit of 'q' by fixed amount of 'x' keeping utility constant. This

condition will hold when the demand curve for 'q' is perfectly elastic and price of 'x' is fixed.

2) If change in 'q' from q_0 to q_1 is extremely small. In this case, we are actually dealing with a very small portion of the graph such that the indifference curves become nearly linear locally.

Hence, we can expect the WTP and WTA to diverge significantly if (a) 'x' is not a perfect substitute for 'q' and (b) change in the environmental good is large. The necessary condition for such an outcome is that the indifference curves should be non-linear. The demand curve for 'q' should be downward sloping and change in **'q' should be non-marginal or substantial. Summarising the result, we can expect** the WTA and WTP to diverge substantially, if (a) change in the environmental good is big enough so as to make compensation of losses by increased consumption of market goods difficult and (b) uniqueness of the environmental good makes it difficult to substitute it for other goods.

10.3.2 Marginal Willingness to Pay

In the above sections, we have applied the concept of MWTP curves. In this section, we show how the MWTP curve or the demand curve for an environmental good is derived. For estimating the demand curve for any normal good, the standard approach is to obtain transaction data on price and quantity demanded and trace out the demand curve using statistical methods. However, this approach cannot be applied to environmental goods since they have no prices. This problem can be avoided by using the concept of *restricted demand*. We measure statistically (using observations) how demand for a market good changes with its own price and quantity of an environmental good. We then deduce the MWTP for the environmental good as a function of its own quantity and the market goods price.

Consider a set-up with two goods: market good 'x' and environmental good 'q'. Price of market good is denoted by p_x. For instance, certain types of houses may be taken to be the market good and air quality may be taken to be the environmental good. Demand for houses is then a function of its own price as well as its air quality. Using this example, 'x' is quantity of housing demanded, p_x is price of houses and 'q' is air quality. This is the 'hedonic pricing method' of valuation of environmental services which is discussed in greater detail in Unit 11. Using data on house sales and air quality in different locations in an urbanised setting, the following relation between quantity of housing demanded (x), price of houses and air quality is obtained:

$$X = h\ (p_x\ , q) \qquad (10.1)$$

For a conventional demand curve, all the arguments on the right hand side are prices (with additional variables such as income). But here we have both price and quantity as arguments on the right hand side. Hence, it is called a *restricted demand curve*. Using the above relation, we find the MWTP for q. MWTP is the ratio of the change in WTP to the change in q. Fig. 10.4 shows the restricted demand for our chosen market good (i.e. housing). There are two demand curves, one for 'q', and the other for $q + \Delta q$. Here Δq is a small positive number. Improvement in air quality by Δq increases the demand for housing and the demand curve for housing sifts upwards. The change in consumer surplus which is the shaded area between the two demand curves is the change in the willingness to pay for small change in air quality or ΔWTP. If Δq is known (and assumed to be infinitesimally small) and ΔWTP can be computed, then the following equation holds:

$$\frac{\Delta WTP}{\Delta q} = MWTP = f(p_x, q) \qquad (10.2)$$

Hence, we get the demand curve for the environmental good or the relation between the MWTP for the environmental good and its quantity.

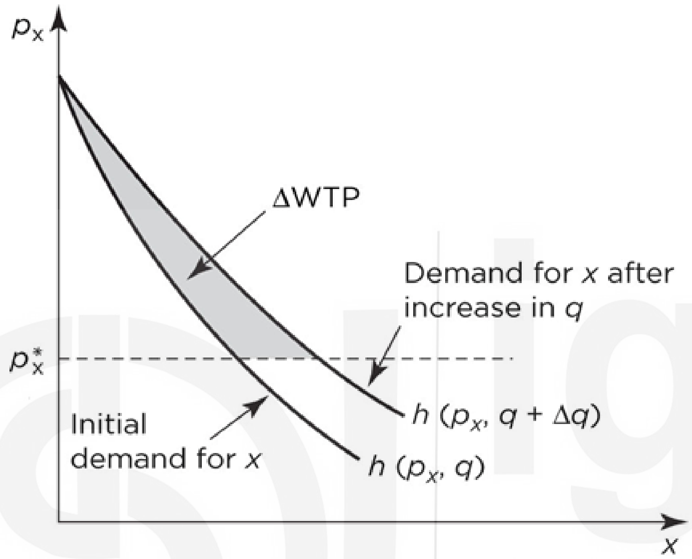


Fig. 10.4: Marginal Willingness to Pay

The above method of deriving the demand for environmental good has certain limitations. This is because the demand for environmental good is only expressed through housing demand. While it is true that good quality air in the surroundings increases demand for houses located there, or poor air quality in the locality decreases the pleasure one derives from living in those dwellings, adverse air quality also affects travel, work and recreation experiences. Hence, the demand found by the above method may be taken to be a lower bound on the demand for the environmental good.

Check Your Progress 2 [answer within the space given in about 50-100 words].

1) How is MWTP related to 'willingness to accept'?

……………………………………………………………………………….

……………………………………………………………………………….

……………………………………………………………………………….

……………………………………………………………………………….

2) Is it true that MWTA is always 'greater than' MWTP? If not, why is it so? Illustrate with some examples where they are different.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

3) State the two instances where the WTP would be exactly equal to WTA.

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

4) Under which two situations would you expect WTP to be widely divergent from WTA and for such a situation to result, what is a necessary condition?

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

10.4 LET US SUM UP

The economic value of the environment comprises of both use and non-use values. Since environmental goods have no markets, hypothetical markets have to be constructed for them using the underlying preferences of the individual. The demand curve for environmental goods are essentially the marginal willingness to pay curve where marginal willingness to pay is analogous to price. These curves can enable one to find out the consumer surplus or the total willingness to pay or accept compensation. The idea is to get a monetary estimate of environmental benefits or costs. Willingness to pay or accept compensation are equivalent in most contexts although they may diverge substantially if change in the environmental good is big enough so as to make compensation of losses by increased consumption of market goods difficult. Such a divergence may also result if the environmental good is unique which makes it difficult to substitute it for other goods.

10.5 KEY WORDS

Use Value : Value that comes from the actual usage of the environmental good.

Non-use Value : Value which arise even when the good is not actually used (e.g. existence value).

Existence Value : Value which arises from mere knowledge that the environmental resource exists.

10.6 SOME USEFUL BOOKS AND REFERENCES

1) Harrison and Rubinfeld (1978). Hedonic Housing Prices and the Demand for Clean Air, *Journal of Environmental Economics Management*, 5:81-102.

2) Kolstad, Charles, D (2011). "Intermediate Environmental Economics", Second Edition, Oxford University Press.

3) Thomas Callan (2007). Environmental Economics, 2007 Thomson Learning Inc. Indian Edition.

4) Callan, Scott J. and Janet M. Thomas, "Environmental Economics & Management: Theory, Policy, and Applications," 5th Edition.

10.7 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) Since non-priced services are subject to over-exploitative usage with negative externalities to society, valuing/pricing the environmental services helps in streamlining proper usage (Section 10.1).

2) Consumptive use (e.g. crops, fish) and non-consumptive use (recreational) are the two types of 'direct use value'. Aesthetic value is an example of 'indirect use value'.

3) Option value refers to willingness to pay today for its use tomorrow (e.g. preservation of wild life).

4) Respiratory ailments on account of environmental pollution amounts to 'environmental damage' with 'negative environmental benefit'.

5) Existence value, altruistic value and bequest value (Sub-section 10.2.2).

Check Your Progress 2

1) MWTA > MWTP. This is because WTP is limited by the income of the individual whereas WTA is not subject to any such constraint.

2) For environmental good, WTP and WTA may not be the same (Sub-section 10.3.1)

3) In cases of linear indifference curves (Sub-section 10.3.1)

4) If (a) change in the environmental good is big enough so as to make compensation of losses (through increased consumption of market goods) difficult and (b) uniqueness of the environmental good makes it difficult to substitute it for other goods. The necessary condition for such an outcome is that the indifference curves should be non-linear.

UNIT 11 NON-MARKET VALUATION OF ENVIRONMENTAL SERVICES*

Structure

11.0 OBJECTIVES

After reading this unit, you will be able to:

- distinguish between the 'stated preference' and 'revealed preference' methods of evaluating environmental resources;
- explain the 'contingent evaluation method' (CVM) of evaluating the non-market environmental resources;
- discuss the 'travel cost method' (TCM) of valuation of environmental resource;
- derive the conditions for attaining market equilibrium under the hedonic price method (HPM);
- estimate the 'willingness to pay' of a consumer for a non-market environmental resource by the HPM; and
- outline the issues for the empirical application of the HPM in terms of its stages and specific needs.

* Ms. Priti Agarwal, Assistant Professor, CVS, DU, Delhi.

