6.0 Economic Analysis

Traditionally, the Environmental Impact Assessment (EIA) was meant to be an independent report related to the environmental impacts of the development project. The assessment had minimal links with economic analysis. There have been considerable discussions among various stakeholders involved in project processing, financing and implementation on how to measure the economic importance of expected environmental impacts. This section focuses on the emerging role of economic evaluation of environmental impacts, specifically on how to use such information in environmental assessment. A brief summary of the principal methods available for placing monetary values (costs and benefits) on environmental impacts, a taxonomy of valuation methods, and steps involved in economic evaluation of environmental impacts are also presented.

6.1 Role of Economics in Environmental Impact Assessment

The economic analysis of development projects has had a relatively long history. Initially, environmental impacts were deemed external to development projects, and hence were excluded from economic analysis. Subsequently, it became the practice to describe environmental impacts quantitatively. Since the mid-1980s there has been a growing interest in placing monetary values on environmental impacts and combining these values into overall project analysis work. In this regard, the Asian Development Bank's (ADB) "Economic Analysis of the Environmental Impacts of Development Projects" (Dixon et al., 1988) can be considered an excellent example. Despite this, until the mid-1990s the analysis described in the publication was rarely applied to actual projects. In 1996, the ADB published "Economic Evaluation of Environmental Impacts: A Workbook" as a follow-up to the 1987 work. It provides the practitioner with a step-by-step valuation procedure. Another publication, the ADB's latest "Guidelines for the Economic Analysis of Projects" (Asian Development Bank, 1997), documents how the economic values of environmental impacts can be integrated into project analysis.

The role of environmental economics in an EIA can be divided into three categories, namely: 1) the use of economics for "benefit-cost analysis" as an integral part of project selection; 2) the use of economics in the assessment of activities suggested by the EIA; and 3) the economic assessment of the environmental impacts of the project.

Environmental economics can aid in the selection of projects in that benefit-cost analysis can be used in the prescreening stage of the project, and the environmental components can be brought into the process of presenting various options and selecting among them. Doing so eventually leads to a project selection process which takes the environment into consideration. In the second role, the economic assessment is focused on the cost assessment of environmental mitigation measures and management plans suggested in the EIA. The economic analysis in the EIA may include a summary of the project costs and how such cost estimates would change due to the activities proposed under the EIA. This component can be considered as an accounting of the environmental investment of a project. The third role, which is the economic assessment of the environmental impacts of a project, is geared towards seeking the economic values (of both costs and benefits) of the environmental impacts. These impacts are neither mitigated, nor taken into account in traditional economic analysis of projects. They should be identified by the EIA and sufficient quantitative and qualitative explanations should be given in EIA documents. The economic evaluation of environmental impacts is related to project intervention, however, methodological difficulties and the traditional thinking that environmental impacts are external to the project have prevented its incorporation into the overall economic analysis of the project.

To illustrate the functions of environmental economics in EIA, consider the case of a power plant. Power can be generated using various forms of energy, including coal, hydropower and geothermal sources. If, in the prescreening, environmental economics is used to identify environmental costs and benefits among the options and is used to select the project, then the first function of environmental economics has been used. Hence, a coalfired power plant may have been selected and the environmental components may have already been recognized through the preliminary accounting of likely benefits and costs. If the power plant installs an electrostatic precipitator to reduce total suspended particulate emissions, that is a mitigation measure. As such, its costs should be included in the project cost estimates. If the economic assessment was conducted without including the cost of environmental mitigations, it would be biased with the actual cost of the project estimated at a lower figure. Thus, it is important to provide a summary of both the project costs and the related environmental costs in the EIA report — doing so provides insight about the additional costs that a project proponent would incur to correct the environmental damages caused by the project.

On the other hand, the previously mentioned coal power plant may have many other environmental impacts; some may be mitigatable, others not, yet each has a distinct economic value. For example, the generation of CO_2 and the emission of additional gases is an inevitable function of coal burning. One may not be able to directly compensate for such emissions, but there are activities which may reduce the damages caused by them. For instance, although not a mitigation measure, it is clear that the introduction of an afforestation program will result in more trees, thereby increasing the potential of forests to absorb CO_2. Now suppose the new power plant uses state of the art technology in power generation; as a result, the power authority can close some of the old and inefficient power plants. If this is possible, environmental benefits besides those directly associated with the project operations may be obtained. Economic analysis of such environmental impacts can help the project analyst to express the economic benefits of the project in a more complete manner.

In summary, the use of economic analysis in EIA can aide in assessing the proposed project more objectively. If the EIA exercise is used as a planning tool in an iterative manner, it is possible to reduce the negative environmental impacts and capture more positive environmental components if the economic analysis of such impacts is possible with every iteration. The result of integrating economic analysis of environmental impacts can be very useful in enhancing the quality of a project.

