Economic Evaluation of Environmental Impacts

Chapter 2

I. General Issues

Traditionally, market failures have been considered as the reason why the full assessment of the economic dimensions of environmental impacts (see Box 2) is difficult to include in the economic analysis of projects. Three broad issues are briefly discussed: (i) externalities, (ii) market failures, and (iii) irreversibilities—particularly to clarify confusion between the first two. In addition, important issues in the economic evaluation of environmental impacts of development projects include measures for identifying and screening impacts, valuation of environmental benefits and costs, and integration of these considerations into the economic analysis of projects (ADB, 1996). In this chapter, methods for undertaking these tasks will be explained.

A. Externalities

There are certain economic activities—or outcomes—that are not (or cannot be) taken into account by market mechanisms. These are not traded in the market, and no prices can be observed. A large number of environmental impacts (or environmental goods and services) fall into this category. Examples include: (i) uncontrolled smoke emissions from factories; (ii) gas emissions from internal combustion engines; (iii) soil erosion that silts streams and reservoirs; (iv) chemical discharges from industry or agriculture; (v) odors from livestock farms or garbage dumps; and (vi) noise pollution from factories.

Box 2. Environmental Impacts

Environmental impacts can be defined as the good or bad bio-physical consequences in a receptor (people, plants, and materials) after a change in exposure to a stressor (chemical, physical and/or biological agents; types and levels of pollutant emissions or habitat alterations). Impacts are generally characterized in terms of human health, human welfare, environmental resources, and global systems impacts.

Human health

Health impacts. *Death or increased probabilities of death (mortality) or illnesses (morbidity) including cancer, malaria, respiratory diseases, headaches, etc.*
Occupational health impacts. *A category of health impacts that arises from accidents/injuries on the job. Injury can range in severity from temporary impairment to permanent disability or death.*
Accidents/injury impacts. *Accidents on and off the project site.*

Human welfare

Aesthetic impacts. *Visual, noise, traffic congestion and other impacts that affect the senses or one's appreciation of a thing, quality, or event.*
Materials impacts. *Damages caused by particulate matter and acid deposition from sulfur dioxide air emissions, including surface soiling, surface erosion, blistering, paint discoloration, corrosion and tarnishing of metals and electronic components, fading, reduction of fabric tensile strength, and spalling of buildings and monuments.*
Resource use impacts. *Changes in the productivity or value of commercial, subsistence, or recreational uses of such natural resources as forests (e.g., timber), agricultural lands (e.g., for crops), fisheries (e.g., for subsistence diets), or wildlife (e.g., for ecotourism).*

Environmental resources

Biodiversity/endangered species impacts. *Impacts on the diversity of flora and fauna, species that are endemic or unique, and species habitat and corridors (e.g., flyways for birds).*

Coastal and other marine ecosystems impacts. Impacts on reef, fishery, and other biological resources in saline water.
Groundwater impacts. Impacts on water in the subsurface environment.
Terrestrial ecosystems impacts. Flora and fauna, minerals, soil, forest or grassland habitat.

Global systems

Global impacts. Changes in weather patterns and global climate, and ozone depletion caused by increased atmospheric concentrations of greenhouse gases and ozone depleting substances. Global impacts include such large-scale consequences as climate change and biodiversity loss.

Environmental impacts can be on- or off-site; physical, psychological, or socioeconomic; short- or long-term; and financially internal or external.

Physical impacts. These include the physical (e.g., loss of species diversity) and chemical (e.g., diseases that result from exposure to cancer-causing substances) effects of an activity on people and the environment.

Psychological impacts. These include such effects as increased stress as a result of an environmental impact caused by a project activity.

Socioeconomic/cultural impacts. Dislocation or forced relocation of people, loss of homeland, lost income, changes in the demand for skills in local labor markets, effects on subpopulations (e.g., farmers, indigenous peoples), changes to buildings or institutions of cultural importance, and impacts affecting religious beliefs, cultural traditions, or lifestyle.

Note also that there are indirect impacts. These are impacts on one type of receptor that in turn cause impacts. For example, changes in forest habitat may have indirect impacts on human welfare because people who live nearby may depend on the forest for food and medicinal plants.

Source: ADB, 1996.

Many externalities[2] have public good/bad characteristics (Bator, 1958). Examples of this attribute are: if the air in a city is polluted, then it affects individuals living in the area; or the scenic view offered by a public park increases the utility of all passers-by. The public nature of externalities is based on its nondepletable characteristics. If externalities are depletable, it becomes a private externality.

Note that only technological externalities involve real resource allocation issues. For instance, suppose an increase in electricity consumption by urban consumers raises the price of electricity to be paid by farmers to operate water pumps. This does not involve any resource misallocation and is not considered a technological externality.[3] Thus, the term externalities from this point refer only to technological externalities. An example is the increase in an individual's health resource cost from air pollution resulting from increased volume of harmful air emissions from industrial production in one's area.

One of the best ways to address externalities is to incorporate them into proposed projects. For example, a hydropower project may allow the de-commissioning of coal-fired thermal power plants that are responsible for serious air pollution. Or, a watershed project may improve soil-management practices and thereby reduce downstream sedimentation and chemical contamination of streams, rivers, and lakes. In assessing the economic value of an externality that is being integrated into a project, one would first consider alternative methods to avoid or to reduce the external costs arising from particular economic activities. Unavoidable costs exist and they must be considered as project costs. Market-based data can sometimes be used in assessing these values. When market-based data are unavailable, project analysts are required to utilize alternative methods. The productivity difference—or replacement cost—can then be used as an alternative measure of economic values.

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2 *Baumol and Oates (1975) classify the economic activity or outcome as an externality if an individual's utility or production relationship includes real variables whose values are chosen by others without particular attention to the effects on the said individual's welfare. Externalities do not include economic interdependency or deliberate rival activities among economic agents of society.*

3 *Often termed as pecuniary externality.*

B. *Market Failures*

The market system is a powerful, relatively inexpensive, self-adjusting and responsive mechanism for resource allocation. Yet market failures occur when the price mechanism fails to come up with the social optimum in resource allocation. Environmental implications become difficult to value when they do not pass through regular pricing mechanisms (the market). There are various reasons for market failure including the presence of externalities.[4]

Environmental impacts may also be subject to market failure because of their public-good nature, or because of the absence of complete and coherent property rights. Public goods are those for which exclusion of potential users (beneficiaries) is difficult if not impossible, and the use by one individual does not diminish the availability for others. The earth's atmosphere is an example of just such a public good—it is difficult to exclude individuals (or factories) from discharging waste into the atmosphere, and the use by one polluter does not diminish the availability of waste-disposal services by others to a certain extent (when limits are reached, they become congestible goods). Property rights become an issue when it is impossible to delineate clear ownership rights and duties. Some argue that externalities are mainly due to undefined property rights. It has been argued that when the cost of negotiation (transaction cost) is negligible, an efficient solution for resource allocation can be reached without considering distributional impacts (Coase, 1960). This is known as the Coase Theorem, which has significant implications on environmental policy. The fisheries of the high seas represent a good example of natural resource allocation, market failure, externalities, and the property rights problem (see Box 3).

