Challenges in Economic Evaluation of Environmental Impacts

Chapter 3

I. Evaluation Issues

Proper evaluation of environmental impacts requires that a number of conceptual issues be carefully considered. These include the correct understanding of environmental cost, choice of valuation technique, setting the time horizon, assessing distributional impacts and intertemporal issues, and evaluating risk, uncertainty, and ethical considerations. These are discussed in the chapter's first section and the last section concentrates on anthropocentric element in the economic evaluation of environmental impacts.

A. Environmental Cost

Environmental externality costs from a productive or consumptive process can be identified as the cost resulting from the provision of a resource, which can be passed on to a third party. These costs are not incorporated into the price of productive or consumptive resource, and can cause damages to human health, human life, materials and ecosystems. For clarification, it should be noted that this cost is not equivalent to the cost to the government or the cost associated with meeting social obligations in production or consumption of the resource (e.g., compliance with environmental standards resettlement, etc.). Although there could be a similarity, environmental cost is different from the well-known dead weight loss due to interventions in any market. The environmental cost is a form of social cost due to the non-existence of markets, while dead weight loss is due to intervention in the proper functioning of a market.

Environmental externality costs can occur despite complying with all national rules and regulations. Therefore, meeting environmental standards does not mean that there is no unaccounted environmental cost. The cost of compliance is likely to be included as part of the base cost—hence is treated as a financial cost. There should be no confusion between the two types of costs. Environmental externality cost can be defined as a social cost and it is not reflected in resource prices. Although this cost decreases as a function of improved technology, studies have shown that it still amount to a significant proportion of current resource prices.

Taking the energy sector as an example, it is the general practice in many countries to set electricity regulations and standards to select demand and supply-side least-cost options. Often, when utilities develop their least-cost plans, these approaches do not consider the social cost or cost of environmental externalities. There is a possibility to include cost of regulated externalities. However, not all emissions are regulated, and in such cases, prices reflected in the market are inefficiently low and quantities sold in the market are inefficiently high. If the externality is to be positive, the price and quantity relationships work in opposite directions. Therefore, the basis of internalizing environmental externalities is an attempt to recapture some of the unpriced externalities to the resource prices.

To determine the true value of the least cost in the selection of resources, one must consider the environmental costs imposed on society when a particular resource is used. If utility planners ignore the incorporation of environmental cost into the least-cost selection of resource use, it implies that they place zero value on environmental costs. Quantifying the environmental cost in currency terms allows, for example, utility planners and government regulators to minimize health and other pollution damages. The implication of this approach is to encourage resource providers to use less polluting resources for their production.

Studies of environmental costs associated with coal plants in the Pacific Northwest, US, for example, indicate that as much as 95 percent of the quantifiable environmental costs associated with such plants are attributable to human health risks (Ottiger, et al., 1990). This shows that valuation of human health risk is one of the most significant aspects in environmental valuation. They are significant because of their magnitude in comparison to other risks in many instances. These values are also controversial because they are often confused with *values* of human life, not *risks* to human life.

Valuation of human life is controversial because for some, it is unethical. It should be noted here that the valuation of human life is different from the value of human health risks, and the latter should be estimated. This is even more relevant when the economic value of health risks consists of either society's willingness-to-pay to avoid the risk, or willingness-to-be-compensated to suffer the risk. The economic value of a health risk is not the value of certain death; it is the value of a risk shared by members of an exposed population. The value is based on everyone sharing the risk, without knowing the specific individuals who will suffer mortality or morbidity.

Health risk values are often expressed as values per human life. This is an inaccurate terminology. Aggregating values to a single life facilitates comparison, but it creates the impression that human life itself is being valued. Risk values are typically calculated for very small risks. An analyst may determine, for example, that each increment of risk of 1/100,000 probability of exposure has a value of $0.2. If the population where that the risk was imposed is 100,000, it would be expected that one person would be affected. Since that amounts to 100,000, people each with a $0.2 value, the total risk value would be $20,000. Thus, the statistical value of the incidence would be $20,000.