6.2 Steps in Economic Valuation of Environmental Impacts

Economic analysis of environmental impacts is important in project preparation to determine whether the net benefits of undertaking the project are greater than the alternatives, including the non-project scenario. Project alternatives often vary in their economic contribution and environmental impacts. Economic assessment of different alternatives in the early stages of project planning should provide important inputs to improve the quality of decision-making. The economic analysis of the environmental impacts of the selected projects also allows for a more complete assessment of the project's costs and benefits. A general procedure that can be followed in economic analysis of environmental impacts is presented in Figure 6-1 (adapted from Asian Development Bank, 1996).

Screen 1 of Figure 6-1 indicates that in the case of internal or mitigated impacts, there is no need to look for an extensive monetization of environmental impacts. They are already treated as part of the project. However, one has to assure that they are properly costed or valued in economic terms and appropriately incorporated into the economic cost benefit streams of the project. As explained earlier, this is the first part of the economic analysis section of the EIA report. A good EIA report should include a section on all economic aspects of the project, including the results of a cost benefit analysis of the overall project after incorporating the internal or mitigated impacts.

Screens 2 and 3 reflect instances when qualitative assessment and documentation is important. Screen 4 refers to the second component of the economic analysis of the EIA which gives an assessment of environmental impacts that can be quantified. At a minimum, the following six tasks need to be completed in the economic analysis of environmental impacts:

1. determine the spatial and conceptual boundaries of the analysis;
2. identify environmental impacts and their relationships to the project;
3. quantify environmental impacts and organize them according to importance — the impacts described qualitatively, if they cannot be expressed in quantitative terms;
4. choose a technique for economic valuation;
5. economic valuation (place monetary values) of environmental impacts identified; and
6. set an appropriate time frame and perform the extended benefit cost analysis.