11.1 INTRODUCTION

There are many techniques for valuation of environmental goods and services. Broadly, they can be categorised into two methods: *stated preference* method and *revealed preference* method. Under the stated preference method, people are directly asked to state their willingness to pay for the environmental good in question. One such method is the Contingent Valuation method (CVM) which is discussed in detail in this unit. Under the revealed preference method, preferences for environmental goods and services are ***inferred*** from observed behaviour in actual markets. For this purpose, markets closely related to the environmental good may be chosen. For instance, variation in real estate prices across the city due to variation in air quality can be used to infer people's valuation of clean air. We discuss two techniques under the revealed preference approach viz. the Hedonic Pricing Method (HPM) and the Travel Cost Method (TCM).

11.2 CONTINGENT VALUATION METHOD

Although the revealed preference methods can value many environmental goods, they cannot measure the existence value of an environmental good. For instance, the value of arctic wilderness or climate change cannot be determined using revealed preference methods. In such cases, we have to rely on the 'constructed markets' approach i.e. in cases where markets do not exist, a market is constructed to generate the value of demand for an environmental good. Constructed markets are of two types: experimental and hypothetical. Valuation using hypothetically constructed markets are known by various names such as *stated preference*, *hypothetical valuation* or *contingent valuation (CV),* etc. Here, consumers are directly asked how much they are willing to pay for any environmental initiative i.e. *if there were a market* (or contingent to the existence of a market). In experimentally constructed markets, the researcher begins by considering all the market characteristics (including allowing trading of money) for the good. In field experiments, the general population is placed in a realistic setting. Such markets serve the purpose of real markets set up by the experimenter.

In contingent valuation (CV) method, the individual is posed a set of questions directly asking him to reveal his 'willingness to pay' (WTP) for the 'good'. For instance, people living in areas with poor air quality may be shown pictures of areas with good air quality and they may be asked how much they would be willing to pay to move to such areas. CV studies have been used to generate monetary estimates of damages from oil spills or hazardous waste accidents. Such estimates are required to claim legal damages from the firms responsible for causing such hazards. Such studies also play a role in formulation of public policies for encouraging the preservation of environmental resources.

For a CV study, the survey designed and administered should have three parts: background information (on the study and the environmental good), a section eliciting value and a section on background information of the respondents. Practitioners of CV follow a well-developed protocol so that reliable estimates of willingness to pay are generated. Basically, there are the following six major components in a CV study.

1) **Defining the Market Scenario:** The respondent has to be informed about the market scenario so that he develops the right approach to provide responses which are meaningful. The respondents should be so selected that they are well informed and educated about the topic so that their responses are unbiased. Many-a-times, the respondents are unaware and time constraints prevent imparting education to the respondents. For instance, in studies trying to value groundwater, people are not aware of the degree of groundwater contamination and the risks associated with it. We, therefore, have to define the 'good' which has to be valued. For instance, due to oil spills, a beach has been damaged. In this case, we should value which environmental good? A view of the beach? Or a day at the beach? Here, the respondent should be reminded that there are substitutes. For instance, in estimating the value of a damaged beach, the respondent should be told that uncontaminated beaches exist at some distance. It is also important to take note of the payment mechanism i.e. how the respondent is willing to pay: through a parking fee or taxes. For instance, let us assume the 'good' is avoiding oil spill at a beach. For this, a believable payment mechanism would be a tax on gasoline which can be used to hire additional inspectors on oil tankers. Further, the scenario should be plausible, otherwise the respondent may not take it seriously. For instance, if someone is asked how much he is willing to pay to completely eliminate pollution, he may not believe it since pollution can only be reduced but not altogether eliminated.

2) **Choosing Elicitation Method:** How should the valuation response be elicited from the respondents? Here, there are four approaches: (i) direct question method, (ii) bidding game method, (iii) payment card method and (iv) referendum choice approach. In direct question method, people are simply asked to state their willingness to pay for the 'good'. However, very few real markets may exist for respondents to relate and answer in a realistic manner on the price of an environmental good. That makes an individual unfamiliar for this direct approach due to which his responses may lie in extremes i.e. from very low to very high numbers. In the bidding game method, a certain WTP amount is mentioned to the respondent and then he is asked to state an yes or no response. If he says 'yes', the WTP number is increased gradually, till he says a 'no'. If he says 'no', the WTP number is decreased gradually, till he says a 'yes'. Such a method may suffer from 'starting point' bias. For instance, the results may be different if bidding starts at 1000$ versus 1$. In the payment card method, the respondent is shown a card with many figures spanning across the expected range of responses. However, the problem with this approach is that such range of values may have in-built clues. In referendum choice method (or discrete choice method), the respondent is presented with a WTP figure and asked whether he accepts it or not. Different respondents are presented with different WTP figures so that a range of plausible WTP is generated. Here, a bias may be introduced if the interviewer deliberately presents a WTP figure based on the

respondents' income. To avoid this, care should be taken to ensure that the WTP figures are randomly chosen.

3) **Designing Market Administration:** After the survey is designed, it needs to be administered i.e. conduct of survey and collation of responses needs to be done. For administration of survey, there are four methods: mail, internet, telephone and in-person. Although mail surveys are cheap, they suffer from high non-response. Internet surveys are variant of mail surveys. Examples are online surveys which are gaining in its importance with the internet becoming widespread. In telephonic surveys, mobile phone surveys are gaining popularity. But in phone surveys, one cannot provide pictorial clues which are helpful in eliciting proper responses. Additionally, it is difficult to conduct mobile phone surveys as people refuse to entertain calls due to large number of junk calls. In-person surveys are expensive but reliable. But they also suffer from interviewer bias. Further, even people who are not sensitive to environmental issues may mask their true willingness to pay in trying to be *socially correct.*

4) **Sample Design:** We have to choose the sample for answering the CV questionnaire. For this, first identification of the population concerned, depending on what 'good' we are trying to value is important. In other words, we should have the precisely defined population or the 'sampling frame' from which we can draw the sample. For instance, if we are looking into visibility in Delhi, then the question is whether we should target visitors or residents? If we choose residents, we also have to choose a geographical area of interest. Next we need to decide whether we have to examine households or individuals. Having decided the sampling frame, a random sample can then be surveyed.

5) **Experimental Design:** Designing a CV instrument, administering it and statistically analysing it, are important steps of an experimental design. Given that data collection is a costly exercise, the survey should be designed carefully so as to collect appropriate information efficiently without unintended bias. This is the process of experimental design.

6) **Estimation of Willingness to Pay Function:** The goal of the CV survey is to develop statistically significant estimates of willingness to pay for a particular environmental good. Hence, in this last step, using the survey responses or data we estimate the WTP function.

CVM is advantageous because it can be used to measure existence value. But since the approach is based on a hypothetical market situation, individuals' WTP in actual situations may be different. Additionally, in such hypothetical markets, there is no budget constraint due to which choice or decision-making is vague. Moreover, individuals may choose to free-ride rather than reveal their WTP.

Check Your Progress 1 [answer within the space given in about 50-100 words]

1) Distinguish between the 'stated preference' and the 'revealed preference' approaches of evaluating an environmental resource without a clear market with suitable illustration.

....

....

....

....

2) Under what situations, the revealed preference method fails? What is the recourse adopted in such cases?

....

....

....

....

3) How does the contingent valuation method work? Illustrate the purposes for which the CV method can be useful.

....

....

....

....

....

4) What are the six major components of a CV study?

....

....

....

....

5) What are the four methods of administering a survey under the CVM? What are their shortcomings?

....

....

....

....

6) What is the ultimate goal of a CV study? What are the advantages and the disadvantages of the CVM?

....

....

....

....

....

11.3 TRAVEL COST METHOD

The Travel Cost Method (TCM) is a revealed preference method of valuation of the environment. The underlying logic behind TCM is that the value an individual attaches to a recreation site can be deduced from the effort an individual or family makes to visit the site (i.e. in terms of the time and money spent). TCM is frequently used to value natural parks and recreation sites as well as assess the environmental damages caused. For instance, let us assume that visitors to a beach decline to visit due to pollution in the beach. We can use TCM to value the beach in clean state as well in polluted state. The difference between these values gives a quantitative measure of damage to the beach from pollution.

