ASSESSING BENEFITS FOR ENVIRONMENTAL DECISION MAKING

INTRODUCTION

Dear friends, in this module we shall examine the conceptual issues, the approach to measuring environmental benefits, and the estimations of benefits and understand that how assessment of benefits are helpful in decision making.

We have seen that the environmental policy is guided by risk assessment and risk management, and they play a pivotal role in decision making process. The matter of concern is that once the degree of environmental risk has been identified then the public official begin to formulate policy. And the aim of such policy is to minimize the risk and that is the benefit to the society. Attaining this objective involves opportunity costs. The policy makers would think in terms of opportunity cost in the sense the use of resources to control risk of one type, has cost in terms controlling other risk i.e. resource used to reduce smog are no longer available to improve public education. It is different for policy maker to gain grips with suck decision making. However there are strategies that can be effective in environmental policy development and one such is, benefit cost analysis.

We must remember that benefit cost analysis is based on basic principle of economics, i.e. rational people think at the margin in the sense that they balance the variables which they deal with, e.g. balancing cost and benefit at margin to maximize what they aim at, could be utility, profit or welfare. In this respect the cost-benefit analysis is useful to evaluate the associated gains and losses to society. A policy maker gets efficient solution result when cost and benefit are equal at margin.

The policymakers can use cost-benefit analysis as a guide to environmental decision only. When they can quantify the associated social costs and benefits. However, some intangibles that are difficult to quantify such as longevity of human life, improved aesthetics and the preservation of ecosystems. The process is difficult but critically important.

(1) ENVIRONMENTAL BENEFITS: CONCEPTUAL ISSUES

For assessing policy - induced environmental benefits, we need to have the appropriate level of analysis. As we have seen that health and ecological gains can be assessed as damage reduction. The changes in damage reductions by relevant measure brought about by policy are called incremental benefits.

(a) Identifying Incremental Benefits

Incremental benefits are the reduction in health, ecological and property damage associated with an environmental policy initiative. They can be brought about by policy changes. The focus here is a change and not in absolute level. Economic theory takes in to account the effects that occur at the margin, of course. They are changes but are measured at a point. When the relevant change is over discrete ranges it is referred to as incremental rather than marginal. Because policy evaluation is concerned with identifying damage reductions over some discrete time period, the appropriate measure of benefits is incremental.

In order to identify incremental benefits, the analysts must compare the actual or expected benefits to society after some policy is implemented to a baseline measure of current conditions. Environmental benefits have categories, like improvements in human health, aesthetics, the economy, recreation, property and the ecology.

There are two types of incremental benefits in terms of damage-reducing effects; *primary environmental benefits and secondary environmental benefits*. The former is a damage-reducing effect that is the direct consequence of implementing policy, for e.g. a lower incidence of respiratory ailments, more prosperous fishing industry resulting from clean water regulations. The later is an indirect gain to society associated with policy implementation. This benefit comes through the simulative effect of a primary benefit, e.g. increase in worker productivity resulting from the primary benefits of improved health.

(b) Conceptually valuing Environmental Benefits

The value of reduction in environmental damage to the society as well as cleaning up hazards waste site can be dealt with by assuming. Such reduction in damage i.e. value to the society assuming as a private good traded in the open market. If this is so, then the demand price would convey the marginal benefit of each additional unit of the good. The problem is that environmental quality is public, non-marketed good. The absence of prices and the dilemma of non-revelation of preferences caused a determination of how society values a cleaner environment. In theory if we could infer society's demand for environmental quality. We could then measure the incremental benefits of environmental policy.

To illustrate this we shall take in to account the model of air quality based on SO_2 pollution abatement. Since the demand for this public good, represents society/s decision, it is both the marginal private benefit (MPB) and the marginal social benefit (MSB) of air quality. Thus, we can refer to the demand for SO_2 abatement as MSB = 25-0.3A, where MSB is measured in millions of dollars, and A is the percentage of SO_2 abated.