Environmental goods and services for which no reliable market prices are available will often include public parks and recreational areas, non-timber forest products, groundwater, common grazing grounds, open-access

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[4] *Among these reasons are: market imperfections, increasing returns to scale, lack of property rights, pervasive demand or supply characteristics, indivisibility, congestability, and non-rivalness. However, it is not the book's intention to provide in-depth discussions.*

Box 3. Property Rights

All environmental problems are property rights problems; pollutants transcend the property regime pertinent to the firm (or household), thus giving rise to the external costs that comprise externalities (Bromley, 1991). Externalities are evidence that the "nominal boundary" of a firm (or of a household), which is the source of these external effects, does not coincide with the "real boundary" of that entity. By the "nominal boundary" we mean the socially recognized domain over which the owner has control. In agriculture, this would be the extent of the land on which the farm is located. In industrial settings, the "nominal boundary" would cover the geographic extent of the factory including the land on which it resides. But the "real boundary" of farms and firms reaches out to encompass the physical domain over which their pollutants travel. Agricultural chemicals that wash off fields into waterways is an example of physical effects transcending the nominal boundary of the farm. Air or water pollution from chemical factories—or from manufacturing facilities—leaves smokestacks or pipes and enters physical domains under the legal jurisdiction of others. That is why environmental problems are property rights problems.

In addition to the classic pollution example, most conflicts in fishery management, groundwater management, forestry, or the extraction of exhaustible resources, arise because of difficulties in clarifying the property regimes (Bromley, 1991). The presence of externalities indicates a failure of the legal system—property regimes—to structure domains of economic activity so that all of the costs and benefits associated with economic choices are brought to bear on the relevant parties.

The correction of externalities will often be characterized as government "intervention" in the market. But the idea of intervention must be considered carefully. Is it "intervention" when government decides to step in to protect coastal fisherfolk from industrial pollution? We see that "intervention" to polluters is "protection" to the fishing industry. If government does nothing against the destruction of a coastal fishery it is still choosing sides—in this case against fishing and in favor of the chemical industry. Few would label doing nothing as government "intervention." But if government decides to protect the fishery against industrial chemicals then those engaged in chemical manufactures may feel that the government has intervened in the market. The idea of government intervention in the market depends on the presumed property regime. That is, if the fishing industry is protected from chemical contamination by the status quo legal regime, then if *government steps in to allow the destruction of fish stocks by chemical firms, that may well be seen as intervention by the fishing industry. The judgment of "intervention" is seen to be a function of who is protected by the status quo property regime.*

Concerns for pricing and resource valuation are embedded in property rights issues as well. Pricing programs for water and other natural resources is part of the property regimes over natural resources. Groundwater pricing is an example of an economic instrument (pricing) being asked to do what property regimes have failed to do. That is, a price for a unit of groundwater conveys signals about the social opportunity cost of extraction. In the realm of urban water supplies, we see the same idea. Here, as in groundwater extraction for industry and agriculture, there is a sense that drinking water is a "free" good and should be made available to all at zero price. But water, whether from underground aquifers or from surface sources, is a scarce resource that will be wasted unless there is some property regime in place that can generate appropriate prices for the scarce water resource (ADB findings show that in Asia, up to 65 percent of water is wasted).

When one has a right in something it means that the benefit stream arising from that situation is explicitly protected by some authority system. The authority system gives and takes away rights by its willingness—or unwillingness—to agree to protect one's claims in something. To have a property right, therefore, is to have secure control over a future benefit stream. And it is to know that the authority system will come to your defense when that control is threatened. The thing of value is the benefit stream and this benefit stream is the property interest that individuals seek to have protected with property rights.

The degree of protection afforded by a particular structure of property rights is always relative to other social concerns and priorities. While property rights in land are usually more secure than property rights in other assets, this is not universally so across different cultures. The structure and content of rights are social decisions; rights are socially constructed to serve some collective purpose.

Property rights must be well specified, transferable and effectively enforced; an unenforced right is effectively no right at all. Therefore property rights can be defined as the proper relationships among people with respect to using things and the penalties for violation of these proper relationships. Without clear and enforceable property rights the allocative function of markets cannot work. Since there is no properly defined property rights with respect to many natural resources—ambient air, ocean fisheries, eroded soil—other ways of reaching efficient solutions are needed.

fisheries, and in some cases irrigation water. There are no market transactions to produce signals (prices) that can guide resource allocation decisions. These resources can no longer be considered free goods and services in many parts of the world, thus requiring alternative valuation methods for guided resource allocation. Surrogate prices or proxies can be used to assess the economic value of these environmental goods and services. In some cases, either price or quantity to be assessed for these goods and services can be traced through market-based information. Local investigators may be able to help find such information either by conducting a sample survey or, by controlled experiments. Often, shadow price for items like fuelwood or non-timber forest products can be obtained. Recreational values or scenic values can be obtained from close proxies.

The presence of market failures is not a sufficient reason for other intervention in resource allocation or conservation. Wolf, Jr. (1979) qualifies that market failure is only a necessary condition, while better allocation and conservation of resources by a nonmarket entity is the sufficient condition—and that both conditions must be present to warrant market intervention. Despite the satisfaction of both conditions, there are cases when intervention fails. Effectively correcting market failures requires coordinated effort to ensure that institutional and policy failures are not present.

Those who favor free market or minimal government intervention argue that in most cases, market failure can be corrected by creating conditions that are more favorable to market operations, such as privatization and market development. On the other hand, advocates of pro-active government intervention for market failure support continuous implementation of checks and balances as a solution. Empirically, it has been shown that a blend of market, political and administrative mechanisms is the most suitable pragmatic way of addressing issues in natural resource allocation and conservation.