11.3.1 Theoretical Framework

Consider a single consumer and a single site (park). The consumer has to maximise his utility from the number of visits to the park per year (v) and the cost of purchases of market goods during the visit ('x'). Let p_0 represent the out-of-pocket expenses of visiting the site (travel and food expenses) and f represent the admission charge to the park. We further assume that the consumer works for L hours to earn wage 'w'. Now, the consumer's utility maximisation problem is:

$$Max\ U\ (x, v) \text{ such that } wL = x + (p_0 + f)v \qquad (11.1)$$

Further, apart from the above out-of-pocket expenses, the consumer also devotes time in travelling to the site and in being at the site. Since this time could have been alternatively devoted to work earning income, we need to account for this time spent. Let us assume that the consumer has total T hours of time and that t_t is the travel time required for a single round trip visit to the site and t_v is the on-site time associated with a single visit.

$$\text{Thus, } T = L + (t_t + t_v)v \qquad (11.2)$$

The constraint in the utility maximisation problem given above can therefore be modified by substituting for $L = T - (t_t + t_v)v$. We, therefore, have:

$Max\ U\ (x, v)$ such that,

$$w[T - (t_t + t_v)v] = x + (p_0 + f)v$$

$$wT = [x + (p_0 + f)v] + w\,(t_t + t_v)v$$

$$wT = x + \{p_0 + w\,(t_t + t_v) + f\}v = x + (p_t + f)v = x + p_v v,$$

where, $p_v = p_t + f$.

$$p_t = p_0 + w\,(t_t + t_v) \qquad (11.3)$$

Now, it is clear that the price of a visit p_v comprises three terms: out-of-pocket expenses p_0, admission fee f and the value of time measured at the wage rate i.e. $w\,(t_t + t_v)$, 'w' being the opportunity cost of travel time plus on-site time. Solving this maximisation problem, we get the individual demand function for site visits as:

$$v = g(p_v, y) = g(p_t + f, y) \qquad (11.4)$$

Summing the individual demand curves over the population, we get the market demand for park visits. Adding an additional term q for 'quality of the park', the above demand function becomes:

$$v = g(q, p_t + f, y) \qquad (11.5)$$

Now, we can derive the willingness to pay for a small change in 'q' by drawing a figure with p_v (price of park visit) taken on the vertical axis and the number of park visits per year (v) indicated on the horizontal axis (Fig. 11.1). There are two demand curves, the lower one for quality q_1 and the higher one for better quality of the park $q_1+\Delta q$. For a small change in quality of the park Δq, consumers respond by increasing park visits from v_1 to v_2 at price p^*. The consumer surplus increases by area ABC. Now, the ratio of area ABC to the change in q ($i.e.\,\Delta q$) gives the marginal willingness to pay for increases in q. Repeating this exercise for various quality levels, we get the marginal willingness to pay function for quality.

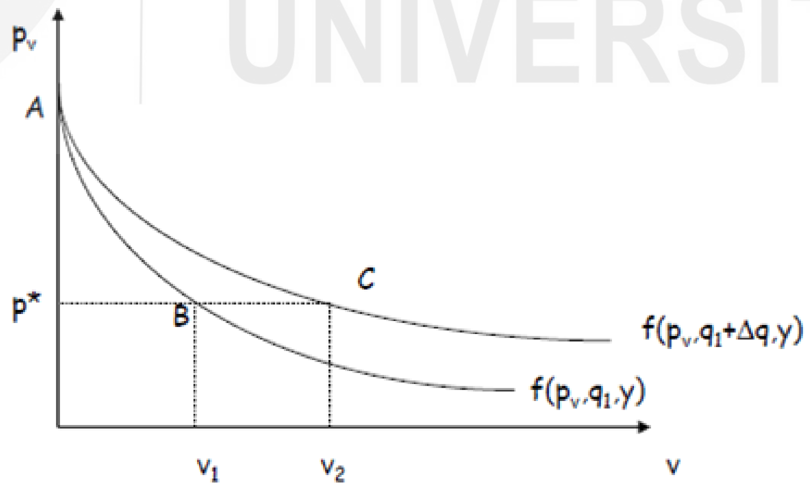


Fig. 11.1: Consumer Surplus due to Change in Quality of the Park

Source: Kolstad, 2011.

In case the individual has to choose between various sites, the demand for one site can be taken to be a function of the price of other sites, as well as the quality of other sites. If we consider three sites, A, B and C, the demand for site A is given by:

$$v_A = g_A(q_A, q_B, q_C, p_A, p_B, p_C, y) \quad (11.6)$$

Although the above formulation appears simple, the empirical application is complicated. One can compute the demand for trips to site A as a function of the quality of site A and price of visit to site A. Then it can be examined how the demand changes when the quality of the site changes.

The model explains the factors which drive the demand for site visits. But it is too simplified as in real world, the individual may not consider recreation time as totally replaceable by labour time. Further, work hours may be restricted by contract and the individual may not be able to earn additional money from wages.

11.3.2 Difficulties in Application

Implementation of travel cost method has many problems the most important being estimation of value of time. Opportunity cost of travel time may not correspond with the wage rate since people value travelling more than working i.e. they consider the opportunity cost of travel time to be lesser than the wage rate. Moreover, access to the recreational site may be limited by congestion in which case TCM may give downward biased estimates. It is also difficult to control for other factors which affect access to the recreational site such as presence of a highway, substitute opportunities for recreation, etc. TCM is not effective in measuring benefits accruing to commercial users of the resource as it can measure only recreational benefits. Further, TCM can measure only the user value with a disadvantage of not being able to capture the 'existence value'.

11.4 HEDONIC PRICING METHOD

Hedonic pricing method (HPM) is also a revealed preference method of valuation of the environmental services. Here, the value of qualitative attributes of the environment, such as air quality (which does not have a market) is deduced using peoples' revelation of their preferences for products embodying such attributes. Any good can be taken to be a bundle of attributes whose valuation depends on the characteristics they possess. Hence, the explicit price of the product can be determined by valuing its implicit attributes embedded in the product. For instance, property prices differ across locations with an area having clean air (or low pollution) having higher property prices. Here, the price of clean air is embodied in the price of housing. One can therefore specify a model for housing prices where the market price of a house 'P' is a function of location, number of rooms, air quality of the community, etc. Thus:

$$P = f\ (X_1, X_2, \ldots \ldots X_n, A) \quad (11.7)$$

where, the X-variables represent housing characteristics and A stands for air quality of the community. The implicit price of air quality is the increase in property price as a result of improvement in air quality. Empirically, housing prices have been found to vary with distance from a waste disposal or landfill site. Greater the proximity to such sites, lower the housing prices. Thus, an empirical model regressing housing prices on distance from landfill sites is expected to give the sign of 'distance from site' negative indicating the inverse relationship between the two variables.

11.4.1 Theoretical Framework

Let us again consider the housing market. A house being a bundle of several characteristics (such as number of rooms, environmental quality of the location, neighbourhood quality, etc.), housing prices implicitly includes the price of air quality. Our aim here is to extract the price of air quality explicitly. For simplification, we assume that the good (housing) has a single characteristic (i.e. air quality) but of different levels. First, we determine the price of housing with the implicit price of air quality. In the second stage, we derive the consumers' demand curve or the consumer's willingness to pay for changes in air quality.

If we consider a single homogeneous market such as a city, we would be assuming that each house is characterised by a single variable 'z' standing for air quality levels. Hence, p(z) expresses the house price as a function of air quality levels called the hedonic price function p(z). We shall try to understand how p(z) behaves by looking at how consumers and producers react differently to p(z). Assuming competitive markets, we shall work backwards to see how the hedonic price function p(z) can be constructed. We must consider two separate cases: one for consumer and the other for producer and then bring the two together to get an idea of the equilibrium.

11.4.2 Consumers' Choice

Let us consider a consumer who buys only one house and all other goods collectively denoted by 'x'. He has income 'y' which has to be allocated between 'x' and a house of a chosen air quality level 'z'. His utility maximisation problem is given by:

$$Max\ U\ (x, z) \text{ such that } x + p(z) = y \qquad (11.8)$$

where p(z) is the market determined 'hedonic price function' or curve. We need to determine how much the consumer is willing to *bid* for the house so as to match with the offers made by the suppliers so as to maximise his utility. Let θ be the maximum amount the consumer is willing to bid for the house to attain his desired level of utility $\widehat{U}$ and the desired level of air quality 'z' subject to his income constraint 'y'. Hence, the problem of finding the maximum bid becomes:

$$Max\ \theta_{\ x,\theta} \text{ such that } U\ (x, z) \geq \widehat{U} \text{ and } x + \theta\ = y \qquad (11.9)$$

Note that the variables y, z and $\widehat{U}$ are exogenous (i.e. independent and fixed) and x and θ are to be determined. The bid function can thus be written as $\theta\left(y, z, \widehat{U}\right)$. Fig. 11.2 shows two bid functions for two different utility levels for a single consumer, with lower bid function representing higher utility (since the same bidding amount is associated with better air quality). The bidding amount is measured on the vertical axis. Each point on the curve shows the bidding amount of the consumer for different levels of z implying that the consumer is willing to bid higher for better air quality. p(z) is the market determined hedonic price function or curve. The question here is: at what level of z, the consumer's utility is maximum? Such a level or point is attained where the 'bid function is tangent to the hedonic price function p(z)'. Hence, at utility maximisation, θ must be equal to p(z) and at this point, the consumer is willing to buy the house.