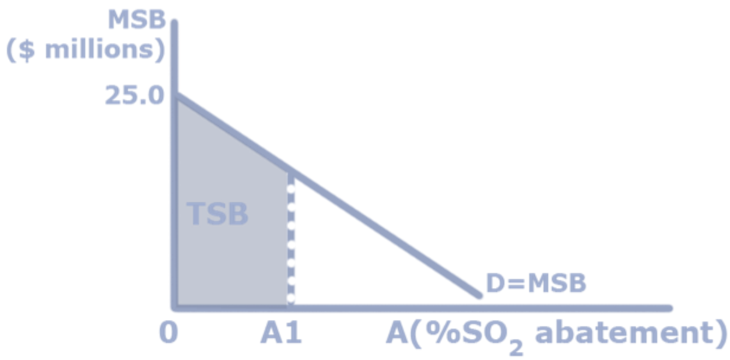


Figure - 1 Marginal Social Benefit (MSB) and Total Social Benefits (TSB) as Air Quality

The graph of this relationship is shown in this figure. At each level of abetment, MSB is measured as the vertical distance from the horizontal axis up to the demand curve. The total social benefit (TSB) for any abatement level are measured as the aggregation of 'these vertical distances or the area under the MSB curve up to that point. In figure, the TSB for some hypothetical abatement level A_1 are shown as the shaded area under the demand curve up to A_1 using this model, we can measure the incremental benefits from a policy induced increase in SO_2 abatement in three steps :

1. Find the baseline level of TSB before the policy is undertaken

2. Find the new level of TSB after the policy is implemented

3. Subtract the baseline TSB from the post-policy TSB.

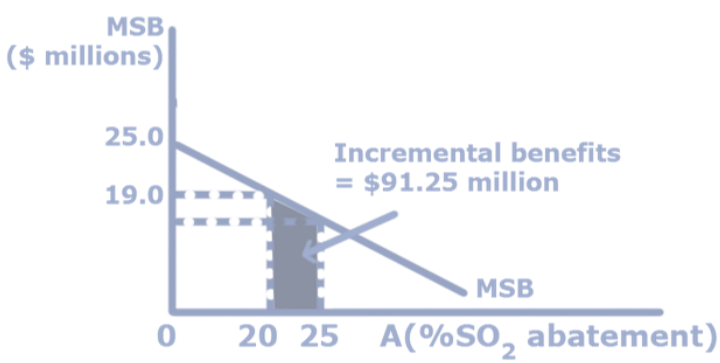


Figure 2 Modeling Incremental Social benefits for Air Quality using the MSB Function.

Suppose that the current level of SO_2 abatement is 20 percent, and the object is to find the incremental benefits of a policy that increases abatement to 25 percent. How should this be measured? First find the baseline. TSB. Notice that the MSB at the 20 percent abatement level is $19 million. The TSB at this level are shown as the area under the MSB curve up to that point, or $ 440 million. This value represents society's *Willingness to pay (WTP)* for the benefits achieved when 20 percent of SO_2 emissions are abated. If a policy increased SO_2 abatement to 25 percent. MSB would be $ 14.5 million and TSB would rise to $ 531.25 million. These incremental benefits are difference between the two TSB values or $ 91.25 million, shown as the shaded area under the MSB curve between the two abatement levels.

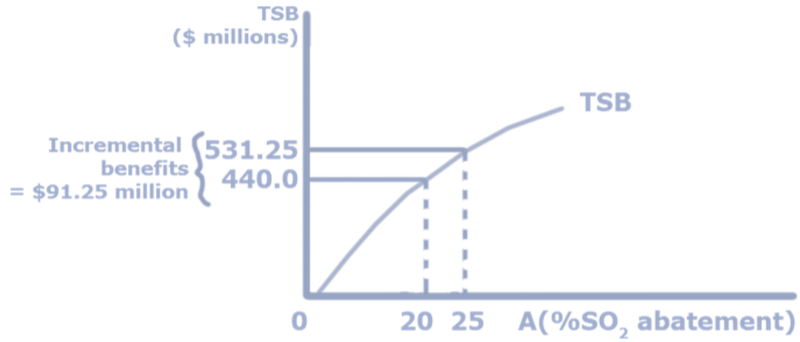


Figure -3 Modeling Incremental Social Benefits for Air Quality using the TSB function