As with other environmental risks, the value an individual places on a health risk depends on the likelihood and magnitude of its expected damages. These damages include real economic costs such as increased medical expenditures, loss of income, and other economic products, as well as decreases in the quality or length of life. Early attempts to derive health risk values were based largely on an accounting of these costs. Individuals take such considerations into account to determine their willingness-to-pay to avoid or willingness-to-be-compensated for health risks. Finally, it should be clarified that health risks are different from the risk and uncertainty in a project's outcome, which is further discussed in this chapter.

B. Appropriate Valuation Methods

Tables 1 and 2 in the preceding chapters specify a number of valuation approaches and techniques that may be appropriate in particular project settings. It is important to exercise great care in selecting methods and approaches. As indicated earlier, where direct market-based prices or verifiable quantities are available, they should be used. Where such prices and quantities are not available, the analyst should try to use actual cost figures (including opportunity cost) as proxies for the value of environmental impacts. When such cost figures are also not available, it will be necessary to assess monetary benefits using other methods such as the contingent valuation method, or the benefits-transfer method. Where benefit estimation becomes too speculative, as a rule, cost-based methods become more practical.

C. Accounting Stance

The project accounting stance is the geographic scope over which project benefits and costs are to be calculated. In general, project economic analysis will have an accounting stance that coincides with the boundaries of the nation in which they are undertaken. However, financial analysis may be limited to private or firm boundaries. This is because economic analysis is geared toward capturing broad socioeconomic factors which may not necessarily be important from a financial analysis viewpoint. While some project benefits and costs will be concentrated in the immediate project regions, for economic analysis, the analytical domain is, generally, the nation-state. However, if the impact goes beyond the boundaries of a nation-state, then transboundary impacts exist.

There are transboundary impacts that have a bearing on the whole world and these are classified as global impacts. These global impacts do not necessarily have a uniform effect across countries. Often it affects a particular country or a group of countries more than they affect the rest of the world. To complicate the issue further, there are cases where the impact source countries and the affected countries cannot be identified.

Global warming is a global impact. It has been shown in many scientific studies that the increase in greenhouse gases (GHGs) is a major contributing factor of accelerated global warming. Global warming creates a complex array of environmental, social, and economic problems for countries. It is possible to estimate the total amount of GHGs a country emits. However, once emitted, GHGs become added to a global stock. At this point, identitfication of its effects on individual countries is an impossible task. Warming affects the whole world but the extent of the effects varies from one country to another.

It is quite correct economically to use several accounting stances—for instance the nation-state, the nearby region, and the "rest of the world." These stances are additive. It may be helpful to think of accounting stances as a set of books—one for each geographic region pertinent to the analysis (the nation-state, the contiguous region, the rest of the world). It should be kept in mind that these are project impacts; accounting for all its effects is important. The fact that some effects travel beyond the nation-state boundaries does not warrant that they be ignored.

The development of a project-level economic analysis theory has progressed dramatically since it was first used. In the past, the economic evaluation of environmental impacts was not considered an important aspect of project-level economic analysis. During the last two to three decades, methodologies for taking environmental impacts have been developed. At present, accounting for environmental externalities is common-practice in project-level economic analysis. These developments were realized, despite the traditional thinking that impacts external to the project should not be considered as part of the project's impacts.

Currently, there appears to be disagreement among economists regarding how to account for global impacts. Similar to the case of internalizing environmental externalities, there is a strong justification for complete accounting of overall project impacts. The concept of total economic value (shown in Figure 1) clearly shows that all impacts, whether on-site, off-site, short-term and long-term, must be accounted for to assess the value of an environmental impact. The existence of markets or proper institutional mechanisms for trading global environmental goods and services should be a secondary concern in valuation. Thus, global impacts should be included in project analysis. All impacts—local, national, transboundary and global—can be included in project economic analysis (see Appendix 2 for a more detailed discussion).

