Environmental Assessment Sourcebook 1999

CHAPTER 4

ECONOMIC ANALYSIS OF PROJECTS AND POLICIES WITH CONSIDERATION OF ENVIRONMENTAL COSTS AND BENEFITS

1. This chapter reviews current economic approaches to the analysis of projects and policies and discusses possibilities for better integrating environmental concerns. Part I outlines current practices as they relate to the analysis of traditional projects, to public expenditure and investment reviews, and to the analysis of economic policies, such as in the context of economic and sector work, or in connection with structural or sectoral adjustment operations.

2. Part II deals with four key issues: physical impacts of projects and policies valuing these in monetary terms; the discount rate; and issues of risk and uncertainty.

Approaches for valuing environmental impacts are emphasized. Where possible, practical examples are given for "broad-based" analyses, which deal with what has often been referred to as "externalities." Conclusions are presented in Part III.

PART I: REVIEW OF CURRENT PRACTICES

The Context for Economic Analysis of Projects and Policies

3. Most governments pursue certain general objectives in terms of economic growth, income distribution/poverty alleviation, and proper management of natural resources. There may be some complementarities in these objectives, but it is accepted that significant trade-offs are involved, at least in the short term. Given the existing scarcities of financial and human resources in developing countries, it is particularly important to invest the limited resources in such a way as to reap the maximum benefit in terms of the country's objectives. Sound economic analysis of projects and policies is an important means of making the allocation process more efficient.

Economic Analysis of Projects

4. Project analysis is a method of presenting systematically the choice between competing uses of resources. It assesses costs and benefits with a common yardstick. Benefits are defined relative to their effects on the improvements in human well-being. Costs are defined in terms of their opportunity costs, which is the benefit foregone by not using these resources in the best of the available alternative investments.:

Economic Analysis Versus Financial Analysis

5. Economic analysis of projects differs from financial analysis. The latter focuses on money profits accruing to the project entity. Various financial indicators are used to evaluate the entity's ability to meet its financial obligations and to finance future investments. The economic analysis, on the other hand, measures the project's effect on the efficiency of the whole economy. Rather than financial prices, shadow prices are used that reflect opportunity cost. The cost and benefit streams are compared, and indicators such as net present value (NPV) and internal rate of return (IRR) are calculated. Sensitivity analyses are undertaken to determine which component(s) of the project are particularly important for a satisfactory outcome.

Social Cost-Benefit Analysis

6. Basic cost-benefit analysis (CBA) uses economically efficient values of costs and benefits to determine which projects contribute the most toward the growth/efficiency objective of the economy, independent of who the beneficiaries are. The SCBA tries to take income distribution effects into account by assigning higher weights to benefits accrued by the poor (Squire and van der Tak 1975). In practice, formal weighting systems have seldom been used in project analysis. Income distribution, and indeed other social goals, have typically been treated ad hoc.

Past Shortcomings with Regard to the Environment

7. In principle, economic analyses are to take into account all costs and benefits of a project. With regard to environmental impacts, however, there are two basic problems. First, environmental impacts are often difficult to measure in physical terms. Second, even when impacts can be measured in physical terms, valuation in monetary terms is difficult. In spite of such difficulties, a greater effort needs to be made now to "internalize" environmental costs and benefits by measuring them in money terms and integrating these values in economic appraisal (see Part II).

The Value of Considering Environmental Effects Early on in the Project Cycle

8. The main purpose of the economic analysis of a project is to ascertain whether the project can be expected to create more net benefits than any other, mutually exclusive option, including the option of not doing it. Consideration of alternative options therefore is a key feature in proper project analysis. Often, important choices about alternative project options are made early on in the project cycle. These options may differ considerably in their general economic contribution, and they may also differ greatly in environmental impact. Therefore, including environmental effects in the early economic analyses, however approximately, should improve the quality of decision-making.

Public Investment Reviews

9. An important lending institution like the Bank needs to consider not only the viability of individual projects, but also the overall investment program of a country. The Bank's leverage is limited, however and governments may be sensitive about outsiders' views on priority-setting based on explicit criteria. This is particularly so when "national security concerns" are invoked in justification of projects, or when projects are politically motivated. Nevertheless, an overall appraisal of a country's public investment program (PIP) is important. Money is fungible, and the financing of a sound project by the Bank might permit a country to utilize its own or other resources to finance a project that may make only a limited contribution to the overall objectives.