C. Irreversibilities

The presence of irreversibilities is a particularly difficult problem in the economic evaluation of environmental impacts. For instance, excessive groundwater extraction can lead to calcification of an aquifer and its ultimate destruction. Projects that encourage the spread of tubewells can contribute to serious overdraft of aquifers. Similarly, badly managed irrigation projects can lead to excessive salinity that will ruin agricultural areas. Projects that destroy unique biodiversity, or that contribute to the destruction of endangered species, impose serious environmental costs. Here, the valuation problem can be overcome through the use of contingent valuation methods (hypothetical market assessments).

Conservationists view that sustainable development requires stable populations, cropland protection from soil erosion, reforestation, increased recycling, energy conservation, and increased utilization of renewable energy. It has been argued that the traditional economic vision is inconsistent with this view hence the continuing debate between ecologists and economists. Some economists espouse a steady-state economy where population growth is zero and per capita consumption is restrained (Daly, 1980). A compromise would be to regard resources as having an importance that transcends economics, providing a rationale to preserve them as merit goods. This idea is now referred to as following the "precautionary principle". This middle-ground taken by economists and ecologist advocates keeping a resource (e.g., wetland, special habitat or species) out of the reaches of "development" or "intervention".

The desirability of conserving resources needs to be taken into account when considering public investments with potential irreversible loss. The safe-minimum standard of conservation suggests a way to minimize the maximum possible loss when the expected benefit or cost of the resource is unknown. Although difficult to assess *a priori*, the approach can be reviewed as more information is gathered over time (Tisdell, 1993; Bishop, 1978).

II. Nonmarket Goods and Services

The term nonmarket is used to cover a wide variety of situations wherein markets are nonexistent, incomplete or institutionally restrained from reflecting interactions between supply and demand. The term, however, does not preclude that the market has nothing to do with the goods and services in question. The market may provide information but is likely to be incomplete or indirect. In such cases, the market will not reflect accurate information of the *true value* of the good or service.

Nonmarket goods and services form a diverse group of commodities. The diversity of these commodities lies in their economic and ecological values. Most will reflect physical non-rival characteristics with significant economic implications. Some may have the attribute of non-exclusiveness, which makes it difficult to assign property rights. When property rights cannot be assigned, the market price will not reflect the true value of the commodity. In such cases, the cost of assigning property rights could be much higher than the benefits. User demand for nonmarket commodities may be direct or derived. Some environmental amenities may be consumed on-site while others may be off-site. For example, water flow generated and regulated by a protected area could be a non-rival derived demand with some of the benefits being off-site and nonmarket.

The advantages or disadvantages of the various available methods depend on the circumstances under which a commodity is valued. Care must be exercised in defining the benefits and costs attributed to the use of the good or service to avoid omissions and double counting. It is noteworthy that the economic evaluation of non-market commodities requires substantial ingenuity.

The methods for the valuation of nonmarket environmental goods and services can be broadly classified under two categories. These are income compensation approaches and contingent valuation[5] methods. The first category includes the travel cost method and the hedonic value method, while the second includes willingness-to-pay and willingness-to-accept, which can be used to value recreational benefits and the cost of air pollution, respectively (Randall, 1985).

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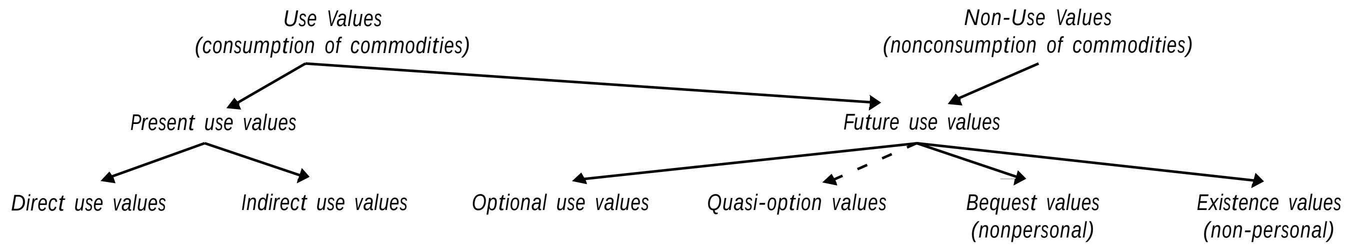
5 *Also referred to as experimental markets.*

III. The Valuation Problem

The following sections discuss the various methods for determining the monetary values of environmental impacts. The methods in which market prices are used are fairly standard approaches that largely rely on changes in physical production, or on direct cash expenditures. Other approaches use surrogate markets. When the market is not providing the correct signals for environmental resources, multiplying price by quanitity does not result in acceptable figures for the value of the resource. Therefore, the concept of total economic value (TEV) was introduced by environmental economists in the early eighties. The different components of TEV are shown in Figure 1 and provide a good starting point for understanding the valuation aspect of economic analysis.

Environmental impacts can be divided into two categories, use value and nonuse value. Detailed examples are provided in the figure. The first category involves impacts that cause measurable changes in the production of a specific good or service. The second category involves impacts that cause direct changes in the quality of the environment. Nonuse values are more interesting and challenging to understand. The option values are driven by motives, and reflect wiilingness-to-pay to keep options for future use. Options can materialize depending on the information available, hence quasi-options arise. Bequest value, on the other hand, is not defined based on an individual's desire to consume or use resources, but is based on the intention of keeping it for use by future generations. This is purely borne of altruistic intentions. Finally, existence value refers to an individual's willingness-to-pay for the existence of any resource purely for the sake of its being. The complex nature of valuing environmental resources through TEV, raises the issue of why such a concept is used when it is not the case in other valuation exercises. The answer is, where resources become non-unique, or market-forces can determine its value through the regular mechanism, the nonuse value becomes so small or will already be included in the market price. For non-unique resources, therefore, TEV is not required and market prices can act as an adequate proxy for its value.