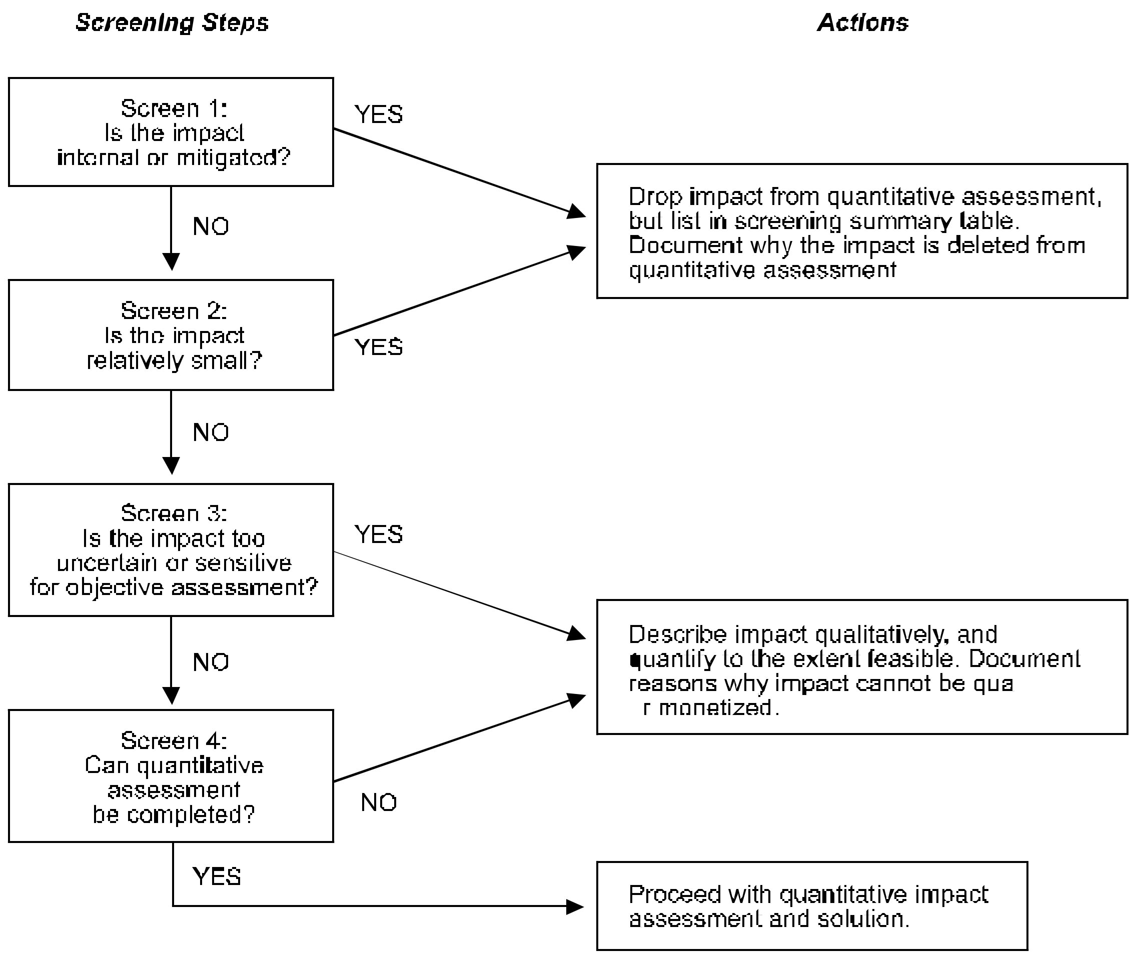

Figure 6-1: The impact screening process.

The boundary of the economic analysis refers to the conceptual and physical limits of the analysis. It may consider on-site and off-site environmental impacts that are consequences of project activities. Another consideration is the type of goods and services that should be included in the analysis. The complexities of a project's environmental impacts may cause some difficulty in establishing the spatial and conceptual boundary of the economic analysis. The rule is to start the analysis with directly observable and measurable impacts.

A successful EIA report should provide the required information for economic analysis of the environmental impacts. Necessary output of Tasks 1, 2, and 3 show a list of all possible environmental impacts of the project. Thus, the EIA should identify and completely document all impacts, providing sufficient quantitative and qualitative descriptions. This list becomes the basis for the economic valuation carried out in Task 5.

Valuing environmental impacts in monetary terms is the most difficult part of the economic analysis. This necessitates the use of valuation techniques (discussed in the remainder of this chapter) appropriate to the environmental impacts being investigated. Choosing the appropriate valuation techniques is itself a difficult task, requiring expert judgment from economists and environmental specialists.

6.3 Methods for Economic Valuation of Environmental Impacts

The remainder of this chapter deals with the various techniques that may be used to determine the monetary values of environmental impacts. The methods in which market prices are used are fairly standard and straightforward approaches that rely largely on changes in physical production or on direct cash expenditures. Other approaches use surrogate markets. The valuation flowchart presented in Figure 6-2 provides a good starting point towards understanding the valuation aspect of economic analysis. Environmental impacts can be divided into three categories. The first two categories are those that cause measurable changes in the production of a specific good or service, and thereby affect: 1) human welfare, and 2) human health. The third category is those that cause changes in the quality of the environment. Figure 6-2 provides a classification system for alternative valuation methods.

Table 6-1 presents applications of economic valuation methods to specific environmental impacts of different types of projects. Readers are advised to refer to the table as each valuation technique is discussed in section 6.7 (Dixon et al., 1988; Carpenter and Maragos, 1989).