10. An analysis of Public Investment/Expenditure Reviews (PI/ERs) has been undertaken by the Bank. The following recommendations were made to improve their cost-effectiveness: (a) clear, achievable objectives should be set (e.g., by limiting the number of sectors covered); (b) coverage of issues should be selective and tailored to country circumstances, except for core components (PIP and recurrent expenditures for the main sectors); (c) the Bank should avoid taking direct responsibility for drawing up the PIP; (d) more attention should be paid to upstream sector work (to be included in the PI/ER); and (e) for a crisis mission, a detailed aide-memoire will be more timely and often more cost-effective than a full report (de Melo 1988). :

Analysis of Economic Policies: 11. Previous Bank guidelines on the economic analysis of projects dealt exclusively with projects in a narrower sense. Since the guidelines were issued in l980, sectoral and structural adjustment lending has increased rapidly and stabilized at around 25 percent of Bank lending. Also, "hybrid" projects are now financed that contain elements of both investment-type and policy-based operations. For sound economic analysis, the same cost-benefit standards should apply to the whole spectrum of "projects" that are financed.

12. Most of the policy and institutional reforms supported under structural adjustment loans are intended to increase the efficiency of the economy and to promote economic development. The extent to which

economic growth is increased by the reforms is seldom explicitly expressed in quantitative terms. The design of policy reforms would be improved if better attempts could be made to identify and (wherever possible) estimate their costs and benefits, based on a comparison of the standard "with policy" and "without policy" projections (Kanbur 1990).

13. With regard to recognizing and including environmental concerns in economic analyses explicitly of macro-policies, a number of observations can be made, particularly on national income accounts and the environmental effects of macro-policies on the natural resource base. :

Performance Measurement in the National Income Accounts

14. Performance is currently measured by the growth in Gross Domestic Product GDP, and policy reforms are justified on the basis of their short-, medium-, or long-term contribution to such growth. While GDP measures market activity reasonably well, it does not include non-market value added. More importantly, since GDP does not consider depreciation of man-made capital and also leaves out the degradation of "natural capital", it is an inaccurate measure of true, sustainable income (Ahmad, El Serafy and Lutz 1989).

15. The Bank and the United Nations Statistical Office (UNSO) are conducting case studies to develop methods for deriving and Environmentally-adjusted Net Domestic Product (EDP). Until such work has come to fruition, policy analysts should keep in mind the limitations of current national accounts information. The most desirable policy reforms are those that increase EDP rather than GDP, since EDP more accurately measures "sustainable" income.:

Tracing Policy Effects on the Natural Resource Base

16. Interactions between the economic system and the environment are complex and our understanding of them limited. Ideally, a comprehensive model is needed that traces the package of policy reform through the economic and ecological system. Generally, time and data limitations preclude the use of such models in developing countries. Practical policy analysis is usually limited to a more "partial equilibrium" approach that seeks to trace the most important impacts of specific reforms, qualitatively and, where possible, quantitatively.

17. Several studies contain practical examples of what an analyst can achieve even with limited time and resources available. Binswanger (1989) showed that in Brazil general tax policies, special tax incentives, the rules and land allocation, and the agricultural credit system all accelerate deforestation in the Amazon. These policies also increase the size of land holdings and reduce the chances of the poor to become farmers. Mahar (1989) made a thorough historical analysis of government policies and programs in Brazil. He traced many of today's problems in the Amazon to the decision in the mid-1960s to provide overland access to Amazonia -a decision made before enough was known about the region's natural resources to be able to develop it is a sustainable manner.

18. In a study on Costa Rica, Lutz and Daly (1990) reviewed incentives and regulation, and attempted to assess how these affect deforestation and sustainable land use. They found that most of the deforestation at present is being done not by squatters, but by the logging industry, banana companies and large cattle ranchers, driven by profit and asset maximization motives.

19. In another study, Lutz and Young (1990) traced the effects of agricultural policies on the natural resource base. Some of these can be assessed relatively easily, at least in quantitative terms. For example, where the removal of a fertilizer or pesticide subsidy is being considered in an adjustment program, it is clear that, as a result of the proposed reform, government expenditures will decrease, farmers' use of these products will decrease, and environmental effects will tend to diminish as well. The quantitative effects essentially depend on the relative elasticities involved.

20. For certain policy or institutional reforms, it may not be possible a priori to determine the environmental impact in the short or long run, since there may be both positive and negative environmental effects. The net effect may depend on the size of the relevant parameters that are case-specific and which must be estimated.