Figure 1. Components of Total Economic Value of Environmental and Natural Resources (Goods and Services)



Direct use values	Indirect use values	Optional use values	Quasi-option values	Bequest values (nonpersonal)	Existence values (non-personal)
Value is generated from direct consumption of commodities.	*Value is generated from indirect consumption of commodities.*	*Value is generated from maintaining options for either direct or indirect consumption of commodities in future.*	*Value depends on information available from the resource. These values may be due to altruistic or selfish reasons.*	*Value is generated from conserving of consumption opportunities for future generations. These values may be due to altruistic reasons.*	*Value is generated from preserving existence of biological resources for their own sake.*
Examples:					
Food, fiber, timber, fuel-wood, medicines, recreation, etc.	*Maintenance of ecological systems, nutrient recycling, carbon sequestration, watershed protection, etc.*	*Use of biodiversity in future pharmaceutical products; use of genes in increasing future agricultural productivity*		*Preserving unique habitats, species, etc.*	*Preserving endangered habitats, species, etc.*

This classification has been an evolving work, and it is anticipated that with more information, the classification system will continually change.
Source: Adapted from Barbier, et al., 1991; Pearce, et al., 1990; and Peterson and Randall, 1984.

Figure 2 gives a breakdown of major categories of environmental goods and services which come from wildlife and forest resources, which can be used to illustrate the uniqueness of resources in relation to TEV. The figure identifies the type of demand, beneficial products or services, location where exchange can take place, and the relative magnitude of option or existence value components of TEV as adapted from Petersen and Randall (1984). It clearly shows that the relative magnitude of the option value of environmental resources tend to increase with uniqueness of the resource in question.

IV. Valuation Methods

There are a number of methods available for economic evaluation of environmental impacts. The valuation method chosen will depend on data availability and on other circumstances related to the good or service being valued. The following section provides a brief description of some often used valuation methods.[6]

A. Changes in Production

Techniques that use changes in production as the basis for measurement are direct extensions of traditional cost-benefit analysis. An example would be reduced crop yields caused by air pollution from a nearby chemical plant. Physical changes in production due to environmental impacts are valued using market prices for inputs and outputs. If market distortions exist—perhaps because of market structure—appropriately modified market prices (shadow prices) are used. The monetary values thus derived are then incorporated into the economic analysis of the project, with other necessary adjustments made. In using this approach, the following steps can be followed:

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6 *There is a wide range of literature that discusses valuation methods in detail. Such examples are included in this sections reference list, most notably Winpenny (1991).*

Figure 2. Major Categories of Environmental Resources/ Goods and Services from Wildlife and Forests

Wildlife and Forest Systems	Resource	Beneficial Product or Service	User Demands: Direct or derived?	User Demands: Location	Typically priced in the market?	Option and existence value significant?
	Raw wood	Lumber	Derived	Off-site	Yes	No
Air	Mineral Deposits	Minerals	Derived	Off-site	Yes	No
	Range forage	Livestock products	Derived	Off-site	Yes	No
	Water	Water for downstream use	Direct, derived	Off-site	No	Maybe*
		Flood protection	Direct	On-site, off-site	No	Maybe*
		Recreation	Direct, derived	On-site and vicinity	No	Maybe*
Flora	Wildlife populations					
Water	Habitat					
Fauna	Landforms	Ecological continuity	Direct	On-site, off-site	No	Yes
	Atmospheric visibility	Scenery	Direct, derived	On-site and vicinity	No	Maybe*
	Biological processes	Waste assimilation		On-site, off-site	No	Maybe*
	Carbon sequestration	Global benefits	Direct, derived	On-site, off-site	No	Maybe*
Soil	Oxygen release	Clean air	Direct, derived	On-site, off-site	No	Maybe*
	Biodiversity	Ecological continuity	Direct, derived	On-site, off-site	Yes/No	Yes

*The possibility of significant option and existence value is real, and should be considered in cost/benefit estimation.
Source: Adapted from Peterson and Randall, 1984.

1. Identify the changes in production caused by the environmental impacts (both on-site and off-site).

2. Assess the effects on production "with the project" and "without the project". The "without-project" option is necessary to identify the changes caused by the project, and to clarify the degree of impact caused by the project.

3. Make assumptions about the time horizon over which the changes in production must be measured, the correct prices to use, and any future changes expected in relative prices.

4. Finally, monetized values should be integrated into the cost-benefit analysis after relevant adjustments are made.

Several Asian studies have applied changes in production in the valuation of environmental impacts. From Winpenny (1991) the annual value of wetlands in Thailand is estimated at $280 per hectare based on gross income from fishery, paddy, and charcoal production. Other studies using the technique include: Yan (1993) which estimates sulfur dioxide damages based on change in farm output, and water pollution damages based on changes in farm output and fisheries production in the Jiangsu Province, People's Republic of China (PRC); Amarasinghe (1994), and Abeygunawardena and Tilakasiri (1993) which estimates flood protection benefits based on paddy productivity in the Kiralakelle and Nilawala river valleys, Sri Lanka; and Myers (1988) which estimates coastal deforestation and siltation damages through shellfish production losses in the Philippines. Several studies by Dixon, et al. have used this technique to estimate impacts of various environmental changes (Dixon, and Hodgson, 1989; Dixon and Hufschmidt, 1986; Dixon, et.al., 1994; and Hodgson and Dixon, 1992).

B. Health Effects

Ideally, the monetary value of health impacts should be determined by the willingness to pay of individuals for improved health, but due to the extreme difficulty in obtaining such values, in actual practice, "second best" techniques may be used. For instance, the lost earnings and medical costs resulting from environmental damages caused by a project—or the savings that would occur if a project prevents adverse health impacts—can be the basis for monetary valuation of the health effects of a project. This method is known as the *loss-of-earnings approach*; it is also called the human-capital approach. There are slight differences in the sense that human-capital approach estimates are based on the total value of life based on lifetime earnings. The following situations warrant the use of the loss-of-earnings approach:

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, nonlife-threatening, and does not have major long-term effects.

3. The precise economic value of earnings and medical care is known.

In addition to use in health-related morbidity or mortality situations, this method can also be used to measure loss of (income) earnings caused by exogenous reductions in productivity. This approach is relevant when considering road and industrial plant safety, as well as projects that affect air pollution in major cities of developing countries (Munasinghe, 1993). The approach has been widely used in cancer and life-threatening cases. Insurance companies have also used this approach. There are many ethical questions which have been raised regarding this approach, particularly since it results in a higher valuation of life with higher levels of income (see section on ethical considerations in Chapter 3, Part I). The value of children's and non-income-earner's lives cannot be estimated through this method.

A study by Rola and Pingali (1993) cites that the health cost due to pesticide exposure can be valued through treatment cost and opportunity cost of farmers' time during recuperation. Their study of farmers in Guimba, Nueva Ecija Province in the Philippines estimates that the average health cost of three forms of nitrogen/insecticide damages ranged from P623 to 6,735 ($23 to 248) during the wet season.