In the case studies presented in Chapter 4, analysis for both with and without economic evaluation of environmental impacts is given in view of the different opinions on the matter. In all cases, the economic analysis is presented and internal rates of return are calculated. In natural resource development projects, the classification of environmental vs. non-environmental impacts is difficult. In some cases, the exclusion of environmental benefits/costs renders the project not economically feasible. In these cases, an integrated evaluation is presented. Whenever possible, economic, environmental and global impacts and their valuation are segregated. The provision of complete information provides more comprehensive inputs to aide decision-makers.

D. Time Horizon

The time horizon for the economic evaluation of environmental impacts should coincide with the economic and technical life span of the project. However, where the positive or negative impacts on the environment are expected to persist beyond the project's life span, the time horizon of the analysis should be extended accordingly. There are two ways to accommodate an extended time horizon. First, one can extend the cash-flow analysis for a number of years specific to the project under consideration. Second, one can 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 a specified time period or to infinity.

This situation will be most prevalent in projects with covenants that exceed the economic or technical life of the project. Consider a project for which an important component consists of policy reform to modify pricing practices that affect the environment. Here, the full depreciation of the benefit and cost streams directly related to the project (at the end of its economic or technical life) will hold no bearing on the associated policy reforms that were an integral part of the project. In simple terms, environmental policy reforms may outlive the physical project with which they are associated.

E. Distribution Aspects

Economists do not have complete agreement on the issue of addressing distributional aspects in project analysis. The consequence is that there is also no consensus on the distributional considerations when undertaking economic evaluation of environmental impacts. Yet distributional concerns are always an implicit part of project evaluation and selection at the national level and efforts to make them explicit will often improve project selection and evaluation.

The theoretical basis for cost-benefit analysis is the Kaldor-Hicks criterion, or the concept of potential Pareto improvement. Potential Pareto improvement does not require that the project's winners offer actual compensation to losers. However, it requires the condition that winners should potentially be able to compensate the losers. Compensation to losers is not necessarily borne by winners. Similarly, according to the Kaldor-Hicks criterion, regardless of the winners or losers of the project, the discounted benefit should exceed the discounted cost of the project. Therefore, some economists argue that addressing equity aspects within the context of project analysis is a violation of the efficiency criterion which the analysis is based on. However, due to many reasons including political appeal and international assistance requirements, addressing equity issues are considered prudent in the economic evaluation of environmental impacts.

Several approaches have been suggested in addressing income distribution or equity aspects in project analysis; this section describes some of the methods. In 1972, the United Nations Industrial Development Organization (UNIDO) proposed that the net present value (NPV) of a project be disaggregated according to the different income groups. This shows which income groups will gain and which groups stand to lose due to a particular project. Another approach was proposed by Little and Mirrlees (1974) advocating shadow pricing. This is based on the premise that different inputs may belong to specific groups in society (e.g., shadow wages to help labor groups). Yet another procedure was by Squire and Van der Tak (1945). The process attaches weights to consumption bundles. Income distribution or equity issues have also been addressed via project design. For instance, the approach may be a simple targeting effort, such that the project should be located in an area where majority of households have low incomes. Another is to specifically design a project that assures that workers (in the case of privatization) or local people (in the case of foreign investment) will have a stake from the very beginning.

Carefully crafted economic analysis of environmental impacts can factor in some of these equity considerations.

Equity issues in natural resource management are quite complex. For example, consider a forest reserve in a DMC which has unique ecosystem values. Rural communities surrounding the forest reserve may want to develop the area for building roads, schools, hospitals, harvesting timber, and agricultural production. On the other hand, urban residents of the country, as well as foreign tourists, may want to protect the forest reserve for their recreational and visitation benefits. Even if economists conduct a well-designed WTP survey, it might turn out that peripheral rural communities' WTP to protect the forest reserve is much (possibly negative) lower than urban and foreign tourists' WTP due to differences in their income levels. Various groups such as bilateral and multilateral aid agencies and some trust funds have developed ways to transfer income from individuals with higher WTP to peripheral communities with lower income levels to protect such unique ecosystems. Yet addressing such concerns in the context of project analysis is extremely difficult.