The Case for More Environmental Analysis Under Resource Constraints

21. Little and Mirrlees (1990) noted that between the mid-1970s and 1990, there occurred a "rise and decline of project appraisal in the World Bank and elsewhere," and claim that currently the incentives are inadequate for project analysts to undertake thorough, in-depth analysis of projects.

22. In view of the existing discrepancy between what ought to/could be done and what is actually being done, the question arises whether it is realistic to expect more thorough treatment of externality issues. However, even in situations where task managers have limited resources at their disposal, natural resource and environmental issues may be critical to the success or failure of a project or

policy. Therefore, even under budget constraints, where environmental issues are involved, some funds should be spent on environmentally-oriented economic analysis, preferably early in the project cycle. Part II suggests "best practice" for integrating natural resource and environmental issues into economic analyses of projects and policies.

PART II: POSSIBILITIES AND CONSTRAINTS FOR INCLUDING ENVIRONMENTAL COSTS AND BENEFITS INTO ECONOMIC ANALYSIS OF PROJECTS AND POLICIES

23. Four key issues in measuring environmental costs and benefits are discussed here: (a) determining physical impacts and relationships; (b) valuing impacts in monetary terms; (c) discounting; and (d) risk and uncertainty. Emphasis is given to methods and approaches.

Physical Impacts and Relationships

24. The first step in environmentally sound economic analysis is to determine the environmental and natural resource impacats of the project or the policies in question. These impacts are determined by comparing the "with project" and the "without project" impacts. The difficulty in doing this varies greatly. For example, solid waste production of an industrial plant can be estimated easily, whereas it is much more difficult to identify all the environmental impacts of a trade policy reform, of air pollution, or even of soil erosion on agricultural productivity.

25. For determining physical impacts, an economist will have to rely on the expertise of engineers, ecologists, agronomists, social scientists, and other specialists. The task is complex in that some physical relationships may not be known, may be stochasitc or may occur only over the long-term.

Valuing the Impacts in Monetary Terms

26. A number of conceptual approaches have been developed for valuing physical impacts relationships. An environmental impact can show itself in a measurable change in production or environmental quality. Different methods are appropriate depending on the types of effects (see Table 4.1).

27. The methods and approaches discussed below are applicable in developing countries. The techniques are presented in decreasing order of reliance upon market information, beginning with those that rely on actual market prices, and ending with survey-based and other hypothetical methods.

Market-Based Methods

28. The primary feature of these methods is that they are based directly on market prices or productivity. They are applicable where a change in environmental quality affects actual production or production capability.

Table 4.1. Chief Valuation Techniques

SURROGATE MARKET POTENTIAL EXPENDITURES DIRECT VALUATION VALUES OR WILLINGNESS-TO-PAY

Change of productivity Property values Replacement costs Loss of earnings Wage differences Shadow project Defends expenditures Travel costs Contingent valuation Marketed goods as proxies

Change-in-Productivity Approach

29. Development products can affect production and productivity positively or negatively. For exa mple, a land management project involving soil conservation measures, may yield increased agricultural output. The incremental output can be valued by using standard economic prices.

30. The environmental costs of reclaiming wetlands or of water pollution are now being recognized. Where these affect fish catch either in the short-term or long-term, the value of fish catcah can be estimated directly by using actual or projected market prices. (Wetlands are beneficial in more ways than fish catch, of course; for a detailed discussion, see Chapter 2.)

31. An empirical example of the change in productivity approach is a study by Anderson (1989) that measured the benefits of afforestation in Nigeria. Studies show that in Northern Nigeria, shelterbelts have significant effects on crop yields, generally in the range of 10 to 30 percent. Therefore, in addition to the wood production, the benefits from increased farm production should be considered (see Table 4.2).

32. Loss-of-Earnings Approach. Changes in environmental quality can have significant effects on human health. Ideally, the monetary value of health impacts should be determined by the individuals' willingness to pay for improved health. In practice, "second best" techniques may be necessary, such as valuing earnings that are foregone through premature death, sickness or absenteeism; and increased medical expenditures. This approach may be relevant, for example, when considering road and industrial plant safety, and projects that affect air pollution in major cities.

Table 4.2. Estimating the Benefits of Afforestation

Trees provide a variety of benefits other than wood. Thus, economic analysis concentrating only on wood production clearly underestimate total benefits from tree planting. In the Anderson study cited, four benefits of afforestation (for Northern Nigeria) were considered: (a) stemming future declines in soil fertility; (b) improving current levels of fertility; (c) acquiring tree products (firewood, poles, fruit, etc.); and (d) increasing the availability of fodder. (Fodder can be increased by increasing soil fertility and by planting fodder trees and shrubs as part of a farm forestry program. In turn, these practices can enhance economic output or livestock benefits.)