An alternative model of the same result is shown above in figure - 3 where TSB are graphed directly with SO_2 abatement. At each abatement level, the TSB are shown as the vertical distance from the horizontal axis up to the curve. The TSB for the 20 percent baseline abatement level, and for the 25 percent post policy abatement level are $ 440 million and $ 531.25 million respectively. Incremental benefits are shown as the vertical distance between the two points on the TSB curve or $ 91.25 million.

(c) User versus Existence Value

User value means benefit derived from physical use of or access to an environmental good. Existence value means the benefit received from the continuance of an environmental good.

In the absence of market price it is difficult to know the values that society attaches to good. The value of a good like clean water or air is difficult to quantify because of the many intangibles involved. However economists recognize that some intangibles are measurable, by getting sense that how society perceives the benefits of environmental quality. Conceptually, the two sources of value given above i.e. user value and existence value enable us to measure society's total valuation of an environmental good, which can be expressed as:

Total value of environmental quality = user value + Existence value

(1) User value

User value could be direct or indirect, depending on whether the individual physically consumes it or gets utility by observing it. If a person is using lake for swimming then it is a direct value to him for lake, but if he is looking a view of lake then it is indirect use of it and that is indirect value. Thus *direct user value* is the benefit derived from directly consuming services provided by an environmental good. And indirect user value is the benefit derived from indirect consumption of an environmental good. Both direct and indirect user value are elements of society's total valuation of environmental quality.

(2) Existence Value

The very existence of natural resources and the creations of nature are the sources of value to the society. In such circumstances, benefits accrue to society from simply knowing that there resources exist and are being preserved. This component of total valuation is referred to as existence value. The existence value is an important motivation for privately funded conservation efforts and for many environments policy initiative. Endangered species Act, which provides for the protection and preservation of animals, birds, plants and fish threatened with extinction.

Mitchell and Carson (1989), valuing public goods, classify the motives for existence value as *vicarious consumption* and *stewardship*, among others. *Vicarious (indirect) consumption* refers to the notion that individuals value a public good for the benefits it provides to others. This suggests that the utility derived is interdependent, which means that an individual can receive benefit from the knowledge that others are enjoying the public good. *Stewardship* arises both from a sense of obligation to preserve the environment for future generations and from the recognition of the intrinsic value of natural resources.

Total value	=	User value	+	Existence value
		(Direct and		(vicarious consumption
		Indirect use		and stewardship value)
		Value)		

Recognizing how society values an environmental resource is important for identifying the social benefits of a policy proposal and deciding which estimation method might be most effective in quantifying those benefits.

(2) APPROACHES TO MEASURING ENVIRONMENTAL BENEFITS AN OVERVIEW

Economists have made serious efforts in developing methods to estimate the benefits of environmental quality improvements. These methods are aimed at estimating primary benefits and they consider secondary benefits estimation as an insignificant. Smith and Krutilla (1982) have put the measurement techniques in to two broad categories; (a) Physical Linkage approach and (b)the Behavioral Linkages approach.

(a) Physical linkage Approach

This approach measures benefits based on a technical relationship between an environmental resource and the user of that resource. A common estimation procedure that uses this approach is the damage function method. This method uses a functional relationship to capture the link between a continental and any associated damages, using this function, incremental benefits are measured as the deduction in damages arising from policy Induced decreasing in the contaminant. This damage reduction is then monetized to obtain a dollar value of the benefits brought by the policy.