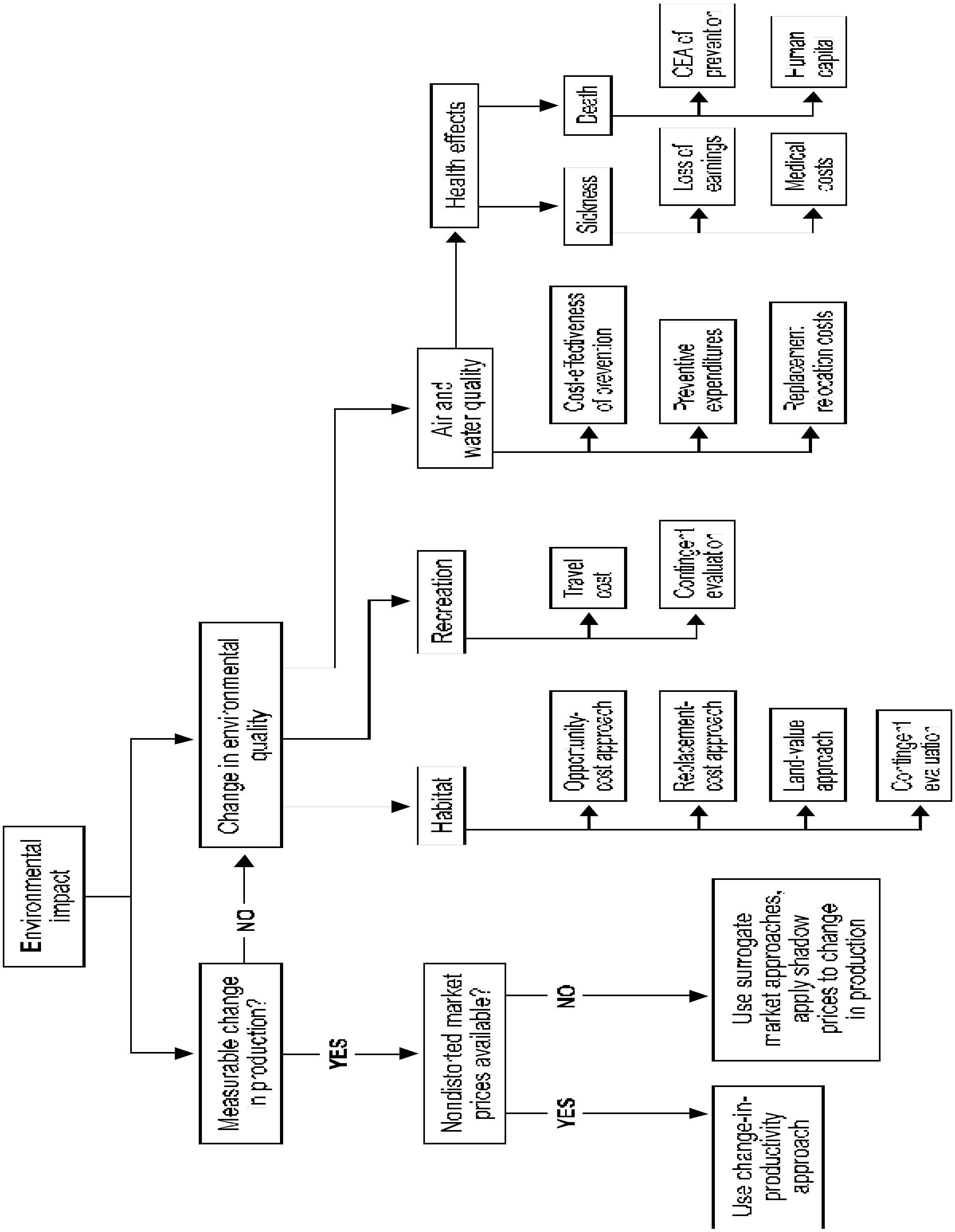

Figure 6-2: A simple valuation flowchart (*source:* Dixon and Bojo, 1988).

Table 6-1: Examples of development projects, possible environmental impacts, and measurement and valuation techniques (*source:* Dixon et al., 1988; Carpenter and Maragos, 1989).

Type of Project	Environmental Impacts	Measurement and Valuation Techniques (comments)
Agriculture, Forestry and Fisheries Development		
Hill forest development	Project will increase fuelwood and fodder production and protect critical watershed	• Change in productivity of forests and agricultural land • Opportunity cost of dung as fertilizer to value benefit of alternative fuel
Fisheries development	Project contributes to over exploitation of shrimp resources	• Change in productivity of fishery due to overfishing
	Project vessels competing with artisanal fishermen – project catch not fully incremental	• Loss of earnings of artisanal fishermen must be subtracted from project – catch projections
	Evidence of overfishing inshore	
Brackish-water shrimp culture	Removal of mangroves for construction of shrimp ponds	• Change in productivity of fishery due to mangrove removal
Livestock development	Effects on forests and rangeland of overgrazing	• Change in productivity of forests and rangeland • Opportunity cost of dung as fertilizer
Irrigation		
Low lift pump maintenance	Shallow flooded areas over drained resulting in lack of water for surface water irrigation in dry season	• Change in productivity due to moisture deficit in dry season
Irrigation and settlement	Project located in watershed in good condition; there should therefore be low sedimentation rate	• (Watershed management covenant in loan agreement to assure that increased development resulting in increased sedimentation would not affect project's future operation)
Outfall drain	Project should have positive environmental impacts by correcting waterlogging and soil salinization problems	• Change in productivity from better growing conditions • Cost effectiveness of alternative rehabilitation designs
Infrastructure		
Road development in hilly area	New cuts in embankments not stabilized with vegetation, causing potential for soil erosion and landslides	• Change in productivity due to soil erosion and sedimentation • Loss of property due to landslides
Urban water supply	Project contributed to increased waste-water volume without providing adequate sewerage facilities	• Loss of earnings directly due to flooding or indirectly from increased incidence of waterborne disease • Loss of property due to flooding • Willingness to pay
Provincial cities water supply	Watershed denudation in the upper recharge area of the project affects project performance	• (The broader issue of management of watershed on which the project depends should have been given consideration)
Water supply	Water diverted from downstream users by artificial well recharge in river bed	• Change in productivity of downstream water users • Willingness to pay
Low-income urban housing	Increased air pollution due to use of underfloor heating systems burning soft-coal briquettes	• Cost effectiveness of alternative heating designs • Loss of earnings from increased respiratory diseases
Industry and Power		
Gas turbine generation	Design as peak-load facility to run on gas; no air quality control included in design; was used as base-load facility run on oil; air quality adversely affected by emissions	• Cost effectiveness of alternative designs to decrease emissions