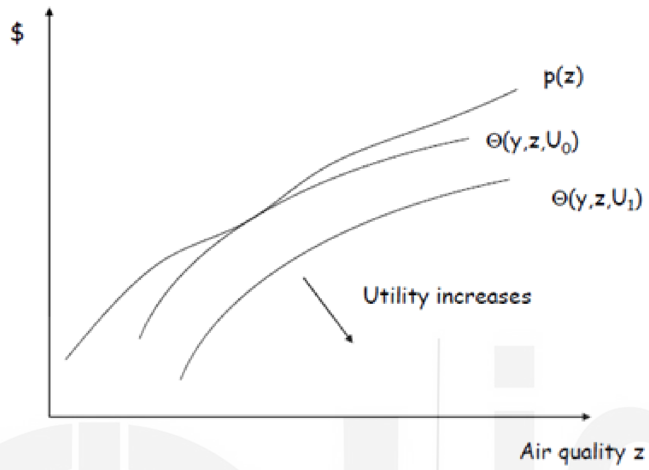


Fig. 11.2: Consumers' Choice

Source: Kolstad, 2011.

11.4.3 Producers' Choice

On the production side, let us assume there are suppliers producing house with characteristic 'z' and with constant returns to scale. Let the input prices be given by 'r' so that the per unit cost is indicated as a function: c(r, z). If the producer offers a price of δ, then profit per house is:

$$\pi = \delta - c(r, z) \qquad (11.10)$$

Hence, the price required to realise a certain level of profit is given by $\delta(\pi, r, z)$. This is called the offer function which shows the price at which the producer is willing to offer the house.

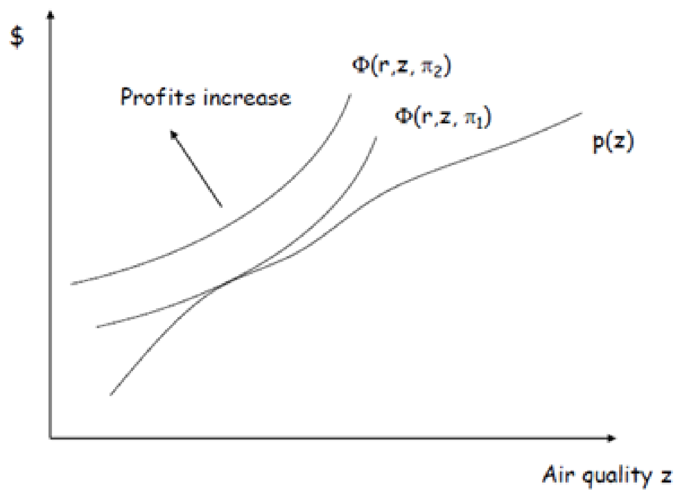


Fig. 11.3: Producers' Choice

Source: Kolstad, 2011.

Fig. 11.3 shows two offer functions for a single producer where the curve above is associated with higher profit (Π_2). Each offer function is increasing showing that the offer price increases as the quality of the house improves (i.e. in terms of location, air quality, amenities, etc.). The point of tangency of the offer curve touching the hedonic price line is the 'choice point'. At this point, the producer sells the house.

11.4.4 Market Equilibrium

From the above discussion, it is clear that each point on the hedonic price function is an outcome of tangency between the bid function of a consumer and offer function of a producer. Fig. 11.4 shows three consumer-producer pairs and three tangential points which are joined to get the hedonic price line showing combinations of z and p(z). Along this line, the slope of the offer function, slope of the bid function and the slope of the price line are all identical. Note that the slope of the price line shows the change in p(z) for a unit change in z. Hence, it shows the marginal price of z or air quality which is identical for producers, consumers and the market (all the three slopes being identical).

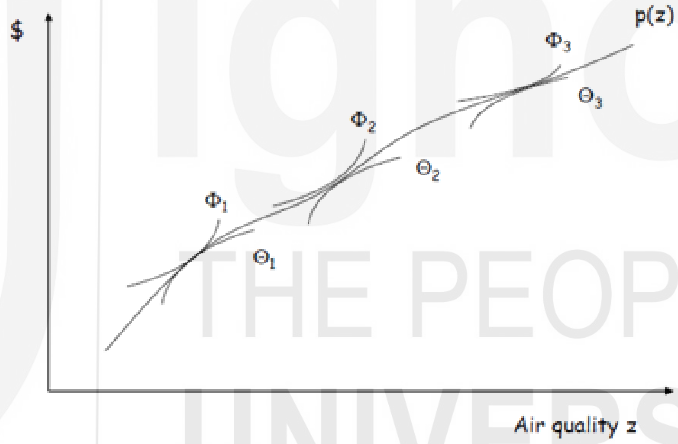


Fig. 11.4: Equilibrium in a Hedonic Market

Source: Kolstad, 2011.

11.4.5 Willingness to Pay (WTP)

The hedonic price function determined by the market forces shows how the price of a house varies with air-quality levels. It gives the marginal price of air quality at different levels of z. But it does not give a demand function (or the marginal willingness to pay) for the chosen characteristic i.e. air quality. We are interested in knowing an individual's marginal willingness to pay for one more additional unit of air quality. In Fig. 11.5, p'(z) is the slope of the hedonic price line (or the marginal price line) which is trending downward in z (i.e. price of the house falls as the air quality level rises or worsens). We have two marginal willingness to pay (MWTP) functions for the two different individuals considered. Each MWTP function shows how much the individual is willing to pay for different quantities of z which is sloping downward due to diminishing marginal utility. Intersection of MWTP function and the marginal price line determines the choice of z for the individual i.e. the households will choose z such that the demand curve intersects the hedonic price function. Till this point, the willingness to pay for the unit exceeds the price of the units.

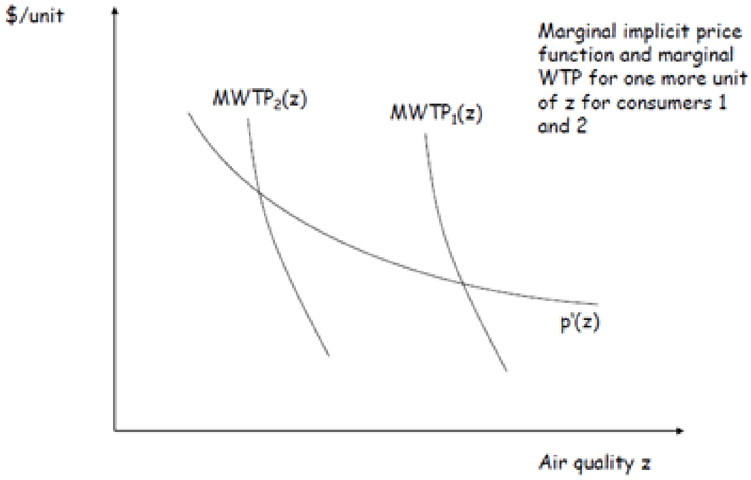


Fig. 11.5: Marginal Willingness to Pay for z
Source: Kolstad, 2011.

Hence, each point on the hedonic price function represents an intersection with the MWTP or demand curve of an individual. Such a demand curve is useful for welfare analysis and estimation of consumer surpluses.

11.5 EMPIRICAL APPLICATION

Having discussed the Hedonic Pricing Theory, we now take a look at how it is used empirically. Housing prices depend on several attributes: (i) structural attributes (e.g. number of rooms and bathrooms), (ii) environmental attributes (e.g. air quality, clean water availability, proximity to dumping yards) and (iii) locational attributes (e.g., proximity to schools and hospitals). The hedonic price function expresses housing prices by factoring these attributes. Using data on sale prices of various houses with differing characteristics, we can employ regression analysis to obtain the hedonic price function. Such a function can be linear or non-linear but we can differentiate the function with respect to any of these characteristic to get the implicit price function. For instance, in the first stage, we can get the implicit price of good quality water. In the second stage, the implicit prices can be regressed on actual quantities of water consumed by households and other characteristics. This will give the marginal willingness to pay for water. Basically, this is the price-quantity relation or the demand curve which traces the individual or household's willingness to pay for extra unit of water or extra quality water. Such a demand curve or willingness to pay curve will differ across households due to difference in income and other characteristics.

Application of HPM requires data on housing prices and other characteristics of housing. Moreover, it is based on the assumption that households have perfect information which may not be true. The housing market may not be in perfect equilibrium as high transaction costs would discourage households from relocating to other desirable locations. Additionally, the characteristics of households may be collinear making estimation of hedonic price function difficult.