Some economists argue that the human capital approach is not an economic valuation method. It does not measure revealed or stated preference, hence it is not a welfare measure. In developed countries, large-scale willingness-to-pay (WTP) studies have been conducted to assess the value of health. These have shown that the valuation of human life is quite different from the valuation of statistical life (see pages 48-49). In these countries, estimates from WTP surveys yield figures which are inconsistent with human capital approach values. It is often the case that the human capital approach produces much lower values than WTP studies. In developing countries, the discrepancy is larger. Furthermore, only a limited number of WTP studies are available in developing countries.

C. Market Prices

When actual market prices exist, the analyst's task is relatively straightforward. Here, there is no need to attempt to assign monetary values for costs or benefits due to the project. Instead, the project input or output is described in physical terms and potential benefits and costs are then monetized using actual market prices. However, market distortions should be corrected through appropriate conversion factors.

For example, to determine the importance that individuals attach to impacts on the environment, the preventive-expenditure approach examines actual expenditures made by individuals to avoid experiencing environmental damages; this is called *averting behavior* in the literature. This actual demand for the mitigation of environmental damage may be seen as a surrogate demand for environmental protection. Obviously, individuals will commit their own financial resources only if their subjective estimate of the benefits is at least as great as the costs. A measure of individual perception of these damages is given by the magnitude of the financial resources allocated to prevent them. The necessary assumptions in this approach are: (i) accurate data exist on the costs of mitigating expenditures; and (ii) there are no secondary benefits associated with the expenditures, or they are ignored. Note that perfect substitutability is the basis of the 'averting behavior technique' which looks at how averting input substitute for changes in environmental goods (Georgiou, et al., 1997). For example, expenditures on bottled water can indicate a household's valuation of clean drinking water.

Simple averting behavior models can give incorrect estimates if they fail to incorporate the technical and behavioral alternatives to individuals' responses to quality change (Georgiou, et al., 1997). Furthermore, since an individual's willingness to incur such costs is constrained by his/her abillity to pay, this approach only provides a minimum estimate of the benefits achieved. In this regard, individuals may insist that they have a right not to be exposed to such environmental damages. Should this be the situation, the correct measure of environmental damages would be the minimum that these individuals would be willing to accept by way of compensation in order to continue to experience the damages (Bromley, 1995).

D. Opportunity-Cost Approach

The opportunity-cost approach is used when environmental resources are difficult or impossible to measure. Basically, opportunity cost refers to the value of the best foregone alternative. For instance, the price of fuelwood can represent the opportunity cost to the use of cow dung as fuel. Thus the price of fuelwood, which is the best foregone alternative, is used to value cow dung which has no established market price. The concept can also be used for an estimate of benefits, by calculating the value of what must be sacrificed for the sake of preservation. Situations where this approach may be useful include alteration or destruction of tropical rainforests, establishment and protection of wildlife sanctuaries, and preservation of cultural or historical sites and natural vistas. It is particularly very useful in cases where a policy precludes access to an area—such as estimating foregone money and in-kind incomes from establishment of a protected area (Georgiou, et al., 1997). 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, the effect on the environment of the different technological options can be valued with this technique.

A 1983 study by Fleming used indirect opportunity cost of other employment to value fuelwood in the forests of Nepal ($8/cu m) to estimate the damages of deforestation. The study looked into the preservation of fuelwood through the Phewa Tal Watershed Development Program which aimed at sustainable provision of fuelwood and fodder to meet local needs, while arresting the destruction of natural forest areas. Other more recent Asian studies include Gunatilake's (1994) valuation of the Muthurajawela marshlands and the Hantana forest in Sri Lanka, through foregone income from fuelwood gathering (Abeygunawardena and Wickramasingha, 1991).

E. Implicit/Surrogate Market Techniques

Implicit/surrogate market techniques can be used to value environmental attributes such as clean air, unobstructed views, or pleasant surroundings. The basic assumption in this method is that the valuation of the environmental attribute at issue is the difference in value after all other variables—except for the environmental attribute at issue—have been controlled for. Three distinct approaches fall under this general category: (i) property value differentials, (ii) wage differentials, and (iii) travel costs.

Property Values. The basic assumption in using this approach is that a buyer's attitude towards an attribute of a property (physical, aesthetics, or environmental) is reflected in the willingness to pay for the property. In deciding to buy a house, one would expect its value to be equal to its construction costs plus an appropriate mark-up. In reality, decisions to buy a house are influenced by a wide range of attributes, only some of which are physical. Other considerations are location to certain amenities, distance from good schools, markets, and other general neighborhood attributes.

The property-value approach is designed to control certain variables so that any remaining price differential can then be assigned to the unpriced environmental effect—either good or bad. A drop in property value may be due to increased noise or air pollution, or view obstruction; an increase in property values will occur if these undesirable environmental attributes are corrected. 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 identical housing situated in less frequently flooded areas. Based on the assumption of a freely functioning and efficient price market, the approach is founded upon a sound theoretical base and is capable of producing valid estimates of benefits as long as individuals can perceive environmental changes (Georgiou, et al., 1997).

In 1993, North and Griffin used the hedonic property valuation approach to assess the willingness-to-pay for water using water source as a housing characteristic. The study, from a survey of 1,903 Philippine households, developed a bid-rent function and found that households are willing to pay about half their imputed rent to have piped water.

Wage Differentials. In a well-functioning market economy, the demand for labor equals the value of the marginal product of the worker at that time, and the supply of labor varies not only with prevailing wages, but also with working and living conditions. This suggests that a higher wage will be required to induce workers to live in polluted areas, or to undertake risky occupations. The differential wage become a “risk premium” that is required in order for labor markets to clear. Workers are presumed to be able to move freely among jobs and therefore to be able to choose particular jobs in particular areas at certain wages that 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 can be estimated for improvements in levels of various attributes. Common attributes affecting wage differentials are differential risks to life and health, and the level of urban amenities.

Travel Costs. Observed behavior can be used to estimate the value of an unpriced environmental good or service by treating different levels of travel costs as a proxy for variable admission prices. From these differential travel costs it is possible to derive a demand curve for a recreational site and thus to derive estimates of its total economic value. From this, one can then derive the total amount of consumers' surplus from the actual use of the park and then derive estimates of the net economic value of the park. The method is a technically well-developed valuation approach which has been extensively used because it is grounded on actual observed behavior. However, the technical and data requirements are generally large, making a proper travel cost application a relatively expensive approach to nonmarket valuation.