(b) Behavioral linkage Approach -

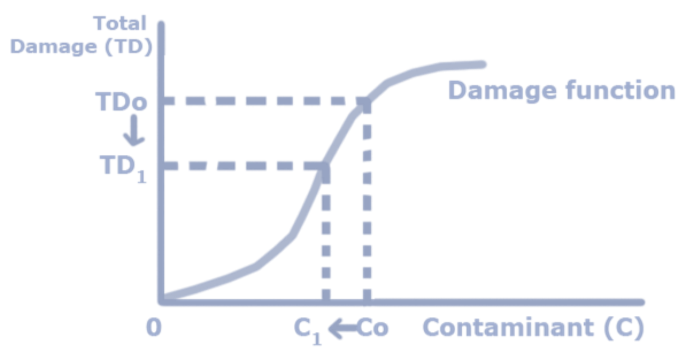
This approach estimates benefits using observations of behavior in actual markets or survey responses about hypothetical markets for environmental goods. Techniques that assess responses immediately related to environmental changes broadly termed direct methods. Two types of direct methods are the political referendum methods, which relies on actual market information, and the contingent valuation method (CVM), which uses hypothetical market data. Indirect methods are those that examine response not about the environmental good itself but about some set of market-conditions related to it. They are,

(1) averting expenditure method (AEM) the (2) Travel cost method (TCM) and the hedonic price method (HPM)

(3) ESTIMATION UNDER THE PHYSICAL LINKAGE APPROACH

(a) Damage Function Method

This method models the relationship between a contaminant and its observed effects to estimate damage reductions arising. From policy. An example of damage functions is shown in figure - H.



The contaminants (c) is measured on horizontal axis and the total damage (TD), on vertical axis. A policy initiative is expected to reduce the contaminant from C_0 to C_1. Based on this model, the proposal would reduce damage by vertical distance between T_{DO} and T_{DI} If, for example, the damage reduction was diminished injury to wheat crops, and this vertical distance might be measured as thousands of bushels of wheat. This could be monetized by multiplying the number of bushels by the market price.

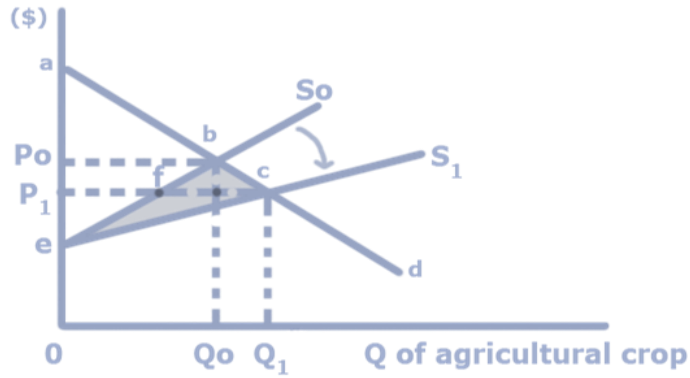
(i) Assessing the damage function method.

This method is useful but it has limitations. First, it estimates only one aspect of incremental benefits. It does not take in to account other crops and its consequences by also positive effect on human health. Second, the procedure is only a first step approach in that it is not capable of simultaneously monetizing the benefits it quantifies.

(ii) Applications of the Damage Function Method

Analysts typically use this function for measuring a specific type of incremental benefit, not for general benefit assessment and the context is often one in which market determined prices are available to monetize the gain.

We shall take an illustration of clean air, i.e. reducing ozone in the lower atmosphere. According to scientific evidence one type of associated benefit is an increase in crop yields conceptually,



such agricultural benefits could be modeled by measuring the change in consumer and producer. Surpluses associated with an increase in crop yield. Figure - 5 models this effect as an increase in crop supply from S_0 to S_1, which in turn causes a price decline from P_0 To O_1

The increase in crop yield associated with a hypothetical ozone, reducing policy can be modeled as shift in crop supply from S_0 to S_1. Before the policy is implemented consumer surplus is area P_0ab, and producer surplus is area P_0be, for a total of area eab. After the policy is implemented and supply shifts to S_1, consumer surplus becomes area P_1ac and producer surplus becomes area P_1ce, for a total area eac. Thus, the incremental benefit is area ebc (i.e. eac-eab) and the society is benefited.