Check Your Progress 2 [answer within the space given in about 50-100 words]

1) Under what situations and to what purpose the method of TCM used?

....

....

....

....

....

2) State the formal theoretical expression with required explanations to bring out the consumer's utility maximisation problem under a theoretical framework.

....

....

....

....

....

3) In answer to question 2 above, modify the expression by accounting for the 'opportunity cost' involved.

....

....

....

....

....

4) State the problems or limitation of applying the TCM in practice.

....

....

....

....

....

....

5) Give an example of a situation where the HPM can be used. State how the HPM can accommodate the 'quality of air' as a factor in determining the housing price in the market.

....

....

....

....

....

6) Specify the utility maximisation function of a consumer with a component for hedonic price in it. How is the preference for desired 'air quality' accommodated into this function?

....

....

....

....

....

7) What does the 'offer function' indicate from a producers' standpoint? What is a 'choice point' and what is its significance in an illustrative housing market situation?

....

....

....

....

....

8) State the limitations of the HPM as applicable to the housing market.

....

....

....

....

11.6 LET US SUM UP

Valuation of environmental goods and services is a challenging task because of the non-existence of markets for such goods and services. However, in some cases, related markets exist. For instance, we can value clean air by using the idea that individuals are willing to relocate to localities having clean air. This is the idea behind the hedonic pricing method discussed in this unit. Another approach, based on related markets, is the travel cost approach. However, this approach cannot measure the existence value of the environment since for valuing the environment just for its existence, we do not have markets or related markets. In such cases, a hypothetical market is constructed and contingent valuation method is applied.

11.7 KEY WORDS

Revealed Preference Method : Under this method, preferences for environmental goods and services are inferred from observed behaviour in actual markets. For this purpose, markets closely related to the environmental goods are chosen.

Hedonic Pricing Method : Under the hedonic pricing method, keeping other things constant, we measure the price of housing for different levels of air pollution and see how the housing price changes due to change in air pollution.

Stated Preference Method : Under this method, individuals are directly asked to state their willingness to pay for the particular environmental good (e.g. contingent valuation method).

Contingent Valuation Method : In contingent valuation method, the individual is posed a set of questions directly asking him to reveal his willingness to pay for the good.

11.8 SOME USEFUL BOOKS AND REFERENCES

1) Callan Scott J and Janet M Thomas, Environmental Economics & Management: Theory, Policy and Applications, 5th Edition.

2) Kolstad Charles, D (2011). Intermediate Environmental Economics, Second Edition, Oxford University Press.

3) Thomas Callan (2007). Environmental Economics, Thomson Learning Inc. Indian Edition.

11.9 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) Under the SPM, people are directly asked to state their willingness to pay for the environmental good. Under the RPM, preferences for environmental goods and services are ***inferred*** from observed behaviour in actual markets.

2) They cannot measure the existence value. We need to go for 'constructed markets approach' in such cases.

3) Under the CV method, the individual is posed a set of questions directly asking him to reveal his 'willingness to pay' (WTP) for the 'good' (Section 11.2).

4) Defining the market scenario, choosing the elicitation method, etc. (Section 11.2).

5) Direct question method, bidding game method, etc. (Section 11.2)

6) One advantage is that it can be used to measure existence value. A disadvantage is that individuals may choose to free ride.

Check Your Progress 2

1) TCM is frequently used to value natural parks and recreation sites as well as assess the environmental damages caused.

2) Max U (x, v) such $wL = x + (p_0 + f)v$ (Sub-section 11.3.1)

3) $T = L + (t_t + t_v)v$. $V = g(p_v, y) = g(p_t + f, y)$ (Sub-section 11.3.1)

4) The most important problem is estimation of value of time (Sub-section 11.3.2).

5) Housing market (Sub-section 11.4.1).

6) Max U (x, z) such that $x + p(z) = y$ (Sub-section 14.4.1)

7) It shows the price at which the producer is willing to offer the house, to obtain a particular level of profit, given a particular value of input prices 'r' (Sub-section 11.4.2).

8) Assumption that households have perfect information, characteristics of households being collinear, etc. (Sub-section 11.4.2).

UNIT 12 GREEN ACCOUNTING*

Structure

12.0 OBJECTIVES

After reading this unit, you will be able to:

- define the term 'resource depletion';
- delineate the concept of 'natural resource cost' in terms of its 'depletion, degradation and protection' perspectives;
- explain the conventional 'System of National Accounts' in terms of its three approaches to estimating macroeconomic aggregates;
- distinguish between NI at Market Price and NI at Factor Cost;
- outline the four 'Types of Accounts' under SNA leading finally to the 'Accumulation Accounts';
- illustrate how the conventional SNA overestimates the GDP to suggest the 'requisite modifications' in SNA;
- distinguish between the concepts of 'produced economic resource' and 'non-produced economic resource';
- describe the recording mechanism followed in SEEA;
- state the two perspectives with which SEEA approaches to account for the contribution of environment to the economy; and
- indicate the 'sequence of economic accounts of SEEA' to reveal to what extent environment related activities are incorporated into its design.

* Dr. Rajeev Kumar, Assistant Professor, SRCC, DU, Delhi.

12.1 INTRODUCTION

Economy and environment interact with each other in the process of consumption, production and accumulation of goods and services. Environment is a key input in almost all economic processes. Environmental assets are the components found in the biophysical environment of the Earth like biological resources (fish, forests, etc.), mineral and energy resources (e.g. iron, coal, etc.) and soil and water resources. Such resources can be both renewable and non-renewable. Consumption of natural resources, at a faster pace than they can be regenerated is, however, a serious economic concern referred to as 'resource depletion'.

In spite of heavy dependence of our economic activities on environment, due recognition was not given to their inclusion in the conventional accounting practices of the 'system of national accounts' (SNA). In other words, SNA did not account for the depletion of natural resources in its estimation of GDP or GNP. Thus, the conventional system of national income accounting was incomplete. Owing to this recognition, of late there has been a growing concern for the measurement and incorporation of resource depletion in the SNA. There is a global consensus for treating the environmental resources as natural capital at par with physical capital.

In this context, 'Green accounting' or 'environmental accounting' aims at quantifying the contribution of both the marketable and non-marketable environmental assets in the estimation of GDP. The former i.e. 'environmental accounting' explicitly incorporates addition or depletion of all environmental assets into the capital account side of the national income equation. The present unit first examines the conventional system of national accounts from the perspective of sustainability and green accounting principles and then explains the alternative system i.e. the 'system of environmental economic accounting' (SEEA) approach to national income accounting.

12.2 COST OF DEPLETION AND DAMAGE OF NATURAL RESOURCES

As mentioned earlier, environment, directly and indirectly, plays a very important role in economic activities. Natural resources are vital for sustaining economic growth and development for current and future generations. Environment supports economic activities directly as a supplier of key material and non material inputs and indirectly through its positive effects on the productivity of the other factors of production. Environment supports economic activities in a number of ways. Millennium Economic Assessment (2005) classified the services rendered by environment into four broad categories:

i) Provisioning Services: This includes goods obtained from natural environment like water, food and mineral and non mineral inputs for economic activities.

ii) Regulating Services: This includes services like improving air and water quality, controlling flood and soil erosion, etc.

iii) Cultural Services: This includes non-material benefits like spiritual enrichment, recreation and aesthetic enjoyment, etc. derived out of environment.

iv) Supporting Services: This includes services that are necessary for the production of all other ecosystem services, including soil formation, photosynthesis, nutrient cycling and water cycling.

Environmental services to the economy have marketable and non-marketable components. Particularly the 'provisioning services' in the form of supply of environmental goods have market prices (e.g. timber and minerals). Most of the other benefits from environment in the form of regulating, cultural and supporting services are non-marketable in nature. The measures of economic activity under SNA (e.g. GDP, NDP, etc.) not only fail to capture all benefits of natural environment, but also do not account for the extent of the depletion and degradation of environmental resources. Natural resources are classified into two categories:

- Non-renewable Resources: Non-renewable natural resources are those resources which have a finite quantity and therefore get depleted over time with their use. These resources are extracted from the natural environment to support economic activities (e.g. fossil fuels, minerals, metals, etc.).

- Renewable Resources: Renewable natural resources are those resources which can regenerate or replenish themselves through natural environmental process (e.g. forests and fisheries). Though these resources are capable of being used repeatedly, they have a natural rate of replenishment. Therefore, excessive utilisation of these resources at a rate faster than their natural rate of replenishment eventually exhausts them completely.