Type of Project	Environmental Impacts	Measurement and Valuation Techniques (comments)
Palm oil processing plant	Untreated effluent of biological oxygen deficiency (BOD) of 20,000 mg/l discharged into river	• Change in productivity in inland fishery due to water pollution • Cost effectiveness of alternative water treatment designs • Loss of earning from increased health problems due to use of polluted water
Tin mining	Environmental aspects given due consideration with respect to waste tailing disposal, water storage pond dike burst prevention and prevention of malarial-mosquito breeding	• (Project accounted for major potential environmental problems. Negative environmental impact should be minimal)
Hydropower development project	Service roads gave access which promoted deforestation resulting in changes in hydrological patterns, soil erosion, siltation, and flooding	• Change in productivity of forests, agricultural land and downstream fishery; reduction in useful life of downstream hydropower facility • Loss of earnings as a direct result of flooding or indirectly from increased incidence of disease
Hydropower development project	Run-of-river power facility located in catchment with heavy development pressure resulting in increased extreme river flow rates and heavy siltation loads	• (Project design and estimates of project's useful life should account for surrounding environmental conditions which will affect project operation even though not a direct consequence of project) • Preventive expenditures made to reduce downstream consequence of deforestation

6.4 Taxonomy of the Valuation Methods

There are many methods available for economic valuation of environmental impacts. Table 6-2 presents a brief summary of such methods classified according to the human behavior and the nature of the market situation.

Table 6-2: Different methods available for economic valuation of environmental impacts.

	Actual Market-based Information	Indirect Market-based Information	Hypothetical-based Information
Actual Behavior	• change in production • effect on human health • preventive cost	• travel cost • wage differences • property values	• created or simulated market
Potential Behavior	• replacement cost • shadow price	• surrogate goods • opportunity cost	• contingent valuation • bidding games

6.5 Guidelines for Economic Valuation of Environmental Impacts

The methodology of valuing costs and benefits of environmental changes is still evolving. In this respect, some general guidelines for conducting economic analyses of the environmental impacts of development projects should be observed in order to carry out any useful analysis. These are, from the Asian Development Bank's *Guidelines for Economic Analysis of Projects* (Asian Development Bank, 1987):

1. Start with the most obvious and easily valued environmental impacts. First select the effects that have directly measurable productivity changes that can be valued by market prices (for example, changes in fish or crop production due to a diversion of water for a hydroelectric power project).
2. Always look at both the benefit and cost sides. A clear distinction should be made between benefits (costs avoided) and costs, as these will be the reference from which changes are measured. For instance, the value of a regulation structure should include, from the cost side, the capital operations and maintenance costs; and from the cost avoided side, the benefits of reduced flooding downstream.
3. Economic analysis should be done in a "with- and without-project framework." Project alternatives should also be considered.
4. All assumptions in the economic analysis should be stated clearly.
5. When market prices cannot be used directly, surrogate market prices should be used.

The time horizon for the economic analysis may coincide with the economically and technically viable project life span. Where the effects on the environment are expected to persist beyond the project's life span, however, the time horizon of the analysis should be likewise extended. There are two ways to accommodate an extended time horizon. The first is to extend the cash-flow analysis for a number of years specific to the project under consideration. The second is to add a capitalized value of net benefits or costs at the normal end of the project period. This approach implicitly assumes that the impact on the environment extends to infinity (Carpenter and Maragos, 1989).

6.6 Issues in the Incorporation of Environmental Values into Benefit Cost Analysis

The evolutionary nature of the process of valuing environmental impacts requires that three important conceptual issues be addressed. To reiterate previous sections, these issues are: i) the need to choose valuation techniques; ii) the definition of analysis boundaries; and iii) the selection of an appropriate time horizon.

Aside from these issues, designwise, economic analysis has a series of limitations when incorporating the environmental values into benefit cost analysis. Economic analysis does not address the effects of the project on **income distribution**. Projects which will benefit wealthy individuals at the expense of poor individuals may be undesirable on distributional grounds, even if they show high benefit/cost ratios. If analysts are careful, however, they can incorporate distributional impacts into the economic analysis by assigning different weights to the different income groups.

Another issue in the economic analysis is **intergenerational equity**. Future generations might have fewer resources available than they would have had without the project, resulting in a high benefit-cost ratio. One way of addressing this issue is directly related to the choice of discount rate. A high discount rate will favor projects with immediate net benefits, while a low one will have fewer restrictive effects on projects with long-term negative benefits and will give more weight to negative future impacts. The environmental impacts of a project could be highly affected by this issue, as some of the environmental issues may have impact over a long period.