The travel cost method was used by Dixon and Hufschmidt in 1986 on the Lumpinee Public Park in Bangkok, Thailand. The study estimates a total annual user surplus of $1.1 million. The method has also been applied in Sri Lanka's forests and national parks (Kotagama and Silva, 1997; Abeygunawardena and Kodithuwakku, 1992).

F. Replacement-Cost Approach

The basic premise of the replacement-cost approach is that the costs incurred in replacing productive assets damaged by an environmental impact can be measured. These costs can be interpreted as an estimate of the benefits presumed to flow from measures taken to prevent those damages from occurring. The theoretical rationale for this technique is similar to that for preventive expenditures arising from averting behavior, except that replacement costs are an actual—rather than a subjective—evaluation of the potential damages. This approach may be regarded as an accounting procedure to work out whether it is more efficient to let damages happen and then to repair the losses, or to prevent damages in the first place. The approach estimates the upper limit of the value of the damage, but it does not really measure the benefits of environmental protection *per se*. The assumptions implicit in this type of analysis are that:

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 undertake the replacement; and

3. there are no secondary benefits associated with the expenditures.

Within the replacement-cost approach, it is often possible to assess the costs of relocating certain activities. This variant uses the actual costs of relocating a physical facility as a proxy for the potential benefits (and associated costs) of preventing the environmental change which would necessitate the relocation. An example would be the construction of an oil palm mill that would discharge wastewater into a nearby stream. One potential environmental harm of such a project might be that a domestic water supply is seriously polluted. In this case one cannot claim any net environmental benefits for the project since the water intake was presumably adequate prior to the oil palm mill. The relocation of the intake simply represents a necessary cost to preserve the existing level of environmental quality (water purity). However, imagine a project that will improve the urban environment by moving a noisy and polluting factory away from a city center. The relocation costs can be considered as the lower-bound estimate of the benefits to be realized by the relocation.

The replacement cost is a popular method of assessing the value of soil erosion. For example, Clark, et al. in 1996 estimates the value of annual soil nutrient loss to be Rs342,755 to 475,033 ($6,688 to 9,269) per acre in Sri Lanka. Other Sri Lankan valuation using this method include: Samarakoon and Abeygunawardena, 1994; Banda and Sangakkara, 1995; and Premachandra and Kotagama, 1995.

G. Shadow Projects

A variant of the replacement-cost approach has been developed to facilitate estimates of 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 and services as 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.

Winpenny (1991) notes that the technique presupposes that it is feasible to replace damaged environmental commodities. The design of such projects is difficult because of the complex environmental interactions which are to be compensated. Furthermore, the shadow project is likely to have its own environmental impacts which may not be understood.

A 1995 study by Niskanen assessed the impact of plantation forestry on soil erosion and carbon sequestration. The study estimates the shadow price of carbon sequestration at $25/mg carbon for timber and pulpwood plantations in the Philippines.

H. Contingent Valuation Methods

Contingent valuation methods (CVMs) are survey-based methods to assess the economic value of the environmental impacts of development projects when no data are available on market or surrogate market prices. These methods are valuable tools in cases concerning diverse goods and services such as: (i) species preservation, (ii) historical or cultural sites protection, (iii) genetic biodiversity conservation, (iv) preservation of open spaces or unobstructed views, or (v) public access to amenity resources such as electricity and water. The ADB encourages the use of such methods in projects concerning water, electricity, sanitation, and wastewater treatment. There are several variants of the approach. The technique is likely to be most reliable for valuing familiar goods such as local recreation amenities and it is the only technique with the potential for measuring existence values.[7] The method can also include open-ended, close-ended or iterative questions in survey form (see section on ethical considerations in Chapter 3, Part I).

Bidding Games. In a bidding game, individuals are asked to evaluate a potential change under a hypothetical situation and to express their willingness to pay (WTP)—or their willingness to accept compensation (WTA)—for a change in the level of provision of an environmental good or service. These individual estimates of WTP may be summed to provide an estimate of aggregate WTP—and hence total economic value.

There are two types of bidding games—single-bid games and iterative-bid games. Single-bid games ask respondents to indicate the maximum price they would be willing to pay for an environmental good (say, clean water), or to indicate the minimum amount of compensation they would accept for doing without that good. The responses are then averaged and extrapolated to arrive at the aggregate WTP (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 maximum WTP (or a minimum WTA) 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 may respond to only one of these possible amounts. The various amounts are randomly distributed over the entire surveyed population. In the end, it is possible to determine the proportion of respondents who would and would not accept particular offers. These answers are then analyzed to determine the WTA on the part of the average consumer, which is then

7 *Georgiou, et al, (1997) points out that tests to measure replicability shows high correlation between the individuals' WTP in test and retest experiments—indicating that the contingent valuation method appears to be a reliable measurement approach. The work also discusses the technique's biases (strategic, hypothetical, payment vehicle, and starting point bias).*

multiplied by the total population to determine aggregate willingness to accept compensation for a diminution of air quality.[8]

An example of CVM in Asia includes the study of Choe, *et. al*, in 1995, for valuation of improvement of surface water quality in Davao, Philippines. In this study, survey instruments were used and 581 in-person interviews were completed. These show that WTP for environmental improvement is low confirming the conventional wisdom about household demand for environmental improvements in developing countries. For example, beach user WTP for quality improvements was about 0.6 percent of mean household income while non-users' WTP was almost zero. CVM has also been the valuation of choice for other Asian studies particularly concerning: air pollution in the People's Republic of China (PRC) and the Philippines (Hu, 1995; and Peralta, 1994); sewerage systems in the Philippines (Camp Dresser and McKee International, 1993); species and wildlife preservation, such as the case of the Philippine Eagle (Oida, 1994); and forest recreation/biodiversity conservation in Sri Lanka and the Philippines (Abeygunawardena, 1992; Gunawardena, et al., 1999; Gunawardena, et al., 1996; and Predo, 1985).

I. Costless Choice

This 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 desirable but unpriced environmental outcome—perhaps a reduction in air or noise pollution. If the individual chooses the environmental good rather than the money, then that would establish the minimum value of the benefits associated with the environmental good to that individual. If the money were chosen, then it would suggest that the individual considered the good to be worth less than that certain amount.

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8 Econometric methods involved in estimating surplus under different methods of data collection is complex and is not discussed in this book.