F. Intertemporal Issues

Intertemporal equity and efficiency warrant special consideration in the economic evaluation of environmental impacts. It should be noted that not only present generation, but also future generations should be considered to assure sustainable development. When a project decision is made today (by the present generation) inherently, the participation of future generations in this decision-making process is not considered. A possible solution is to assign a trustee to take part in the decision-making process. Yet, unless motivated by altruistic reasons, individuals generally make decisions in favor of their own well-being, which obviously considers a much shorter time period than what future generations may want to consider. For example, a particular project may greatly disadvantage future persons vis-à-vis those now living; this could happen if a project required the resettlement—without adequate compensation—of a large number of families to vastly inferior land and thus lead to a gradual increase in poverty. Another example would be a project that resulted in the gradual chemical contamination of domestic water supplies that would, over the long run, hold serious health implications for future persons.

Pigou in his famous book *The Economics of Welfare* (1932) forwards that the government should act as a trustee of unborn generations particularly in decision-making processes, yet this may have serious repercussions. Some officials, whose time horizon is determined by the next election or is exposed to various degrees of corruption, may not be the best agency to act as trustee to the future generation. A consensus-based approach involving representation from a wide spectrum of civil society may be a better approach.

Because of a lack of knowledge about future time paths for economic development, technological uncertainties, and behavioral nature of human beings, it is extremely difficult to develop a mechanism that will assure the preservation or improvement of the welfare of future generations, within the ongoing decision-making process. Environmental economists have proposed safe minimum standards (SMSs) and maximization of expected utility as a means of addressing some of the crucial irreversibility issues, with SMS being a more conservative approach. While some argue that it is better to leave "development" or "intervention" when it comes to unique ecosystems, others argue that nature is changing anyway, and untouched ecosystems in the present generation does not guarantee the present status of the natural resource for future generations.

The discounting of future events—whether environmental benefits or costs—has the practical implication of diminishing the significance of those benefits or costs in the evaluation of projects. The narrow economic perspective is that future events are inherently less significant than events in the near-term. When thinking of monetized streams of benefits and costs this logic has merit. This is especially true when a private firm is contemplating an investment with differential time profiles of costs and benefits. But nation-states are not private firms and hence social cost-benefit analysis of environmental impacts carries a heavier ethical burden than that of the financial analysis in private firms.

When considering the welfare (utility) of individual persons over time, the presumed compelling logic of discounting breaks down. There is no ethical basis for regarding the welfare (utility) of our unborn grandchildren as worth less than our own welfare. Moreover, monetizing their future utility by converting it to "benefits" or "costs" does not rectify the problems inherent in discounting their welfare; the ethical problem remains (Bromley, 1989; Chichilnisky, 1997). The practical implication is that projects with very long-term environmental and social benefits and costs may require special treatment with respect to discounting. There may be a case for using a different discount rate for project costs than for project benefits. This approach is justified on the grounds that future benefits may be more uncertain than future costs. However, with many projects, the environmental costs may be as uncertain as the project's benefits.

It must also be recognized that the choice of a discount rate will influence the feasibility of different types and structures of projects. A high discount rate will favor projects with immediate (or near-term) net benefits, while a low discount rate will give more weight to future impacts. The assessment of a project's environmental impacts is particularly sensitive to the discount rate since many environmental impacts may occur over a long time period.

G. Risk and Uncertainty

Economic analysis must also address the problem of risk and uncertainty assessment (ADB, 1991). Natural events such as drought, floods, earthquakes, and plant and animal diseases may seriously affect projects. Risky events are those to which probabilities can be attached; an example is a 40-year flood, or the probability of a drought over the next 5 years. There is an empirical basis for assigning probabilities to these events, and thus for incorporating their stochastic nature in the economic evaluation of environmental impacts. Uncertain events, on the other hand, are those for which no empirical basis exists to attach probabilities. Examples of uncertain events are the disappearance of the earth's atmospheric ozone layer, the climatic implications of greenhouse gas (GHG) emissions, or the long-term health effects of exposure to certain chemical pollutants.