Since natural assets are used in economic production, there is an environmental cost attached to it. This is the monetary value of the natural assets consumed in the process of production as inputs. We can view this natural resource cost of economic production from three different perspectives viz. resource **depletion** cost, environmental **degradation** cost and expenditure on environmental **protection**.

a) **Resource Depletion Cost:** When the natural resources are used at a rate faster than their natural rate of replenishment, there is a risk of their depletion to extinction over time. So the cost of resource depletion is attached, with the pace (i.e. rate of growth) of their usage in the current economic activities (e.g. environmental cost of cutting trees, extracting minerals and water, exploiting biotic resources, etc.).

b) **Environmental Degradation:** Environmental degradation occurs in the process of production, distribution and consumption by businesses, households and government. Environment is polluted and degraded, in the course of all economic activities (e.g. direct and indirect environmental cost of air pollution, water pollution, soil pollution).

c) **Expenditure on Environmental Protection:** Natural resource depletion and degradation being a universal phenomenon, it has of late become a common fact that significant amount of expenditure is incurred on environmental protection in most of the countries in the World. Such expenditures on environmental preservation, protection and improvement confirms the seriousness with which the mankind has come to regard the societal cost of environmental depletion and degradation.

12.3 SYSTEM OF NATIONAL ACCOUNTS (SNA)

The 'system of national accounts' prescribes a set of international standards of accounting procedures aimed at estimating the value of economic activities in an economy in an accounting year. It provides a comprehensive conceptual and accounting framework for the estimation of macroeconomic data. This comprises of four type of macroeconomic aggregates viz. gross domestic product (GDP), net domestic product (NDP), gross fixed capital formation (GFCF) and depreciation of capital assets.

SNA merely records the market value of the output from various sectors in the economy as positive contributions to GDP. In doing so, it disregards the contribution of natural capital by failing to take into account the environmental degradation and depletion of natural resources. More specifically, the SNA does not account for the number of trees felled, soil fertility affected, water resources depleted and polluted, etc. Hence, assessment on the economic progress of a nation, obtained under the SNA framework, is always an overestimate. In other words, the macroeconomic estimates obtained by SNA presents a misleading picture of the development ignoring the detrimental effects of environmental degradation. Quite often, the damage caused to the environment may be totally irreversible or may impose such a high cost needing to be borne not only by current generation but also by future generations. Under the SNA, the gross domestic product (GDP) is measured by three approaches viz. the product method (or the output or the 'value added method'), the income method and the expenditure method. Estimates of GDP are calculated by two approaches viz. (i) at market prices and (ii) at factor cost.

Product Method or Value Added Method: Under this, the 'gross domestic product at market price' is obtained as the sum of gross value added of all the sectors of the economy i.e.:

$$GDP_{MP} = \sum GVA_i \quad i = 1,2,3,\ldots,n, \qquad (12.1)$$

where, GVA_i for the i^{th} sector is calculated as:

$$GVA_i = \text{Value of Final output} - \text{Intermediate Consumption} \qquad (12.2)$$

The term 'intermediate consumption' used in Equation 12.2 above, is the same as the total value of 'inputs'. Then, the 'net domestic product' (NDP) at MP is obtained as:

$NDP_{MP} = GVA_{MP}$ – Depreciation of Capital (or consumption of fixed capital assets) (12.3)

Thus, in the SNA approach of estimation of NDP from GDP, it includes the depreciation of recognised capital assets but fails to include the cost of degradation/depletion of non-marketable environmental resources (i.e. natural capital) in the production process. Thus, the estimation procedure under SNA is incomplete to this extent leaving scope for modification and improvement.

Expenditure Method: In the expenditure method, GDP is estimated as the sum total of expenditure incurred on goods and services, either consumed or produced, during one year in a country. It measures the GDP at market prices during a year as:

GDP = Private Final Consumption Expenditure (C) + Gross Domestic Capital Formation (I) + Govt. Expenditure (G) + Net Exports (X–M) (12.4)

i.e. $GDP_{MP} = C + I + G + (X–M)$ (12.5)

Expenditure on capital formation [i.e. gross domestic capital formation (GDCF)] includes expenditure on construction of houses, factory, machinery, plants, etc. The letter 'I' appearing inside the brackets of GDCF refers to 'inventory accumulation' from which inventory de-accumulation is deducted. More specifically, 'expenditure on inventory' is calculated as the difference between the 'closing and opening stock' of unsold finished goods, semi finished goods and raw materials. The GDCF and NDCF are, therefore, calculated as:

GDCF = Gross Domestic Fixed Capital Formation (GDFCF) + Net Inventories + Net Acquisition of Valuables (NAV) (12.6)

NDCF = GDCF – Depreciation (12.7)

Income Method: By this method, GDP is estimated by summing up the incomes received by the owners of factors of production in a country in an accounting year in the form of wage, rent, interest and profit. This method estimates national income at factor cost (because the payments to factors of production is the factor cost of firms) as:

GDP_{FC} = Wages and Salaries + Rents + Interest + Mixed Incomes + Dividends + Undistributed Corporate Profits + Corporate Income Taxes (12.8)

Note that if 'net factor income from abroad' is added in the RHS of (Equation 12.8), it becomes GNP and that the right hand side of (Equation 12.8) comprises of the following:

i) Compensation of employees which includes wages, salaries and contributions to social security schemes;

ii) Rent on land, building and equipments;

iii) Interest on capital; and

iv) Profits to entrepreneurs (i.e. dividends, undistributed profits and corporate income taxes).

Thus, in this approach all incomes generated from recognised economic activities are added up ignoring the fact that a substantial part of such income has been obtained by degrading non-marketable natural assets. Thus, there is no account for the cost of damage or depletion of non-marketable environmental assets.

12.3.1 Distinction between NI at Market Price and NI at Factor Cost

The first two methods of computation, given in Equations 12.1 and 12.5 above, estimate the macroeconomic aggregates at market prices. So there is an upward bias in the estimation (through value added method and expenditure method) because of the presence of indirect taxes and subsidies which get assimilated in the market value of the final goods and services. Indirect taxes and subsidies alter the prices of commodities. However, the extent of change in the prices after indirect taxes and subsidies depends upon a number of factors. Imposition of indirect taxes usually causes a rise in the market prices of goods and services. On the other hand, extension of subsidies usually leads to reduced prices of the goods and services. Hence the values of GDP, GNP and NNP we arrive at tend to be exaggerated in the case of indirect taxes and depressed in case of subsidies. For a true estimation of the national income, we need to estimate that part of NNP_{MP} which actually accrues to the factors of production. This needs us to make a distinction between the estimates of NI made at market prices from the estimates made at factor cost. This is because revenue from indirect taxes goes to the government while subsidies benefit owners of factors of production and consumers at the cost of government. Clearly, to calculate the GDP at factor cost, indirect taxes need to be subtracted and subsidies need to be added in the GDP at market prices. Thus:

$$\text{GDP at factor cost} = \text{GDP at market prices} - \text{Indirect taxes} + \text{Subsidies} \qquad (12.9)$$

Likewise, NNP at factor cost is estimated as:

$$NNP_{FC} = NNP_{MP} - \text{Indirect taxes} + \text{Subsidies}$$

$$= NNP_{MP} - (\text{Indirect taxes} - \text{Subsidies})$$

$$= NNP_{MP} - \text{Net indirect taxes}$$

Thus, the conventional national accounting (the SNA) measures capital consumption (i.e. the 'wear and tear') of fixed assets such as buildings or machinery as a part of the cost of production. Natural resources are used as intermediate inputs in the production process and environment is used to dispose of 'emissions and wastes'. But the SNA neither accounts for the former nor recognises the latter. The role of environment in absorbing the emissions/wastes as a non-tradable common property resource (due to lack of well defined accounting practices or property rights) is a lacuna of the SNA. Thus, the above definitions of the GDP/NDP/GDCF/NDCF in SNA overestimates the 'net fixed capital formation' (NFCF) by not accounting for the depletion/repletion of non-marketable natural assets and damage to environment. In other words, GDCF and NDCF, like other macroeconomic aggregates (GDP, GNP, NDP and NNP), are incomplete and do not present a real picture of the genuine capital accumulation or depletion in an economy.

12.3.2 Types of Accounts under SNA

In the SNA classification, there are four types of accounts together leading to the 'accumulation accounts'. These are:

a) **Capital Account:** This records acquisitions and disposals of: (i) 'non-financial assets' as a result of transactions with other units, (ii) internal bookkeeping transactions linked to production (e.g. changes in inventories, consumption of fixed capital) and (iii) the redistribution of wealth by means of capital transfers.

b) **Financial Account:** The financial account records acquisitions and disposals of financial assets and liabilities. Such transactions are shown in the SNA on the left-hand side of the equation, if the transaction has resulted in a net acquisition, or on the right-hand side, if the transaction has resulted in net incurrence of liabilities.

c) **Revaluation Account:** The revaluation account records changes in the values of assets and liabilities that results from changes in their market prices.

d) **Other Changes Account:** This is a record of changes in the amounts of volume of assets and liabilities held by institutional units or sectors as a result of factors other than the above stated explicit transactions (e.g. destruction of fixed assets by natural disasters).