J. *Cost-Effectiveness Analysis*

Although cost-effectiveness analysis (CEA) is not concerned with the derivation of estimates of values for environmental goods and services, it plays an important role in project evaluation. This approach concerns the accomplishment of a predetermined objective given limited resources—either limited funds, inadequate data, or insufficient knowledge of the nature and link between environmental damage and particular human or ecological outcomes. After considering all the alternatives, CEA is used to determine the most cost-effective way to meet a predetermined goal. Compared with other approaches, the major difference of CEA is that it does not attempt to monetize the benefits of projects or programs. It has a very important role to play when considering projects with benefits that are difficult to measure in monetary terms (e.g., health or education projects).

The first step in CEA is to fix a target for project or program outcomes. In the environmental field it may be a certain ambient air or water quality, or an emission standard for industrial facilities. Once a target is chosen, analysis proceeds by examining the various alternatives by which the desired objective can be achieved. This may, for instance, involve comparing the capital and operating costs of alternative pollution-control technologies. The basic goal is to identify the least-cost alternative that will achieve the selected goal.[9]

Since cost-effectiveness analysis does not give an estimate of benefits that can be derived from meeting a given standard or goal, it may happen that the most cost-effective (least-cost) option of meeting a strict standard is still "too expensive." Of course the judgment that it is "too expensive" depends on a number of considerations that may fall outside of the process

9 *ADB often encourages its developing member countries (DMCs) to develop least-cost plans for sectors like energy and other utilities. Once such plans are developed, a selected project in a given area may be supported after an economic analysis. It is important to note that costs of environmental impacts for alternative projects should be included in least cost plans, when selecting a particular project. This is consistent with the methodology followed in the cost-benefit analysis of projects.*

of project evaluation. If this should happen, it would suggest that the proposed standards should be relaxed.

K. Benefits-Transfer Method

The methods described in the preceeding sections require primary data collection and substantial resources, time and expertise. The benefits-transfer method (BTM) facilitates the valuation of environmental impacts by adapting monetary values reported in primary research for similar outcomes in similar locations under comparable circumstances.[10] As with several approaches, BTM is useful because it saves budgetary costs and time requirements for data gathering and analysis. There are four basic steps in obtaining BTM values.

The first step is to select literature that can provide feasible monetary values for the environmental impacts under consideration. Second, these monetary values must then be adjusted to fit the bio-physical baseline, socio-economic, and monetary information of the current project. Third, these adjusted values must then be multiplied by the number of affected individuals to derive the total values per unit of time. Finally, the total discounted values of environmental impacts are calculated over the time period for which such impacts are expected to occur.

Although the method is straightforward, sound judgment must be used or the calculated values may be inapplicable to the project being evaluated. If BTM is to be used, it is important to evaluate the appropriateness of the monetary values for the project setting and circumstances. It is also important to make modifications in the monetary values to account for differences in the primary study site and the new site. If the values from a developed country are to be extrapolated to a developing country (which is often the case), the major differences between the sites should be taken into account. Among the variables where adjustments can be made are in terms of differences in population

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[10] *Although called benefits-transfer method, values and estimates of both costs and benefits can be transferred. BTM references have been compiled to aide analysts, an example of which is the Environmental Valuation Reference Inventory (http://www.evri.ec.gc.ca/evri/).*

densities, personal income, property rights, land prices, institutions, cultures, climates, and natural resources. Adjustments in underlying damage or dose-response functions and the validation of the analysis should be conducted wherever feasible. For projects with possible large environmental impacts, particularly controversial projects, it is suggested that additional resources be devoted towards data collection and validation.

The chapter has discussed the general issues in valuation, and has provided descriptions of prominent valuation methodologies. The succeeding chapter focuses on the issues an analyst faces when undertaking the economic evaluation of environmental impacts.

Table 1 provides a comprehensive set of examples for various types of valuation methods which can be applied on a wide array of environmental impacts in projects. Projects can range from agricultural production, livestock development, rural water supply to energy production. The table shows that an analyst must use not only his/her technical expertise, but integrate site-specific and other relevant factors in determining the type of valuation to be applied. It has been shown that an analyst's ingenuity or creative approach to the valuation problem, along with experience, counts substantially when assessing the quality of valuation results. It is not advisable, for instance, to use WTP approaches when the affected parties are not accustomed to thinking in monetary terms or if there is no understanding of the market system. In such cases, determining exchange values familiar to the affected population may provide a better valuation of the environmental impact. A similar example is that loss of earnings cannot be used as a method to value health benefits when the affected parties are not earning wages. It should be clear from this point that the complexities of the resource and the socio-cultural diversities should be understood for the proper selection of valuation tools.

Table 1. Environmental Impacts of Various Projects and Possible Valuation Methods

Type of Project	Project Component and Environmental Impact	Measurement and Valuation Methods (comments)
Natural Resource and Agricultural Development		
Upland watershed management	*Increases fuelwood and fodder production, and protects critical watershed, resulting in higher quality and quantity of water* *Reduces soil erosion and landslides and improves agricultural production and water supply; improved water supply can be used for hydropower generation, irrigation, and drinking purposes*	• *Change in productivity of forests and agricultural land* • *Change in productivity of irrigated agriculture downstream* • *Opportunity cost of dung as fertilizer or value of benefit from alternative fuel* • *Increased timber value* • *Increased hydropower production due to better regulation and increased flow* • *Willingness to pay for drinking water* • *Biodiversity values and other global benefits*
Integrated coastal resources management	*Controls overexploitation of shrimp and other coastal fishery resources; provides alternative income generation, rural credit, and assists women in development* *Provides fisher education, institution building, and environmental monitoring/ surveillance; controls coast erosion* *Provides coastal and sea pollution control including solid and wastewater management*	• *Change in fisheries and coast-based productivity with and without project* • *Loss of earnings of artisanal fishers must be subtracted from project-catch projections* • *Benefits from coastal erosion control, land value and other property value enhancement, and hedonic pricing* • *Beach development, increased tourism revenue* • *Enhanced recreation values can be accounted either through (i) travel cost method (TCM), (ii) willingness-to-pay (WTP) or hedonic pricing*