It is widely accepted that risk and uncertainty exists whenever an activity has more than one outcome. Almost all development activities involve a certain amount of risk. In general, economic evaluation of environmental impacts deals with risks and uncertainties in prices, outputs, technological changes, natural calamities, and various political changes. Aside from such risks and uncertainties, there are also scientific, technical and biophysical risks, and uncertainties in the valuation of environmental impacts.

For example, the reduction in the intelligence quotient (IQ) level of children living in a city where lead pollution from vehicles is present, cannot be fully predicted due to uncertainty involved in scientific information. Another example is the technical difficulties in the release of chloroflourocarbons (CFCs) into the atmosphere and the resulting damage to the ozone layer. The assessment of economic impacts of such damages for a given country or project would be much more complicated. In some cases, uncertainties may arise from incomplete information or disagreement between sources of information. In other cases, uncertainties may be related to the quality or quantity of the outcome, the dose-response function, or the production function.

Economic evaluation of environmental impacts inherently deals with the prediction of the future, although the biophysical database is extracted from environmental impact assessment. Depending on the nature of the environmental impact, economic evaluation requires the integration of knowledge from many disciplines (e.g., biological, technical, and social) of which economic data is merely a part of total data requirements. Perfect understanding of any of these disciplines, including economics, has not been achieved. Although there is no trade-off between biophysical and economic data (both necessary for environmental economic analysis), there is an optimum amount required. From a practical standpoint, the optimal value lies where the marginal cost of data gathering is equal to the marginal benefit added to the valuation exercise.

Effective risk management of environmental variables can be achieved through three methods. The first is through the internalization of risk, which involves decisions regarding the risk reduction made by the individual facing the risk. An example is to refuse the consumption of fish from polluted water sources. The second is market-based risk management. Examples include food safety in the market place or safety arrangement for workers made in a factory. In this case, market risks have been transmitted to the risk generators, and they have taken precautions to reduce it. The last method is externalizing risks in cases where a proper market is not functioning. Waste disposal, technological hazards and air or water pollution can be used to exemplify this method. In this case, a mixed activity such as collective bargaining, government or non-market intervention may be required to reduce risk. However, the inherently composite nature of environmental risk makes it difficult to simplify the analysis of environmental risks (Segerson, 1992).

In project design, environmental risks can be reduced through privatization or the introduction of Pigovian-type taxes. For example, if consumers are not free to move away from polluted air or an unhealthy work environment, victim compensation-type insurance can be introduced. Another option is that risk generators can be given incentives to reduce the risk. Pigovian-type taxes to reduce air pollution can be considered an example of such an incentive. In privatization, risks need to be bilateral, whereas in the Pigovian-tax case, extra market or institutional intervention may be required (Segerson, 1992).

For risky events, the analyst can use expected values as alternative values for certain variables such as prices or quantities. However, the expected-value method of accounting for risks does not indicate the degree of risk—the range of expected values. Sensitivity analysis can be used to recognize this dimension. 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 of environmental impacts. Sensitivity analysis is the standard treatment for dealing with risk and uncertainty in the economic evaluation of environmental impacts. In doing sensitivity analysis, the following steps should be taken:

1. one-at-a-time analysis of each input or variable holding all other factors constant;

2. changing the value of more than one input or variable at the same time;

3. parametric analysis, moving one or a few inputs or variables across reasonably selected ranges; and

4. probabilistic analysis, using correlation or regression to examine how much of the uncertainty in outcomes can be attributed to the input or variable.

Box 4 gives examples of alternative decision criteria that may be applied in environmental risk assessment.

H. Ethical Considerations

It is now recognized that the economic evaluation of environmental impacts is limited by ethical and moral considerations. This can be seen in controversial efforts to assign monetary values to human life and health status. The previous discussion of discounting the welfare of future persons is another example of the ethical content of economic analysis. While methods have been devised to evaluate project outcomes that will adversely affect human health (the value of lost earnings, the necessary increase in health costs to the individual), it is more difficult to address the question of the economic value of a human life. Noteworthy here are the complications arising from the moral dimension of choice, and the important role of perceptions of individual and group entitlements to certain situations and outcomes.