Finally, the 'accumulation accounts' records the flows affecting the entries in the balance sheets 'at the beginning and end of the accounting period'. The capital and financial accounts being meant to record changes in 'assets, liabilities and net worth' due to savings and capital transfers, the balancing item of the financial and capital accounts are net-lending or net-borrowing items. These two (i.e. net-lending or net-borrowing) are measured identically in both the capital and financial accounts.

12.3.3 Requisite Modification in SNA: Illustrations

The SNA does not recognise the importance of non-marketable natural resources not only as a source of inputs to generate output but also as a final destination for residual wastes and emissions arising out of the economic activities. This is mainly because, till recently, such natural resources were treated as non-tradable. They were hence considered as 'common property resources'. Hence, no explicit pricing system was thought of for such resources. For instance, the role of forests was recognised in markets for timber, honey, medicinal plants, etc. but not for absorbing emissions, purifying air, controlling flood etc. That is, the former set of activities entered into the SNA but the latter set got left out. As a consequence, the estimated value of net domestic product (NDP) and net national product (NNP) in SNA was net of the depreciation of produced capital but not for the depreciation of natural assets. Thus, the estimated values of macroeconomic aggregates were overestimated.

A part of increase in the national income was due to the erroneous recording of expenditure incurred on damaging the natural environment and ecosystem. For instance, SNA recorded the expenditure incurred on cutting and clearing forests for construction of a highway but did not record the loss of multiple social benefits from the ecosystem by the loss of forests by suitable discounting. Likewise, estimates obtained under SNA accommodated for the depreciation of produced capital assets in the form of 'consumption of fixed capital' (CFC) assets but failed to do the same for natural assets. For instance, soil gets degraded due to repeated use in the process of cultivation. SNA records the value of agriculture output in GDP but does not discount for the value of degradation of soil. Another example is of how the transport sector's contribution is added into GDP without accounting for the damage to the environment that the sector causes through pollution.

Environmental degradation and depletion of natural assets have adverse distributional consequences for poor people residing in underdeveloped regions. Poor people depend heavily on natural resources and environment not only for their livelihood but also for many of their daily needs. So when environment deteriorate, they are the worst hit. Apart from this, the gap between developed and underdeveloped regions widens due to environmental degradation. Deteriorating environment thus has the potential to cause inter-generational inequity in the distribution of resources. In other words, forthcoming generation is likely to suffer more if left with poor quality of environment. It is thus clear that a higher GDP estimated through rampant exploitation of natural resources is not only qualitatively poor but also reduces the production potentialities of an economy in the subsequent years.

In view of the above, monetary value of the resource depletion cost, environmental degradation cost and expenditure on environmental protection needs to be estimated and incorporated into the system of national accounts (SNA) to make it account for the loss of natural capital. In other words, SNA is incomplete and there is a need to use the 'green accounting approach' to capture the true income of an economy. The 'system of environmental economic accounting' (SEEA) plugs the loopholes of the traditional system of accounting to which we shall now turn to discuss.

Check Your Progress 1 [answer within the space given in about 50-100 words]

1) Define the term 'resource depletion'.

....

....

....

....

....

....

....

2) What are the three perspectives in respect of which the cost of 'depletion and damage to natural resources' are viewed at? Which one of these indicates the seriousness of mankind to the societal loss due to environmental damage?

....

....

....

....

....

3) Do you agree that the estimates of GDP by conventional SNA presents an overestimate of the economy's real value? Why?

....

....

....

....

....

4) What are the four types of 'accounts' recorded in the SNA? From these, how is the final 'accumulation account' prepared?

....

....

....

....

5) Give two illustrations to indicate how the SNA does not account for the depreciation of natural resources.

....

....

....

....

6) Do you think that the conventional SNA contributes to growing inequity within the economy? How?

....

....

....

....

....

12.4 SYSTEM OF ENVIRONMENTAL ECONOMIC ACCOUNTING (SEEA)

The System of Environmental-Economic Accounting (SEEA) is a multipurpose conceptual framework for describing the interaction between the economy and the environment along with changes in the stock of environmental assets. Utilising a systems approach to organising environmental and economic information, it comprehensively covers the stocks and flows relevant to the analysis of environmental and economic issues. Its Central Framework is interdisciplinary integrating the perspectives from different disciplines (e.g. economics, statistics, energy, hydrology, forestry, fisheries and environmental science).

12.4.1 Stocks and Flows of Economic Assets

Economic assets can be classified into two categories viz. produced economic resource (e.g. buildings and machines) and non-produced economic resource (e.g. land, mineral resources and water resources). These provide inputs for production of goods and services and hence are a source of wealth or asset for households, businesses and government. An important aspect of the stock of both the type of economic assets is that their value and quantity change over time. Hence, SEEA treats them as flows and records them as transactions (e.g. the acquisition of buildings and land) within the economy i.e. as product flows of additions or deletions to the stock of fixed assets. Likewise, non-produced assets are recorded either as flows into the production boundary (e.g. discoveries of mineral resources) or as losses outside the production boundary (e.g. loss of timber resources due to fire). Thus, environment being the source of all natural inputs to the economy are recorded as 'natural inputs' and their depletion is recorded as 'reverse flows and wastes' released as residuals from the economy to the environment (e.g. solid waste, air emissions, pollutant flows into the water). SEEA gives a holistic treatment to environmental stocks and flows by recording the stocks of environmental assets in both physical and monetary terms. In this, the stock of environmental assets in an economy is treated to include both the living and the non-living components that constitute the biophysical environment (including the ecosystems within which they are located). The Central Framework of SEEA is thus a three dimensional measurement of environment comprising of:

a) the physical flows of materials and energy (both within the economy and between the economy & environment);

b) the stocks of environmental assets and changes in them; and

c) economic activities and transactions related to the environment.

12.4.2 Two Perspectives of Environmental Assets

In the SEEA central framework, environmental assets are considered from two perspectives. In the first, SEEA focuses on the individual components of the environment that provide inputs and space to all economic activities (i.e. mineral and energy resources, timber resources, water resources and land). In other words, SEEA focuses on such components of the environment which give material benefits through their direct usage as inputs in the economic activities (Fig. 12.1).

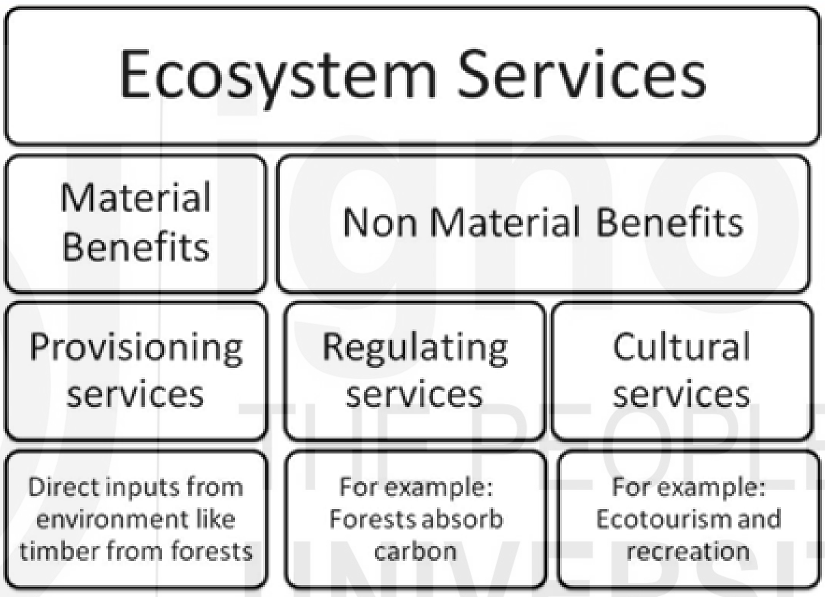


Fig. 12.1: Ecosystem and its material and non-material benefits

Second, in an attempt at 'experimental ecosystem accounting', SEEA covers the interactions between environmental assets and the broad set of ecosystem services comprising of both the biotic and the abiotic (non-living) components of environment (e.g. marine, forests, deserts, etc.). Such 'ecosystem accounting' focuses on the services provided by the environment in three main streams:

a) provisioning services (direct inputs from environment like timber from forests);

b) regulating services (for example trees helps us by absorbing

c) cultural services (for example ecotourism).

Fig.12.2 depicts how the ecosystem services are interwoven between economy, inputs for economic activities by environment and services of residuals absorption rendered by the environment.