Type of Project	Project Component and Environmental Impact	Measurement and Valuation Methods (comments)
Natural Resource and Agricultural Development *(cont'd.)*		
	Mangrove and lagoon rehabilitation improves coastal environment; special area management improves biodiversity and tourism *Moving from coastal to offshore fishing enhances sustainability*	• *Pollution control benefits accounted for through WTP, cost of illness, or loss of productivity* • *Biodiversity values and other global benefits*
Livestock development	*Reduces overgrazing in forests and rangeland* *Reduces soil erosion* *Provides rural credit and development of women* *Improves employment, nutrition, and draft power and increases production of hide, dung, bone, etc.* *Increases agricultural production due to integrated farming.*	• *Change in productivity of forests and rangeland* • *Increased income and employment* • *Increased productivity due to improved human health, nutrition, and quality of life* • *Opportunity cost of dung as fertilizer or domestic fuel* • *Increased productivity of croplands*
Drainage and irrigation management	*Reduces waterlogging and soil salinization/acidity problems* *Controls mosquito-caused and other waterborne diseases* *Watershed development component can be introduced* *Increases inland fisheries*	• *Change in productivity from better growing conditions for agricultural crops* • *Cost-effectiveness of alternative rehabilitation designs* • *Health impacts can be measured through loss of earnings, cost of illness, or preventive expenditures*

Type of Project	Project Component and Environmental Impact	Measurement and Valuation Methods (comments)
Natural Resource and Agricultural Development *(cont'd.)*		
	Increases employment, development of women, incomes, rural credit, and institution building	• *Improved water supply and increased forest products from watershed improvement* • *Increased fish productivity* • *Increased income and productivity*
Infrastructure Development		
Integrated rural development in hilly areas	*Improves social (credit, clean water, community services, market access) and physical (schools, hospitals, rural roads) infrastructure* *Avoids property loss from soil erosion and landslides* *Increases agricultural productivity*	• *Changes in productivity, increased incomes, time savings, and increase in quality of produce* • *Change in productivity due to soil erosion and sedimentation* • *Hedonic pricing*
Urban housing	*Better living conditions and improved well-being* *Increases air pollution due to use of heating systems* *Indoor pollution due to burning coal briquettes, fuelwood, and other cooking fuels* *Environmental nuisances such as dust, noise during construction* *Problems with solid waste and wastewater disposal*	• *Increased productivity and time savings from improved living standards* • *Cost-effectiveness of alternative heating designs* • *Loss of earnings from increased respiratory diseases* • *Cost of illness or cost of medication due to change in housing arrangement*

Type of Project	Project Component and Environmental Impact	Measurement and Valuation Methods (comments)
Infrastructure Development *(cont'd.)*		
	Housing schemes can be connected to (i) district heating systems, (ii) community/municipal sewage and solid waste disposal systems, and (iii) other public utilities.	
Water		
Urban water supply and wastewater management	*Increases wastewater volume without adequate sewerage facilities* *Reduces water for down-stream users* *Large water storage may damage the environment* *Include wastewater treatment facilities as a part of the project. Industry rellocation can also be included. During construction of supply lines or sewerage systems, disturbances can occur* *Improves heath status and reduces waterborne diseases; improves surface water quality which increases property values, aquatic production, and recreation values*	• *Avoided loss of earnings directly due to flooding* • *Change in incidence of waterborne diseases via WTP or health cost* • *Change in productivity of downstream water users* • *WTP for improved health due to better water supply and wastewater treatment* • *Change in property value due to water storage and cleaner surface water via land rent method or opportunity cost* • *Increased aquatic productivity* • *Enhanced recreation values can be accounted either through (i) TCM, (ii) WTP, or (iii) hedonic pricing*
Rural water supply	*Watershed development in upstream areas can be a part of the project.; increases water supply*	• *WTP for improved health or avoided health cost and avoided loss of productivity due to better drinking water*

Type of Project	Project Component and Environmental Impact	Measurement and Valuation Methods (comments)
Water *(cont'd.)*		
	Relies on community organization and creates time savings particularly for women fetching water	• *Willingness to pay for time, cost savings from water fetching and opportunity cost of alternative earnings during water fetching*
Industry and Energy		
Hydropower development	*Service roads promote deforestation resulting in changes in hydrological patterns, soil erosion, siltation, and flooding* *Reservoir inundation causes loss of land, environmental damage, loss of biodiversity, and disturbs fish movements* *Electricity distribution lines may disturb the aesthetic values in the vicinity* *Electromagnetic fields* *Avoided environmental emissions could be due to alternative energy sources such as coal, lignite, or fossil fuel* *May result in relocation and resettlement of indigenous people and reduce agricultural land* *Downstream water users may be affected by regulated water flow*	• *Change in productivity of forests, agricultural land and downstream fishery; competition with downstream hydropower and other water use activities* • *Loss of earnings as a direct result of inundation* • *Loss of biodiversity due to inundation and in aquatic environments due to dam construction* • *Cost of adverse environmental impacts in construction such as dust, noise, water safety* • *Increased incidence of waterborne diseases through cost of illness* • *Cost avoided or opportunity cost of human health and welfare damages due to emissions caused by alternative energy sources (e.g., coal)* • *Loss of earnings or cost of resettlement and relocation* • *Loss of electricity production due to dismantling and closure of old and inefficient coal or fossil-fuel power plants is a cost, but emissions reduction is a benefit*

Type of Project	Project Component and Environmental Impact	Measurement and Valuation Methods (comments)
Industry and Energy *(cont'd.)*		
Coal-fired thermal power plant	*Air pollution (TSP, CO_2, NO_X, SO_2, and other emissions)* *Project components may be land acquisition, resettlement, provision of transmission lines, closure of old and inefficient power plants, institutional strengthening and capacity building, and introduction of clean coal technologies*	• *Loss of productivity and cost of illness due to air pollution* • *Visibility reduction and reduction in water quality through WTP* • *Noise, visibility pollution through change in property values* • *Loss of fish production and other aquatic resources* • *Loss of electricity production due to dismantling and closure of old and inefficient coal or fossil-fuel power plants is a cost, but emissions reduction is a benefit*
Industry restructuring project	*Improves energy efficiency* *Reduces air/water/land pollution (e.g. reduces SO_2, TSP and other industrial wastes such as smoke, dust, heavy metals, wastewater, etc.)* *Reduces waste through cleaner production processes* *Improves workers' health and safety and provides new employment* *Introduces better technologies, change in products and processes, relocation, privatization, and reorientation*	• *Increased efficiency can be measured via reductions in cost, raw materials and energy savings* • *Hedonic pricing for quality differences in goods and services produced* • *WTP for reduced air and water pollution* • *Benefits of health improvement can be measured through reduced cost of illness or increased productivity* • *Hedonic pricing for workers' health and safety* • *Benefits from recycling of waste materials*

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