Considering the benefit of wood products alone results in a modest rate of return of approximately 5 percent. Evaluating the three other benefits raises the net present value fourfold and the economic rate of return to over 15 percent. These calculations were based on conservation estimates of the ecological benefits.

Anderson considered two types of investments: (a) shelterbelts and (b) tree plantings near farm dwellings and on farm boundaries by the farmers themselves. Both have similar qualitative ecological benefits, but different costs, risks, and quantitative effects.

Costs and benefits were estimated in seven steps: (a) determining gross and net farm income; (b) determining the growth of agricultural productivity productivity; (c) determining the rise in gross farm income as a result of protecting the environment; (d) calculating the rate of change in soil fertility; (e) calculating the value of wood per hectare farmed; (f) determining the costs of a project; and (g) computing the value of the land area occupied by trees. (Anderson shows how the calculations were done in "Economic Aspects of Afforestation and Soil Conservation Projects," in Environmental Management and Economic Development, edited by G. Schramm and J.J. Warford. Also see World Bank Technical Paper 154, Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and CrossSectoral Issues, page 142 (Chapter 4).

33. The "value-of-health" approach is often questioned on ethical grounds. It is argued that it dehumanizes life, which is of infinite value. In practice, however, society implicity places finite values on human life and health when it makes policy and project decisions that affect environmental quality, workers' health or safety, etc. If this were not so, we would be justified in spending all of GDP on health improvements.

34. In the case of an increase or reduction in numbers of deaths, a first estimate is made by evaluating the projected loss in earnings of the individuals involved. The value of an increase or reduction in sickness can be approximated by adding medical costs to loss in earnings.

Defensive or Preventive Expenditures: 35. Individuals, firms, and governments undertake a variety of "defense expenditures" in order to avoid or reduce unwanted environmental effects. Environmental damages are often difficult to assess, but defensive expenditures may be determined more easily in monetary terms than direct valuations of the enviromental good in question. Such actual expenditures indicate that individuals, firms or governments judge the benefits greater than the costs. The defensive expenditures can then be interpreted as a minimum valuation of benefits.1/ However, caution is advisable with this approach, especially in cases where governments arbitrarily mandate defensive expenditures having little or no relationship to market forces or free choices. :

Methods Based on Surrogate Market Values

36. The methods and techniques described in this section use market information directly. The approaches discussed are the property value approach, the wage differential approach, the travel cost method, and uses of marketed goods as surrogates for nonmarketed goods. Each technique has its particular advantages and disadvantages, as well as requirements for data and resources. The task of the analyst is to determine which of the techniques might be applicable to a particular situation.

Property Value Approach

37. This approach, also referred to as the hedonic price technique, is a subject of the more general land value approach. Its objective is to determine the implicit prices of specific characteristics of properties. When used in environmental issues, 0its purpose is to place a value on improvements or deterioration in environmental quality.

38. The property value approach has been used to analyze the effects of air pollution in certain areas. Where pollution is localized, the method compares prices of houses in affected areas with houses of equal size and similar neighborhood characteristics elsewhere in the same metropolitan area. The approach is based on the assumption of a competitive real estate market, and its demands on information and statistical analysis are significant; therefore, applicability to developing countries is limited.

Wage Differential Approach

39. This approach is based on the theory that in a competitive market the demand for labor equals the value of the marginal product, and that the supply of labor varies with working and living conditions in an area. A higher wage is therefore necessary to attract workers to locate in polluted areas or to accept risky work.

Again, as in the case of the property value approach, the wage differential approach can only be followed if the labor market is very competitive. Also, the approach reflects only private, not social, valuation of health risks.

Travel Cost Approach

40. This approach is most often used in analyzing the economic benefits of recreational facilities in industrial countries (parks, lakes, forests, wilderness, etc.). Essentially the same approach can also be used to value "travel time" in projects dealing with fuelwood and water collection (Hanley 1989).

41. The surrounding area of a site is divided into concentric zones of increasing distance, representing incrasingly levels of travel cost. A survey of users should be conducted at the site to determine the zone of origin, visitation rates, travel costs, and various socioeconomic characteristics. Users close to the site would be expected to make more use of it because the implicit price for them, as measured by travel costs, is lower than for more distant users. Based on analysis of the questionnaires, a demand curve can be constructed and associated consumers' surplus determined. This surplus represents an estimate of the value of the environmental good in question.