We can see that after the damage reducing measure the distribution of gain to producer and consumer are not equal. The consumer surplus rises from P_0ab to P_1ac. But the original surplus area of producer i.e. eP_0b now becomes epc, it means the area P_0bFP, is transferred to consumers but there is also a gain to producers of area efc. Which one is more or less depends on the slopes of the curves.

(4) DIRECT ESTIMATION METHODS UNDER THE BEHAVIOURAL LINKAGE APPROACH

The direct methods under the behavioral linkage approach estimate environmental benefits according to responses or observed behavior directly tied to environmental quality. Although a number of direct methods are available, but we shall take in to account only one of them. i.e. contingent valuation method (CVM)

(a) Contingent Valuation Method (CVM)

When market data are unavailable or unreliable, economists can use alternative estimation methods that rely on hypothetical market conditions. Such methods typically use surveys to inquire about individual's willingness to pay (WTP) for some environmental initiative. This survey approach to benefit-estimation is known as the *contingent valuation method (CVM)* because the results are dependent, or *contingent,* on the devised hypothetical market. The survey instrument helps to overcome the problem of non-revelation of preferences that characterized the public goods.

Implementing this survey approach involves the following these tasks:

1. Constructing a detail model of the hypothetical market, including the characteristics of the good and any conditions that affect the market.
2. Designing a survey, instrument to obtain an unbiased estimate of individuals' WTP

3. Evaluating the truthfulness of survey respondents' answers.

(1) Assessing the CVM

This method can be applied to a variety of environmental goods because it can assess both existence value and user value. Since it is based on survey study and therefore getting true information regarding WTP. Biases are taken care by researchers by adding more detail to given hypothetical model and improving the design of survey instrument.

(ii) Applications of the CVM

CVM method is used in a variety of contexts to estimate environmental benefits. An important application is estimating the value of a statistical human life. It is also used to measure society's WTP for water quality improvements. Moreover incremental benefits from air quality improvements also have been estimated using CVM. Because the CVM is capable of capturing existence value, it has been used to value ecological benefits, such as preserving an endangered species.

(5) INDIRECT ESTIMATION METHODS UNDER THE BEHAVIOURAL LINKAGE APPROACH

For some environmental proposals, direct estimation procedures like CVM may not be viable. In these cases economists use indirect methods, which make inferences about markets or conditions that are linked to the environmental good under investigation. Basically, there are three methods which are dominating the literature: (1) the averting expenditure method (AEM) (2) travel cost method (TCM) (3) the hedonic price method (HPM).

(1) Averting Expenditure Method (AEM):

An Approach Using Substitutes

Averting expenditure Method (AEM) estimates benefits as the change in spending on goods that are substitutes for a cleaner environment, for e.g. air and water. It uses changes in spending on goods that are substitutes for environmental quality when people find that their utility is negatively affected by the pollution, they undertake averting action by purchasing goods and services that improve their personal environmental quality, such as the indoor air or a private drinking water supply. Notice that in each case averting action implies an expenditure on a substitute good or service. If the general environment is improved by some policy initiative, then the individual can spend less on these substitute goods. This decline in averting expenditure gives an indirect-estimate of the individual's WTP for the associated incremental benefit. If the government policy improves the public drinking water supply, the individual can spend less on these substitute commodities. This reduction in spending identifies the incremental benefits provided by the drinking water policy.