The entitlement issue is often called the "endowment effect." The endowment effect refers to a situation in which a local people have a real or presumptive property right in resources or circumstances. It is in precisely these settings that they will resist efforts to elicit from them some estimate of their WTP for something; they will insist that since they already "own" the resource why should they be asked how much they would pay to keep it? Likewise, the endowment effect will often induce individuals to reject monetary compensation in return for relinquishing control over particular assets. In such situations the analyst must be careful not to impose economistic questions and answers into choice situations that are not economic in nature. The mere existence of economic implications from

Box 4. Decision Criteria for Environmental Risk Assessment

Utility-based criteria

- *Deterministic cost-benefit: Estimate the benefits and costs of the alternatives in economic terms and choose the one with the highest net benefit.*
- *Probabilistic cost-benefit: Same as deterministic cost-benefit but incorporate uncertainties and use expected value of resulting uncertain net benefit.*
- *Cost-effectiveness: Select a desired performance level, perhaps on noneconomic grounds. Then choose the option that achieves the desired level at the lowest cost.*
- *Bounded cost: Do the best you can within constraints of a budget, that is, the maximum budget society is prepared to devote to the activity.*
- *Maximize multi-attribute utility (MAU): This is the most general form of utility-based criterion. Rather than use monetary value as the evaluation measure, MAU involves specifying a utility function that evaluates outcomes in terms of all their important attributes (including uncertainties and risks). The alternative with maximum utility is selected.*
- *Minimize chance of worst possible outcome…maximize chance of best possible outcome, etc.: Political and behavioral considerations frequently dictate the use of such criteria.*

Rights-based criteria

- *Zero risk: Independent of the benefits and costs, and of how big the risks are, eliminate the risks, or do not allow their introduction.*
- *Bounded or constrained risk: Independent of the costs and benefits, constrain the level of risk so that it does not exceed a specific level or, more generally, so that it meets a set of specified criteria.*
- *Approval/compensation: Allow risks to be imposed only on people who have voluntarily given consent, perhaps after compensation.*
- *Approval process: Not strictly a decision criterion for analysis, but widely applied in risk management decision making.*

Technology-based criteria

- *Best available technology: Do the best job of reducing the risk that is possible with "current" or "best available" technology; while it is economically determined, in practice technology-based criteria are often modified forms of utility-based criteria.*

Hybrid criteria

Hybrids of utility- and rights-based criteria are sometimes used. For example, an upper bound on risk may be established (rights-based) below which a cost-benefit (utility-based) criterion is applied.

Adopted from: Garanger, M.M. and M. Henrion. 1990. Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis. New York: Cambridge Press.

situations of choice does not automatically render that situation strictly economic in nature and significance.

The endowment effect also dominates consideration of the proper way to elicit estimates of economic value from respondents in contingent valuation surveys (Bromley, 1995). There are two possible measures by which economists attempt to estimate economic values through hypothetical scenarios and questionnaires. These are called estimates of WTP, and WTA compensation. There is an intuitive plausibility to particular pairings of these two measures. It is logical to insist that WTP is the more appropriate measure when individuals face a welfare-enhancing choice. Similarly, there is solid logic to the idea of determining the WTA compensation for a welfare-decreasing event. That is, when a choice situation holds the promise of welfare gain one should estimate the monetary value of that welfare gain by asking what individuals would be willing to pay. Similarly, when faced with a welfare loss one should estimate what would be required by way of compensation to make individuals indifferent between the alternatives before them. The difference in which approach—WTP or WTA—is followed is not trivial in terms of empirical estimates of monetary valuation. It is common to find that estimates of WTA—or the minimum compensation required—can be three to five times larger than WTP measures for the same event (Bromley, 1995).