Economic analysis also has to deal with **risk** and **uncertainty**. Natural events such as drought, floods, earthquakes, and plant and animal diseases may seriously affect projects. To handle this problem, expected values are used as alternative values for variables (that is, prices, quantities whose precise value cannot be known in advance). By using a single number, this "expected value" method of accounting for risk and uncertainty does not indicate the degree of uncertainty or the range of values which might actually be expected. Sensitivity analysis can also be used to handle risk and uncertainty in projects. Here, the use of optimistic and pessimistic values for different variables can indicate which variables will have the most pronounced effects on benefits and costs.

Another important issue in the economic analysis is the **accounting of the irreversible damage** projects have on available natural resources. Decision makers must give special attention to irreversible impacts since these may have significant consequences in the future. Irreversibility can be accounted for in the economic analysis by the opportunity-cost approach since it indirectly provides information on the cost of preservation. In general, however, the rule should be that if the costs of retaining an option that would otherwise be foreclosed are relatively low then the decision maker should weigh the possibility of retention. To address this issue, caution should be made in the choice of projects, by wisely using nonrenewable resources and implementing projects which promote sustainable use of renewable resources. The welfare of both current and future generations can be enhanced.

Economic analysis is also limited by **ethical and moral considerations in the valuation of human lives**. Although methods have been devised to evaluate project activities which will affect human health, one cannot readily reply to questions on how much compensation an individual will accept for the loss of his life. Ethically, no project proponent could brazenly show willingness to buy/pay for human lives that might be affected by the project.

Economic valuation will also have limits if the resources in question are imbedded in the people's **cultural traditions and value systems**. This is specifically true for cultural, historical, and aesthetic resources where the people's perception of losses of these resources depends a great deal on their cultural and historical attachment to them. People may be unwilling to accept any level of compensation, no matter how high, if they have strong emotional, cultural, or traditional ties to the resources. Conversely, although people may be willing to pay to preserve or retain a resource, they might be constrained by income.

6.7 Methods for Economic Valuation of Environmental Impacts

There are many methods available for economic valuation of environmental impacts. The valuation to be undertaken and the appropriate methods to be chosen depend on the data availability and other circumstances related to the project. The following section provides a brief description of the more important methods available for valuating environmental impacts. Though inexhaustive, it will familiarize the reader with a range of valuation techniques.

6.7.1 Changes in Productivity

Techniques using changes in productivity as the basis for measurement are direct extensions of traditional benefit-cost analyses. Physical changes in production due to environmental impacts are valued using market prices for inputs and outputs, or, when distortions exist, appropriately modified market prices. The monetary values thus derived are then incorporated into the economic analysis of the project.

To use these techniques, the following steps must be taken:

1. identify the changes in productivity caused by the environmental impacts both on-site and off-site;
2. assess the effects on productivity "with the project" and "without the project." The latter option is used to specify the change the project will cause and to clarify the degree of damage or the damage avoided by the project; and
3. make assumptions about the time over which the changes in productivity must be measured, the "correct" prices to use, and any future changes expected in relative prices.

The lost earnings and medical costs that result from environmental damage caused by a project or the comparable savings which would accrue from preventing that damage are the basis for valuation. This technique is known as the **loss of earnings**, human capital or forgone earnings approach.

The loss of earnings approach may be used when:

1. a direct cause-and-effect relationship can be established and the etiology of the disease is clearly identifiable;
2. the illness is of short-duration, not life-threatening, and has no major long-term effects; and
3. the precise economic value of earnings and medical care is known.

In addition to using this technique in health-related morbidity or mortality, it may also be used to measure loss of (income) earnings caused by exogenous reductions in productivity.

6.7.2 Market Prices

Some techniques use market prices to evaluate actual project costs. They do not attempt to estimate a monetary value for the benefits produced by the project. The project output or product is described in qualitative or physical terms and potential benefits must be determined to justify the costs involved.

To determine the importance individuals attach to impacts on the environment, the preventive expenditure approach examines actual expenditures. The demand for the mitigation of environmental damage may be seen as a surrogate demand for environmental protection. Obviously, individuals will commit their resources only if their subjective estimate of the benefits is at least as great as the costs. An indirect measure of individual perception of these costs can then be derived by looking at the amount of resources allocated to avoiding them. Since an individual's willingness to incur costs is constrained by his/her ability to pay, however, this approach only provides a minimum estimate of the benefits achieved. The assumptions implicit in this kind of analysis are:

1. accurate data on the costs of mitigating expenditures are available; and
2. there are no secondary benefits associated with the expenditures.

The **opportunity cost** approach is based on the concept that the cost of using resources for unpriced or unmarketed purposes can be estimated by using the forgone income from other uses of the resource as a proxy. Rather than attempting to measure directly the benefits gained from preserving a resource, that which is given up for the sake of preservation is measured. Where the opportunity cost of preservation is low, a decision is usually made to conserve the resource in its natural state.