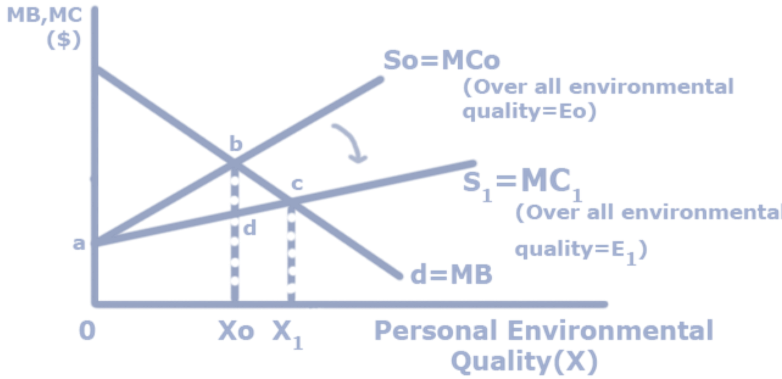


Figure- 6 Measuring Incremental Benefits Using the Averting- Expenditure Methods (AEM)

The AEM model is represented by above diagram where the relevant - market is defined as personal environmental quality (x) The demand curve (d) is also the marginal benefit (MB) function and each supply (s) relationship is modeled as a marginal cost (MC) curve. The critical assumption is that each MC curve represents the averting expenditures on environmental quality substitutes to achieve various levels of personal environmental quality (x), given some level of overall environmental quality (E). In our diagram, MC_0 shows the marginal cost of averting expenditures at the existing level of overall environmental quality, E_0. As overall environmental quality improves to E_1, the individual spend less (or incurs lower cost) to achieve each level of personal environmental quality, and the MC curve moves downward to the right, becomes MC_1.

At the initial equilibrium when over all environmental quality is E_0, the individual's personal environmental quality is X_0, where MB and MC_0 intersect. At this point total averting expenditures are the area under the MC_0 curve up to Xo, or area $OabX_0$. After the policy improve overall environmental quality to E_1 the individual's marginal cost curve shifts to MC_1. At the new equilibrium where MB and MC_1 intersect, personal environmental quality increases to X_1, and averting expenditures change to area $Oacx_1$ to achieve X_1 in the absence of the policy change, the individual would be willing to spend an amount equal to area $Oabcx_1$ Thus, the individual's WTP for the incremental benefits is the difference between $Oabcx_1$ and $Oavx_1$, or triangular area abc. This smaller area can be interpreted as a lower bound for the WTP valuates.

(a) Assessing the AEM

A drawback of AEM arises from the phenomenon known as pointless of production e.g. averting expenditure on goods like Air-conditioner. It does reduce certain health risks of air pollution, but also provides comfort.

(b) Applications of the AEM

The applications of this method is seen in people's incurring expenditure for indoor recreation to protect them from outside home prevailing pollution. This is relevant in case of air and water.

(2) Travel cost Method (TCM): An Approach Using Complements

Travel cost-method (TCM) values benefits by using the complementary relationship between the quality of a natural resource and its recreational use value. For example, the demand for the recreational use of an environmental resource. Such as a lake or a national forest, increases as its quality improves. Therefore as this demand function. Shifts with a change in environmental quality the resulting change in consumer surplus approximates the associated incremental benefits.

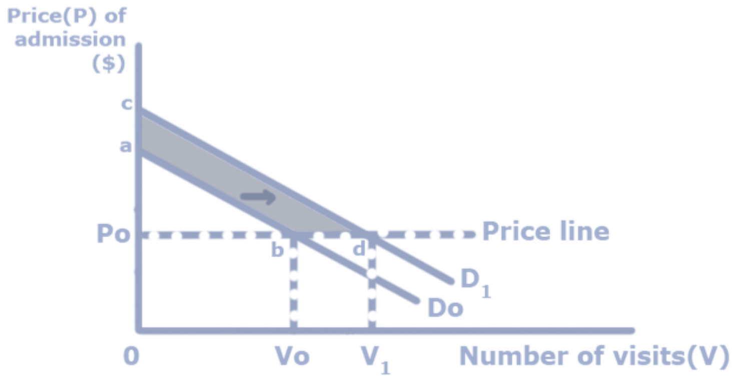


Figure - 7 Measuring Incremental Benefits Using the Travel Cost Method (TCM)