The endowment effect implies that the appropriate measure of resource value is a function of the perceptions of the appropriate *status quo ante*. In one study respondents were willing to pay only $3.50 to preclude the need for a dam (thus saving a scenic waterfall), but demanded $22.00 to accept the loss of the waterfall should the dam be built (Ward and Duffield, 1992). That is, they seemed willing to pay less than one sixth the amount to avoid the destruction of a waterfall than they would require in compensation if the dam were to be built. Is it possible that the respondents frame the choice to be one of paying to avoid the dam (rather than to save the waterfall), versus being compensated to tolerate loss of the waterfall? It is now well-established that individuals value possible gains much differently than they value possible losses (Knetsch, 1990; Knetsch and Sinden, 1984). The problem in most economic evaluation of environmental impact exercises is determining whether those engaged in contingent valuation experiments regard the choice situation as one of a gain or a loss. That perception of gains or losses is critically dependent upon the respondent's perception of individual endowment of environmental goods and services. The WTP approach will often be preferred because WTA studies have traditionally yielded erratic results.

The endowment effect is often quite pronounced if the environmental resources in question are embedded in a community's cultural traditions and value systems. This is particularly true for resources where the perceptions of loss depend on a community's cultural and historical attachment to these assets and resources; sacred forests are an obvious illustration. In such settings, individuals may be unwilling to accept any level of compensation, no matter how high, if they are asked to forego those environmental resources.

II. The Environment and Human Values

The final consideration is that of the anthropocentric element in all efforts to economically evaluate environmental impacts. Conventional economic estimates of environmental values are predicated upon the idea that all such values originate with humans. This means, for instance, that nature has no intrinsic value beyond that which humans are willing to ascribe to it. Of course this position is unacceptable to a wide range of individuals who care about the environment.

The imposition of human values onto environmental resources need not be a problem to the economic evaluation of a project's environmental impacts unless that imposition is regarded as definitive and decisive. In other words, if a project will destroy a particular habitat of no conceivable human value, there will be a great temptation to record no environmental loss because of that destruction. However, it is well known that any particular habitat cannot exist in isolation from other habitats—either near or far—and so a functionalist understanding of ecology would suggest that no complex of environmental resources, no matter how uninteresting, can be sacrificed without potential implications elsewhere in the system.

This does not mean that human activity must cease, and that every blade of grass must become sacred and inviolate. It does suggest, however, that the economic evaluation of a project's environmental impacts cannot be cavalier and dismissive of things that happen to escape human valuation.[11]

The preceding section has highlighted a number of important issues in the emerging role of economic evaluation of environmental impacts. In conjunction with the environmental assessment (EA), economic evaluation of environmental impacts is now recognized as an integral part of project identification, formulation, and evaluation. The economic evaluation of environmental impacts can also provide valuable insights for the economic assessment of activities suggested by the EA. Finally, the most obvious role for economics is in the assessment of environmental impacts of those projects that seem feasible. When properly conducted using an EA to identify and document—both quantitatively and qualitatively—all aspects of a project's likely environmental impacts, the economic analysis of environmental impacts allows for a more complete accounting of the costs and benefits of a project. This enables the project planners to make better decisions regarding particular projects, and it allows for improved project design. It should be noted that aside from project level work, environmental economics has a large and increasing role in environmental policy as highlighted in Box 5.

[11] *It is a warning against reductionist thinking, and aggressive utilitarianism.*

Box 5. Environmental Economics and Policy

The search for appropriate policies for environmental management and for sustainable development is an ongoing process. There has been an increasing recognition of the need to treat environmental implications in a more effective and prudent manner, particularly in internationally assisted development efforts. In broad terms, the problem lies in the failure of market systems from society's viewpoint, to optimally manage and conserve the environment and its consequences for sustainability.

Views on solutions to market failure vary. Arguments have been raised in favor of government or other nonmarket intervention to correct the failure. Some argue, however, that market failure can be overcome by creating conditions more favorable to market operations, and that even idealistic government intervention involves a cost, with government intervention subject to political or administrative failure. Inevitably, the conclusion is that there is no simple universal means for attaining the best allocation of resources. The best approach is likely to be a blend, achieved through a fine-tuning effort in balancing market mechanisms and nonmarket approaches.