Marketed Goods as Surrogates for Non-Marketed Goods

42. There are situations where environmental goods have close substitutes that are marketed, and therefore where the value to the environmental good in question can be approximated by the observed market price. For example, the value of a non-marketed fish variety can be valued at the price of the most similar fish being sold in local markets.

Methods Based on Potential Expenditures or Willingness-to-Pay

43. Sometimes it is not possible to estimate the benefits of environmental quality protection or improvements. In some of these cases, it may be possible to estimate benefits by calculating the costs of replacing the environmental services that have been or might be destroyed by a project, or by estimating what people might be willing to pay to protect an environmental asset. Once again, however, great care needs to be exercised to avoid improper valuation.

Replacement Cost Approach

44. Under this approach, the costs of replacing a damaged asset are estimated. The estimate is not a measure of the benefit of avoiding the damage in the first place, since damage costs may be higher or lower than the replacement cost. However, it is an appropriate technique if there is compelling reason to restore the damaged asset, or certainty that it will be restored.

45. The replacement cost approach has been used to estimate the benefits of erosion prevention measures by calculating the cost of the fertilizer that would be needed to replace the nutrients lost through soil erosion. The method applies only if, in the absence of erosion control measures, the fertilizer would actually be applied.

Shadow Project Approach

46. Used for evaluating projects with negative environmental impacts, this approach involves the design and costing of one or more "shadow projects" that would provide substitute environmental services to compensate for the loss of the original assets. This approach is essentially the same as the replacement cost approach; it is being mentioned increasingly as a way to make operational the concept of sustainability at the project level. It assumes a constraint for maintaining environmental capital intact, and could therefore be most relevant when "critical" environmental assets are at risk.

Contingent Valuation Method

47. In the absence of market information about people's preferences, the contingent valuation method tries to identify them by posing direct questions about willingness to pay. Basically, it asks people what they are willing to pay for a benefit, and/or what they are willing to accept as compensation for tolerating a cost. This process of "asking" may be either through a direct questionnaire/survey, or by experimental techniques in which subjects respond to various stimuli in "laboratory" conditions. What is sought are personal valuations by the respondent for increases or decreases in the quantity of some good, contingent upon a hypothetical market. Willingness to pay is constrained by the income level of the respondent, whereas willingness to accpet payment for a loss is not constrained. Estimates show that willingness to accept tends to be several times greater than willingness to pay.

48. Pearce and Markandya (1989) compared the contingent valuation method with other (more market-based) methods and found that in seven studies one in industrial countries the overlap of estimates is complete, if accuracy is expressed as plus or minus 60 percent of the estimates computed. This result is reasonably reassuring that the contingent valuation method, while not being very precise, nevertheless can produce useful valuations. Data based on the method may be sufficient to rule out certain alternative projects or favor others, and thus can be a valuable tool.

49. The contingent valuation method has many shortcomings, however, including problems in designing, implementing, and interpreting questionnaires (The Energy Journal 1988). While its applicability may be limited, there is now considerable experience in applying this survey-based approach in developing countries, e.g., to evaluate the quality of supply of potable water and electricity services, (Whittington and others; Munasinghe 1990). In certain circumstances, the contingent valuation method may be the only available technique for benefit estimation, and can be applied to common property resources, to amenity resources with scenic, ecological or other characteristics, or to other situations where market information is not available. Caution should exercised in seeking to place a value on the more abstract benefits of environmental assets, such as existence or intrinsic value (Randall and Stroll 1983).

Footnotes 1/ Considerable work is going on to identify defensive expenditures. Such expenditures by firms are treated in the current System of National Accounts (SNA) as intermediate cost and therefore are not part of value added or final output. Defensive expenditures by households and governments, on the other hand, are treated as final expenditures and included in GDP. This practice is being questioned, and proposals are being discussed to change this.

Multi-Objective Decision-Making

50. The methods described above seek to estimate costs and benefits of a given project in monetary terms. When projects/policies and their impacts are to be embedded in a system of broader (national) objectives, some of which cannot be easily quantified in monetary terms, multi-objective decision-making offers an alternative approach which may facilitate the optimal choice among investment options or policies available.