We can model the TCM in figure-7 assuming that recreational demand has been properly identified. Two demand curves for the recreational use of a lake are shown in the diagram, D_0 and D_1. D_0 is the relevant demand at some pre existing environmental quality level E_0. D_1 is the new demand curve after a policy has been implemented to improve the lake's quality to E_1. A price line is drawn at P_0 to represent the admission fee to use the lake. Before the policy is implemented the number of visits to the site is V_0, where visitors enjoy a consumer surplus equal to area abP_0. After the policy is put in to effect, the number of visits, rises to V_1 and consumer surplus increases to area cdP_0. The resulting change in consumer surplus, shown as area acdb (i.e. area cdP_0 minus area abP_0), estimates the incremental benefits to visitors associated with improving the lake's quality.

(a) Assessing the TCM

There are three limitations of this method. They are as follows.

1. It estimates only user value and not existence value - an omission likely to create bias.
2. It focuses on recreational use, making it in effecting for estimating benefits that accrue to commercial users of a resource.
3. The method has been found to generate estimates that are biased downward if access to a site is deterred by congestion.

(b) Applications of the TCM

(1) It values the effect of acid rain damages e.g. lakes

(2) It values the benefits of improving water quality from boat-able to fishable condition.

However it should be noted that, other site differences, such as aesthetics, access to major highways and substitute recreational opportunities, are difficult to quantify and control. Hence is unlikely that the TCM can determine a generalized value of improved water quality.

(c) Hedonic Price Method (HPM): An Approach Using Product Attributes.

The *Hedonic Price Method* (HPM) is based on the theory that a good or service is valued for the attributes or characteristics it possesses. This perception of value suggest that *implicit or hedonic prices* exist for product attributes, and these prices can be determined from explicit price of the product. In environmental attributes of certain commodities.

Housing market have been a classic context for hedonic pricing studies. Such analysis assume that the market price of a home is determined by the implicit value of its characteristics, such as locate number of baths, lot size, and the environmental quality of the community. Therefore, changes in any of these characteristics are capitalized in to the property's price.

The conventional modes specifies the market price of house, p as a function of its attributes. A simplified version of such model is:

$P = F(X_1, X_2, \ldots\ldots\ldots, Xn, E)$

Where each x variable represents some housing attribute, such as lot size or number of baths, and E signifies the associated environmental quality.

As any of these characteristics increases in magnitude, the price of the property P increases. It is this *marginal price* that is the implicit value of that attribute. Thus, as environmental quality improves, the resulting increase in property value can be used to estimate the associated incremental benefits. Once the implicit price of E is determined, the demand for environmental quality can be estimated. This in turn can be used to measure changes in consumer surplus arising from policy-driven improvements in environmental quality.

(a) Assessing the HPM

The positives of this method are;

1. It is highly initiative
2. It approaches the problem of monetizing incremental benefits in a logical way, directly using market price.

The Negatives of this method are:

(1) It requires a fairly complicated empirical model.

(2) The extensive data that it needs on product attributes are not available or incomplete.

(b) Applications of the HPM

There is one most important application of this method, is in measuring how the siting of hazardous waste facilities affects prices of nearby properties.

CONCLUSION

In this module we have analyzed and discussed the conceptual issues and different methods of assessing benefits for environmental decision making. The methods of estimating benefits analyzed here in, do not give us a clear consensus as to which method is superior consistently. Their diversity reflects both the complexity and its importance in public decision making. However the reality is asking that the method ought to be least costly and most beneficial. In the discussion what we have gained is - discovering the inherent - difficulties in any social benefit estimation which are often magnified in the context of environment. The primary challenge is in monetizing gains that involve intangibles not traded in the market place. Hence, economist s have had to device methods to quantify these magnitudes using something other than explicit prices.

However measuring social benefits have been fruitful. Progress has been made in fine-tuning estimation procedures, in recognizing which methods are most useful for which contexts and in interpreting the results.