Possible situations where this approach may be valuable include alteration of tropical rainforests, establishment and protection of wildlife sanctuaries, preservation of cultural or historical sites and natural vistas. The approach can also be used to determine where major infrastructure projects or industrial facilities will be sited. Where alternative locations exist, the approach helps to clarify the additional costs of preserving one area versus another. Similarly, this technique can be used to value the effect of the different technological options on the environment.

6.7.3 Surrogate Market Prices

Surrogate market techniques are approaches which use actual market prices to value an unmarketed quality of the environment (for example, clean air, unobstructed views, pleasant surroundings, etc.). The basic assumption is that the purchasers' valuation of the environmental qualities at issue is the price differential arrived at after all variables except environmental quality have been controlled.

Property Values

The basic assumption in using this approach is that the buyers' attitudes toward an attribute of a property (physical, aesthetics, environmental) is reflected by their willingness to pay for the property. For instance in deciding to buy a new house, one would expect its value to be equal to its construction costs plus an appropriate mark-up. In reality, however, decisions to buy a house are influenced by a wide range of attributes, only some of which are physical.

The property value approach is designed to control certain variables so that any remaining price differential can then be assigned to the unpriced environmental "good." Similarly, environmental "bad" can be measured using this technique, or with a drop in property value due to increased noise, air pollution, or view obstruction. For example, benefits from an urban flood control project could in part be estimated by examining price differences between housing units located in a flood-prone district and similar housing in less frequently flooded areas.

Wage Differentials

The wage differentials approach rests on the theory that in a perfectly competitive equilibrium, the demand for labor equals the value of the marginal product of the worker and the supply of labor varies not only with wages, but also with working and living conditions. A higher wage is thus needed to induce workers to work in polluted areas or to undertake risky occupations. Workers are presumed to be able to work freely among jobs, and therefore to be able to choose particular jobs in particular areas at certain wages which will maximize their utility.

Differences in wage levels for similar jobs may be viewed as a function of different levels in the attributes of a job relating to working or living conditions. If such a relationship between wage levels and attributes could be estimated, implicit prices could be determined. Assuming constant implicit prices (reflecting marginal willingness to pay or the acceptance of lower or higher wages for lower or higher levels of the particular attribute), benefits could be estimated for improvements in levels of attributes. Common attributes affecting wage differentials are risks to life and health, and the presence of urban amenities.

Travel Cost

The travel cost approach is based on the simple premise that observed behavior can be used to estimate a value for an unpriced environmental "good" by treating increasing travel costs as a surrogate for variable admission prices. This approach is widely used to determine values people place on recreational facilities. Usually such goods are provided either free of charge or for a nominal admission fee. The value of the benefits or utility derived from the park, however, is often much larger than the fee, with the difference being the consumer's surplus. To estimate the total amount of a consumer's surplus, one must derive a demand curve from the actual use of the park.

6.7.4 Replacement Cost

The basic premise of the replacement-cost approach is that the costs incurred in replacing productive assets damaged by a project can be measured. These costs can be interpreted as an estimate of the benefits presumed to flow from measures taken to prevent that damage from occurring. The rationale for this technique is similar to that for preventive expenditures except that the replacement costs are not a subjective valuation of the potential damages. Rather they are the true costs of replacement if damage had actually occurred. The approach may thus be interpreted as an "accounting procedure" used to work out whether it is more efficient to let damage happen and then to repair it or to prevent it from happening in the first place. It estimates the upper limit of the value of the damage but does not really measure the benefits of environmental protection *per se*.

The assumptions implicit in this type of analysis are:

1. the magnitude of damage is measurable;
2. the replacement costs are calculable and are not greater than the value of the productive resources destroyed, and therefore it is economically efficient to make the replacement; and
3. there are no secondary benefits associated with the expenditures.

Relocation Costs

This variant of the replacement-cost technique uses the actual costs of relocating a physical facility to evaluate the potential benefits (and associated costs) of preventing the environmental change which would necessitate the relocation. A case in point is the construction of an oil palm mill which would discharge waste water into a nearby stream. Of the various environmental costs associated with this discharge, one might need to relocate a domestic water supply intake which is downstream from the mill.

Shadow Projects

The shadow-project technique was developed in an attempt to estimate the cost of replacing the entire range of environmental goods and services threatened by a project.

The assumptions implicit in this analysis are that:

1. the endangered resource is scarce and highly valued;
2 the human-built alternative would provide the same quantity and quality of goods as does the natural environment;
3. the original level of goods and services is desirable and should therefore be maintained; and
4. the costs of the shadow project do not exceed the value of the lost productive service of the natural environment.