51. Desirable objectives need to be specified. These often exhibit a hierarchical structure. The highest level represents the broad overall objectives (e.g., improving the quality of life), often vaguely stated and, hence, not very operational. Some of these, however, can be broken down into more operational lower-level objectives (e.g., increase income), so that the extent to which the latter are met may be practically assessed. Sometimes only proxies are available (e.g., if the objective is "to enhance recreation opportunities", the attribute "number of recreation days" can be used). Although value judgements may be required to choose the proper attribute (especially if proxies are involved), measurement does not have to be in monetary terms, in contrast to the singlecriterion methodologies used in economic cost benefit analysis. More explicit recognition is given to the fact that a variety of concerns may be associated with planning decisions.

52. An intuitive understanding of the fundamentals of multiobjective decision-making can be provided by a two-dimensional graphical such exposition such as in Table 4.3 (see Volume I, page 147). Assume that a

project has two non-commensurable and conflicting objectives, Z1 and Z2. Assume further that alternative projects or solutions to the problem (A,B, and C) have been identified. Clearly, point B is superior (or dominates) to A in terms of both Z1 and Z2. Thus alternative A may be discarded. However, we can not make such a simple choice between solutions B and C since since the former is better than the latter with respect to objective Z2, but worse with respect to Z1. In general, more points (or solutions) such as B and C may be identified to define the set of all non-dominated feasible solution points that form a Pareto optimal curve (or curve of best options). This line is also called a transformation curve or efficient frontier.

53. For an unconstrained problem, further ranking of alternatives cannot be conducted without the introduction of value judgements. Specific information has to be elicited from the decision-maker to determine the most preferred solution. In its most complete form, such information may be summarized by a family of equi-preference curves that indicate the way in which the decision-maker trades off one objective against the other, as illustrated in Table 4.3. The preferred alternative is that which results in the greatest utility -which occurs (for continuous decision variables), at the point of tangency D of the highest equi-preference curve, with the Pareto optimal curve. In this case, the point E (on an even higher equipreference curve) is not attainable.

54. Several multi-criteria methods have been developed (Romero and Rehman 1987; Petry 1990). Which practical method in particular is suitable to determine the "best" alternative available, depends on the nature of the decision situation. For instance, interactive involvement of the decision maker has proved useful in the case of problems characterized by a large number of decision variables and comp lex causal inter-relationships. Some objectives can be dealt with through direct optimization, while others require the satisfaction of a certain standard (e.g., level of biological oxygen [BOD] not below 5 mg/l).

55. The major accomplishment of multi-objective decision models is that they allow for more accurate representation of decision problems, in the sense that several objectives can be accounted for. However, a key question concerns whose preferences are to be considered. The model only aids a single decision-maker or a homogenous group. Various interested groups will often assign different priorities to the respective objectives, and normally it may not be possible to determine a single "best" solution via the multi-objective model. Also, the mathematical framework imposes constraints upon the ability to represent effectively the planning problem. Non-linear, stochastic and dynamic formulations can assist in better defining the problem, but impose costs in terms of complexity in formulation and solving the model (Cocklin 1989).

56. Nevertheless, in constructing the model the analyst communicates information about the nature of the problem. He specifies what factors are important and how they interact. Liebman (1976) observes that "modelling is thinking made public", and considers this transfer of knowledge to represent perhaps the most important contribution of modelling. With respect to the second point of criticism (i.e., diverse preferences), Liebman suggests that there is value to be gained in constructing models from differing perspectives and comparing the results.

The Discount Rate Issue

57. After the physical effects of projects and policies have been determined and, where possible, estimated in money terms, the next issue is the rate at which the cost and benefits streams are to be discounted. This is a general issue in cost-benefit analysis; but it is particularly important with regard to environmental costs and benefits, since at least some of them are of long-term.

58. In standard analysis, past costs and benefits are treated as "sunk" and are ignored in decisions about the present and future. Future costs and benefits are discounted to their equivalent present value and then compared. In theory, in a perfect market, the interest rate measures both the subjective rate of time preference and the rate of productivity of capital. These rates are equated at the margin by the market, so that the rate at which individuals are willing to trade present for future values is just equal at the margin to the rate at which they are able to transform present goods into future goods by capital investment.

59. Because of imperfect financial markets and government distortions introduced by taxation, the rate of time preference and the rate of capital productivity are not equal. Also, individual decisions differ from social decisions in that individuals are mortal and societies are quasi-immortal. Thus one strong reason for individual preference for the present -the certainty of death coupled with the uncertainty of when it will occur -is absent from the community's point of view. The community has reason to discount the future less than individuals.