Environmental economics as a discipline has become increasingly sophisticated in its ability to derive useful and meaningful insights regarding these concerns. The central issue of using environmental economics in the analysis, formulation, and choice of policies that will enable the achievement of environmental objectives has also increased. A better valuation of resources is required so that producers and consumers face the full (including the social) cost of their decisions and so that planners make a more realistic evaluation of economic possibilities. The increasing role of environmental economics is reflected in the growing recognition of the use of incentive-based economic tools for environmental management.

According to IUCN-UNEP-WWF (1990), the advantages of environmental policies that include economic incentives are: (i) encouragement of the best choice of technology and economic practices to achieve environmental goals; (ii) harnessing of market forces such as individual self-interest; (iii) no greater cost as a rule to administer than regulation; (iv) yield government revenue if taxation, pricing, etc. is involved; (v) encouragement of the development of pollution-reducing technology; and (vi) provision of incentives for the *use and development of alternative environmentally sound products and processes.*

Designing economic incentives to stop, slow or reverse environmental degradation illustrates the application of environmental economics in the design of policy. Economic incentives can be in the form of altering prices or cost levels (e.g., product/emission/input charges and deposit-refund systems); indirect alteration of prices or costs via financial/fiscal means; or market creation and market support. The modification of markets by deciding the value of environmental goods and services and ensuring that these values are incorporated into the price of such goods and services calls for the use of environmental economics.

The successful application of economic incentives calls for the following: (i) the chosen economic incentive should be able to mitigate the range of pollution and resource usage impacts associated with packaging (environmental effectiveness principle); (ii) it should provide a continuous incentive for seeking least-cost solutions (economic efficiency principle); (iii) its impact should be significantly regressive (equity principle); (iv) it should have both low bureaucratic and compliance cost (administrative cost-effectiveness principle); and (v) simple and transparent economic incentives are more easily internalized by the existing market and institutional systems (acceptability principle).

The selection of the appropriate economic incentive is a complex issue. Take the case of environmental taxation. Pigou (1932) observed that the marginal private cost to firms of producing products might diverge from the marginal cost to society of such production. The marginal private costs of production by firms can be brought into line with social costs by imposing tax on the output of the product, which is the source of pollution. In the absence of regulation of this type, firms treat the environment as a free resource for waste disposal and pollute excessively.

Indirect market-based measures like environmental taxes may be favored over direct measures such as emission-based fees and tradable pollution permits, because: (i) quantities of inputs or outputs, which are the basis of the charge, are easier to monitor compared to emissions; (ii) there exists a government tax collection agency; and (iii) taxes generate revenues accruing to the government, which can be used to administer abatement programs. Environmental taxes *are said to provide double dividends: better environmental quality and higher fiscal revenues. Yet the success of environmental taxes is largely dependent on the cost structure of the subjected economic activity. If taxes are set too high (the tax level goes beyond correcting externalities), investments will tend to relocate. This results in a reduction of both producer surplus and consumer surplus, and thus, overall social welfare can decrease. The implementation of environmental taxes will also be affected by: costs of control; monitoring, tax-setting and revenue collection; use of tax revenues; and roles of the local and central governments. The central authority must also possess a high degree of credibility for environmental taxes to be successful.*

Although efficient levels of policy instruments can be defined in principle, in practice, they are difficult to implement. This is due to the large information burden as well as various social, political and institutional factors. The information gap, however, can be bridged by environmental economics through appropriate valuation of environmental impacts. Environmental economics allows a more complete understanding of resource implications for social welfare and alternative courses of action. It also aids in designing and evaluating environmental policies to achieve specific environmental considerations.

Environmental economics strengthens the use of market-based policies. Improvements in the use of such policies improve the policy mix with traditional command-and-control policies—resulting in a more appropriate approach for environmental management and sustainable development. Finally, it is worth noting that no matter how well-designed a project is, it cannot be appropriately implemented unless there are sound environmental policies.

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