6.7.5 Contingent Valuation Methods

Contingent valuation methods are survey-based methods which may be used to value the environmental impacts of development projects when no data are available on market or surrogate market prices. Some of these methods may not be applicable in the analysis of many projects in developing countries, however they are nevertheless valuable tools in some cases concerning such diverse goods and services as species preservation; historical or cultural phenomena; genetic diversity; preservation of open spaces, unobstructed views; or public access to amenity resources.

Bidding Games

In a bidding game, individuals are asked to evaluate a hypothetical situation and to express their willingness to pay or to accept compensation for a change in the level of provision of an environmental “good” or service (for example, access to parks, clean air or water, or unobstructed views). Respondents’ willingness to pay rather than to do without the “good” may be summed up to provide an estimate of aggregate willingness to pay. There are two types of bidding games: single bid games and iterative bid games.

Single bid games ask respondents the maximum price they would be willing to pay for an environmental "good" such as clean water or to quote the minimum amount of compensation they would accept for doing without that "good." The responses are then averaged and extrapolated to come up with the aggregate willingness to pay or an aggregate level of compensation.

In the *iterative (or converging) bid games,* individuals are asked whether they would pay a given amount for the environmental "good" or service. The amount is then varied iteratively until a willingness to pay or a minimum willingness to accept compensation is reached.

Take-it-or-Leave-it Experiments

This method is best illustrated by an experiment asking different groups of respondents if they would be willing to accept $10, $20, or $50 for a decrease in air quality. Each respondent is given only one amount to respond to. The various amounts are randomly distributed over the entire surveyed population. For each given amount, the proportion of respondents who would and would not accept the offer can be determined. The answers are then analyzed to come up with the average consumer's willingness to pay, which in return is multiplied by the number of people affected to arrive at the aggregate willingness to pay.

Costless Choice

The costless choice method involves asking participants to choose from two or more alternatives, each of which is desirable and will cost nothing. The choice might be between a certain amount of money or some unpriced environmental "good" (for example, a reduction in air or noise pollution). If the individual chooses the environmental "good" rather than the money, the minimum value of the environmental "good" to that individual is established. If the money were chosen, then it would be established that the individual thought the "good" to be worth less than that certain amount.

6.7.6 Cost-Effectiveness Analysis

Although cost-effectiveness analysis is not a straightforward valuation technique, it can nonetheless be useful. This approach focuses entirely on meeting a predetermined standard or goal given limited resources (for example, limited funds, inadequate data, or insufficient knowledge of the nature and link between environmental damage and human health and welfare). After considering all the alternatives, cost effectiveness analysis is used to determine the most effective way to meet a goal. The major difference between cost-effectiveness analysis and other approaches is that no attempt is made to monetize the benefits. It is thus a highly useful approach for projects with benefits that are difficult to measure in monetary terms.

The first step in cost-effectiveness analysis is to fix a target. In the environmental field it may be a certain ambient quality or an emission standard for industrial facilities. Once a target is chosen, cost-effectiveness analysis is carried out by examining the various options by which the target can be achieved. This may involve analyzing the capital and operating costs of different pollution control technologies. The basic goal, however, is to identify the least-cost alternative which will achieve the goal selected.

Since cost-effectiveness analysis does not give an estimate of benefits that can be derived from meeting a given standard or goal, it is possible that even the most cost-effective (least-cost) option of meeting a strict standard is still too expensive. This would suggest that standard should be relaxed — cost-effectiveness analysis can help point this out too.

6.7.7 Benefits-Transfer-Method

The Benefits-Transfer-Method (BTM) is a method of estimating the value of environmental impacts by adapting values reported in other studies, preferably in a similar location under comparable circumstances, through primary research. Although the BTM is a secondary valuation technique, it is very practical because it saves budget and time requirements for data gathering and analysis work.

In general there are four basic steps in obtaining BTM values. The first is to select literature in order to obtain values and estimates of environmental benefits and damages. These values then need to be adjusted, in order to fit the bio-physical baseline and socio-economic and monetary information of the current project. The adjusted values are then multiplied by the number of affected individuals to get the total values per unit of time. Finally, the total discounted values of environmental impacts are calculated over the time period which impacts are expected to occur.

Although the method is straightforward, sound judgement must be used or else the calculated values may be totally inapplicable to the project being evaluated. If BTM is to be used, it is important to properly evaluate the appropriateness of the value because a wide range may be found in the literature due to the differences in estimation procedures. It is also important to make necessary modifications in the values to account for differences in the primary study site and the new study site. If the values from a developed country are to be extrapolated to a developing country (which is often the case), the major differences in personal income, property rights, land prices, institutions, cultures, climates and natural resources should be considered.

6.8 References and Further Reading

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