60. In order to favor environmental projects that have benefits accruing in the long run, it has been suggested that lower discount rates be used. This has a drawback, however, in that not only would environmentally sound activities would pass the cost-benefit test more frequently, but also a larger number of projects generally would pass the test and thus lead to additional environmental stress. The main recommendations, therefore, are that:

(a) The standard opportunity cost of capital be used (e.g., 10 percent) for environmental cost-benefit analyses, as it is for NPV calculations and for computing the IRR comparator.

(b) Shortand long-term costs and benefits be estimated as carefully as possible.

(c) A rigorous analysis of non-monetary consequences (including those that might be irreversible) be made to supplement standard cost-benefit analyses.

Issues of Risk and Uncertainty

61. Projects and policies alike involve risks and uncertainities. Risks are involved when probabilities can be assigned to the likelihood of an event occuring, such as an industrial accident. Uncertainty describes a situation where little is known about future impacts and where no possibilities can be assigned to certain outcomes, or where even the outcomes are so novel that they cannot be anticipated.

62. Risk can be insured against and treated as a cost, but uncertainty defies actuarial principles because of novelty of outcomes, e.g., ozone layer depletion was an unknown outcome of CFCs and could not have been evaluated as a risk when they were introduced. Uncertainty is especially important in environmental issues. As projects grow larger in scale and introduce novel substances into the environment, the category of risk becomes less relevant and the category of uncertainity more relevant. The proper response to risk is to count it as a cost in expected value formulations. The proper response to uncertainty is likely a policy of general caution: if one cannot see very far ahead, slow down.

63. Much work has been undertaken on the subject of risk and uncertainty in project appraisal. (For a recent treatment, see Anderson and Quiggin 1990.) In practice, the way risk and uncertainty are included in project appraisal work is through sensitivity analyses, which determine how the IRR is dependent on different variables. Analyses should also be undertaken that indicate how environmental features can affect the IRR of a project and how the project might affect natural resources and the environment.

PART III: CONCLUSIONS

64. Incorporation of the effects of environmental degradation into public decision-making is an essential step towards achieving economically efficient management of natural resources and formulating a practical strategy for sustainable development. In particular, the economic analysis of projects and policies can help a country make investments of scarce resources that contribute most to its overall objectives. "External factors" have often been neglected in the past, but these should now be internalized to the extent possible. In this regard, rough qualitative assessments early in the project cycle can yield valuable returns by identifying environmentally unsound alternatives and focussing on those that are more sound overall -and designing the latter to achieve sustainable development goals.

65. The principles discussed in this chapter have been applied to evaluating environmental costs and benefits in only a limited number of actual situations. Therefore, more case study work is necessary and perhaps could be carried out as part of project preparation. A major purpose in such endeavor is to indicate orders of magnitude, rather than provide fine-tuned numbers. In this fashion, some alternatives could be ruled out, and the key estimates for decisionmaking identified and focussed on.

66. At this time, the best one can do is to use cost-benefit analysis to the extent possible -and push it to its acceptable limits. In addition, risks and consequences that cannot be measured in monetary terms should be identified and rigorously analyzed. These two approaches and good judgement are at present the best strategies for sound decision-making.

References

The Context for Economic Analysis of Projects and Policies

Dixon, J., and others. 1988. Economic Analysis of the Environmental Impacts of Development Projects. Manila, Philippines: Earthscan/ Asian Development Bank.

Gittinger, J.P. 1982. Economic Analysis of Agricultural Projects. Baltimore, Maryland: The Johns Hopkins University Press.

Ray, A. 1984. Cost-Benefit Analysis: Issues and Methodologies. Baltimore, Maryland: The Johns Hopkins University Press.

Squire, L., and H. van der Tak. 1975. Economic Analysis of Projects. Baltimore, Maryland: The Johns Hopkins University Press.

World Bank. 1980. "Economic Analysis of Projects." Operational Manual Statement 2.21. World Bank, Washington, D.C.

Public Investment Reviews

Anderson, D. 1987. Economic Growth and the Returns to Investment. World Bank Discussion Paper 12. Washington, D.C.: World Bank.

Baum, W.C., and S.M. Tolbert. 1985. Investing in Development: Lessons of World Bank Experience. New York: Oxford University Press.

de Melo, M. 1980. Public Investment/Expenditure Review: The Bank's Experience. Washington, D.C.: World Bank.

Analysis of Economic Policies

Ahmad, Y.J., S. El Serafy, and E. Lutz, eds. 1990. Environmental Accounting for Sustainable Development. Washington, D.C.: A UNEPWorld Bank Symposium.