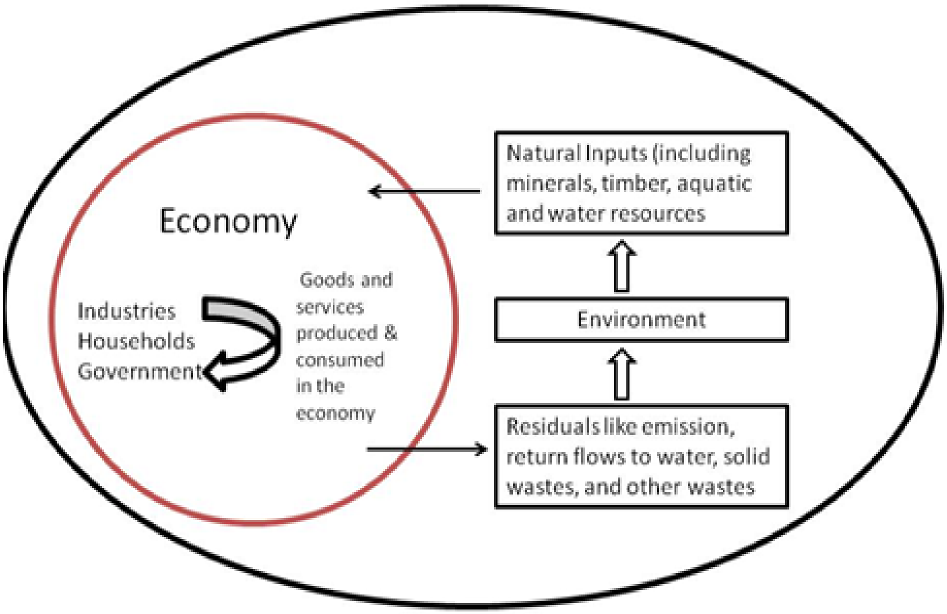


Fig. 12.2: Physical flows of natural inputs, products and residuals

Source: UNSTATE SEEA Central Framework (2012).

12.4.3 Incorporation of Environment Related Activities

SEEA Central Framework not only measures stocks and flows of environmental assets but also records flows associated with the economic activities related to the environment. For instance, expenditures incurred on environmental protection and natural resource management, designing and production of environmental goods and services (such as techniques and equipments to reduce air pollution, etc.) are separately identified and presented in what are known as 'functional accounts'. It can be referred to as 'environmental protection expenditure accounts'. Besides this, the SEEA Central Framework provides a more complete picture by taking into account the environmental taxes, environmental subsidies, etc. Thus, the Central Framework integrates the accounting of various stocks and flows of the economy and the environment in four distinct accounts viz. the (i) production account, (ii) income account, (iii) capital account and (iv) financial accounts (Table 12.1).

Table 12.1: Sequence of Economic Accounts in SEEA

Production Account	
Main entries	Output, intermediate consumption, consumption of fixed capital, depletion.
Balancing items/aggregates	GVA, GDP, depletion-adjusted NVA, depletion-adjusted NDP.
Income Account	
Main entries	Compensation of employees, taxes, subsidies, interest, rent, final consumption expenditure, consumption of fixed capital, depletion.

Balancing items/aggregates	Depletion-adjusted net operating surplus, depletion-adjusted net national income, depletion-adjusted net savings.
Capital Account	
Main entries	Acquisitions and disposals of produced and non-produced assets.
Balancing items/aggregates	Net lending/borrowing.
Financial Account	
Main entries	Transactions in financial assets and liabilities.
Balancing items/aggregates	Net lending/borrowing.

Source: UNSTAT SEEA Central Framework, 2012, Page 22.

Check Your Progress 2 [answer within the space given in about 50-100 words]

1) Distinguish between produced economic resource and non-produced economic resource.

....

....

....

....

....

2) State the three dimensional framework for measurement of environment under SEEA.

....

....

....

....

....

3) What are the three main streams of services provided by environment as accounted under the SEEA?

....

....

....

....

....

4) What are the four distinct heads of accounts maintained under the Central Framework of SEEA for accounting the various stocks and flows of the economy and the environment? What are its internal entries and balancing aggregates?

....

....

....

....

....

12.5 LET US SUM UP

Environment is beneficial to mankind in an unimaginably large number of ways both directly and indirectly in which the invisible benefits from environment surpasses the visible material benefits. Environmental resources are not only key ingredients in economic activities but they also serve as absorbers of residuals. Many of the environmental resources are non-renewable and therefore deplete due to their usage. Many others can be replenished (or reinvigorated) but at a very huge cost unaffordable to a single generation. In the pursuit of material welfare and in the absence of adequate accounting procedures for them, environmental resources are being exploited inefficiently by successive generations. The conventional system of national accounting (SNA) included only the positive contribution of the tradable environmental resources ignoring the immediate and prospective harmful effects of the exploitation of natural resources. System of environmental economic accounting is an upgraded system of national income accounting which while retaining the components of SNA has adequately addressed the issues of environmental depletion and deterioration converted into value terms.

12.6 KEY WORDS

Natural Assets : Natural assets are provided to us by the nature. These include air, soil, water, forests, biodiversity, minerals, etc.

Produced Assets : Produced assets are those which are generated by mankind by using natural and other resources and technology.

Non-produced Assets : Non produced assets are supplied to us by nature free of cost. They include all natural assets.

Marketable Environmental Assets : Marketable environmental assets are those natural assets which can be traded in the market (e.g. timber, medicinal plants, minerals and natural gases, etc.).

Non-Marketable Environmental Assets	:	Non-marketable environmental assets are non tradable natural assets. They cannot be sold and bought in the market because they are common property resources (e.g. river, wildlife, air, groundwater and glaciers, etc.).
Biotic Natural Resources	:	Biotic natural resources are either gathered from the biosphere or may be grown by mankind (e.g. vegetables, birds, trees, plants, algae, worms, etc.).
Abiotic Natural Resources	:	Abiotic resources are non-living objects found in the biosphere (e.g. minerals, water, air and energy resources like petrol, diesel, etc.).
Ecosystem	:	Ecosystem refers to coexistence and mutual interaction of living organisms and non-living components in the natural environment as a system.

12.7 SOME USEFUL BOOKS AND REFERENCES

1) Harris, J.M. and B. Roach (2014). *'Environmental and Natural Resource Economics: A Contemporary Approach,'* 3rd Edition, Routledge.

2) Kolstad, C. (2012). *'Intermediate Environmental Economics'*, Oxford University Press, 2nd edition.

4) Partha Dasgupta (2007). *'Measuring Sustainable Development: Theory and Application,'* Asian Development Review 24(1): 1-10.

5) Roger Perman, Yue Ma, Jmes McGilvray and Michael Common. *Natural Resource and Environmental Economics*, Pearson Education/Addison Wesley, 3rd edition (2003).

6) UNSD (2012). *'System of Environmental-Economic Accounting (SEEA) Central Framework'*.

7) World Bank (2011). *'The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium,'* Washington.

12.8 ANSWERS/HINTS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) Consumption of renewable resources at a rate faster than its rate/pace of regeneration is termed as 'resource depletion'.

2) Resource depletion cost, environmental degradation cost and expenditure on environmental protection. Of these three, the 'expenditure on environmental protection, which has since become a global point of

action, indicates the concern of mankind to the 'societal loss' on account of environmental damage.

3) Yes. Because, by ignoring the cost of natural resource depletion and environmental degradation, the cost of restoring these, so as not to disturb the inter-generation equity, is not accounted in the SNA.

4) The four types of account are: capital account, financial account, re-evaluation account and other changes account. From these, the final accumulation account is prepared by balancing the financial and capital accounts with the components of net borrowing and lending.

5) Cost of cutting trees for constructing highways is recorded but the loss to the society for absorbing emissions, purifying air, controlling floods, etc. is not accounted. The transport sector's contribution to GDP is accounted but not the damage the sector causes to environmental quality by pollution emitted.

6) Within the economy, the poor live in unhealthy surroundings. Hence, air pollution effects, impure water supply consequences, etc. are borne by the poor at a far greater personal loss. Between the developed and the under-developed regions within an economy, environmental degrades accentuates the gulf between the two regions. Cumulatively, over time, it has the potential to cause inter-generational inequity in the distribution of resources.

Check Your Progress 2

1) Buildings and machines are produced economic resource. Land, minerals, water, etc. are non-produced economic resource. The former is man-made and the latter is nature given.

2) (a) The physical flows of material and energy, both within the economy and between economy and environment; (b) the stocks of environmental assets and changes in them; and (c) economic activities and transactions related to the environment.

3) The three streams of services are: provisioning services, regulating services and cultural services.

4) The four accounts are: production account, income account, capital account and financial account (Table 12.1).

ignou
THE PEOPLE'S
UNIVERSITY