Binswanger, H. 1990. Brazilian Policies that Encourage Deforestation in the Amazon. World Bank Working Paper 16. Washington, D.C.: World Bank.

Kanbur, R. 1990. "Projects vs. Policy Reform." Paper presented at the Annual Conference on Development Economics. World Bank, Washington, D.C.

Lutz, E., and H. Daly. 1990. Incentives, Regulations and Sustainable Land Use in Costa Rica. World Bank Working Paper 34. Washington, D.C: World Bank.

Lutz, E., M. Munasinghe, and R. Chander. 1990. A Developing Country Perspective on Environmental Accounting. World Bank Working Paper 1990-12. Washington, D.C.: World Bank.

Lutz, E., and M. Young. 1990. Agricultural Policies in Industrial Countries and Their Environmental Impacts: Applicability to and Comparison with Developing Nations. World Bank Working Paper 25. Washington, D.C.: World Bank.

Mahar, D. 1989. Government Policies and Deforestation in Brazil's Amazon Region. Washington, D.C.: World Bank in cooperation with the World Wildlife Fund and the Conservation Foundation.

The Case for More Environmental Analysis Under Resource Constraints

Little, I.M.D., and J.A. Mirrless. 1990. "Project Appraisal and Planning Twenty Years On." Paper presented at the Annual Conference on Development Economics. World Bank, Washington, D.C.

Repetto, R. 1988. Economic Policy Reform for Natural Resource Conservation. World Banking Working Paper 4. Washington, D.C.: World Bank.

Valuing the Impacts in Monetary Terms

Anderson, D. 1989. "Economic Aspects of Afforestation and Soil Conservation Projects." In Environmental Management and Economic Development, edited by G. Schramm and J.J. Warford. Baltimore, Maryland: The Johns Hopkins University Press.

Dixon, J., and M. Hufschmidt, eds. 1986. Economic Valuation Techniques for the Environment. Baltimore, Maryland: The Johns Hopkins University Press.

Go, F.C. 1988. Environmental Impact Assessment: Operational Cost Benefit Analysis. London: Kings College, Monitoring and Assessment Research Center.

Hanley, N.D. 1989. "Valuing Rural Recreation Benefits: An Empirical Comparison of Two Approaches." Journal of Agricultural Economics 40(3):361-374.

Hicks, J. 1946. Value and Capital. 2nd edition. London: Oxford University Press.

Contingent Valuation Method

The Energy Journal. 1988. Special Issue on Electricity Reliability, Volume 9.

Munasinghe, M. 1990. Electric Power Economics. London: Butterworths Press.

Pearce, D., and A. Markandya. 1989. Environmental Policy Benefits: Monetary Valuation. Paris, France: Organization for Economic Cooperation and Development.

Randall, A., and J. Stoll. 1983. "Existence Value in a Total Valuation Framework." In Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas. Boulder, Colorado: Westview Press.

Whittington, D., and others. "Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Use of Contingent Valuation Surveys in Southern Haiti." Economic Development and Cultural Change 38(2):293-311.

Multi-Objective Decision-Making

Anderson, D., and J. Quiggin. 1990. "Uncertainty in Project Appraisal." Paper presented at the Annual Conference on Development Economics (April 26-27). World Bank, Washington, D.C.

Cocklin, C. 1989. "Mathematical Programming and Resources Planning I: The Limitations of Traditional Optimization." Journal of Environmental Management 28:127-141.

Liebman, J. 1976. "Some Simple-Minded Observations on the Role of Optimization in Public Systems Decision-Making." Interfaces 6:102-108.

Petry, F. 1990. "Who is Afraid of Choices? A Proposal for MultiCriteria Analysis as a Tool for Decision-Making Support in Development Planning." Journal of International Development 2:209-231.

Romero, C., and T. Rehman. 1987. "Natural Resource Management and the Use of Multiple Criteria Decision-Making Techniques: A Review." European Review of Agricultural Economics 14:61-89.

General Reading

Hufschmidt, M., and others. 1983. Environment, Natural Systems, and Development. Baltimore, Maryland: The Johns Hopkins University Press.

Sebastian, I., and A. Alicbusan. 1989. "Sustainable Development: Issues in Adjustment Lending Policies." Environment Department, Policy and Research Division Working Paper 1989-6. World Bank, Washington, D.C.

Tidsell, C. 1986. "Cost-Benefit Analysis, the Environment and Informational Constraints in LDCs." Journal of Development 11:63-81.