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Implementation Guideline: Economic Cost-Benefit Analysis (CBA) of Project Environmental Impacts and Mitigation Measures for Waste Water Treatment Projects (WWTPS)

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January 2013

Acronyms

CBA	Cost-Benefit Analysis
CVM	Contingent Valuation Method
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ESG	Environmental Safeguards Unit
GEF	Global Environment Facility
IDB	Inter-American Development Bank
NPV	Net Present Value
PV	Present Value
PWS	Potable Water Supply
TEV	Total Economic Value
TC	Travel Cost
TORs	Terms of Reference
VPS	Vicepresidency for Sectors and Knowledge
WWTP	Waste Water Treatment Projects

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Introduction and Policy Requirements

The expansion of project analysis to incorporate the environmental effects of a project is a direct descendent of the development of project analysis. Traditional project Cost-Benefit Analysis (CBA) was developed in the United States in the 1930s to analyze large public investments in the water sector. The goal of the analysis was a simple one: the analysis should demonstrate that projects produce positive net benefits over time; that is, the present value (PV) of benefits should exceed the present value of costs. During the next 50 years, analysts perfected the tools of traditional CBA, including issues such as shadow pricing and the determination of a social discount rate. As experience was gained in project CBA, however, it was noted that important environmental and social impacts of a project were being ignored. This led to actions to explicitly expand the analysis of projects.

The first step was the inclusion of the environmental (and social) aspects of a project in a qualitative manner (basically the Environmental Assessment [EA] process). It was soon realized, however, that a further step was needed. Since projects were developed and implemented to increase social welfare (usually measured in monetary terms), it became clear that it would be easier to analyze alternative projects, mitigation measures, and remaining impacts if all of the benefits and costs—direct and indirect, financial and environmental—could be measured using a common *numeraire*: money. Hence, the focus on monetary valuation of environmental impacts began so that these impacts could be included in the more comprehensive analysis of alternatives (and the overall net benefits generated by a project).

Over the past 30 years, the international development banks and various international agencies have led the way in this expanded CBA, applying the approach to the analysis of development projects. Great advances have been made in the qualitative and quantitative analysis of the environmental and social impacts of projects. These changes are reflected in the requirement that major international development banks take these factors into account in project analysis.

Operational Policy 703 (OP-703) of the Inter-American Development Bank (IDB) contains a policy Directive that explicitly calls for economic analysis of environmental impacts and project alternatives. Directive B.5 states that "**The EIA [Environmental Impact Assessment] should be supported by economic analysis of project alternatives and, as applicable, by economic cost-benefit assessments of the project's environmental impacts and/or the associated protection measures**."

B.5 is focused on environmental impacts identified as part of the EIA, while a related Directive, B.9, is more focused on the special case of a project's impact on natural habitats and cultural sites. The explicit wording in B.9 is worth repeating: "comprehensive analysis demonstrates that overall benefits from the operation substantially outweigh the environmental costs." This objective has a simple economic goal (very similar to the original goal of CBA): the **maximization of net benefits** from a project by taking both project and environmental factors into account.

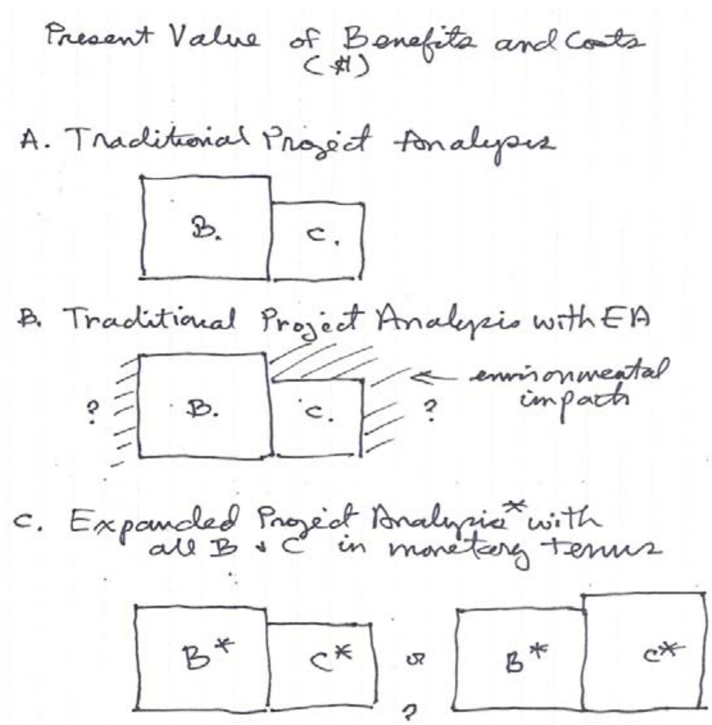
When the Expanded Analysis is Necessary—and When It Is Not

The *Guidelines for Environmental Screening and Classification* (ESG Note No. 2, October 2009) explains the selection of the appropriate Category—A, B, or C—for any project. For most projects, common sense provides useful guidance. Major infrastructure investments will normally have measureable long-term impacts on the environment and sometimes will cause significant conversion of natural habitat. These are Category A projects that will require an EIA and will benefit from the expanded, comprehensive CBA. For many other projects, designation of the correct Category depends on specifics on the ground. The project may be a Category A (those with significant environmental impacts) or a Category B (those with mostly local or short-term environmental impacts) or a Category C (those with minor or no environmental impacts), depending on an initial assessment. This note addresses some of the issues that arise when an expanded, more comprehensive, economic CBA is needed.

Adding the environmental dimension to the analysis builds on the fundamentals of project analysis methods that have been developed over many years. All three project evaluation criteria commonly used to assess the attractiveness of projects—Net Present Value (NPV), Benefit-Cost Ratio (B/CR), and Internal Rate of Return (IRR) (see Annex 1, Definitions, for details on these terms)—are **based on the same data**. Each criterion can be used to make decisions on individual projects or among competing projects. Explicitly adding the environmental impacts in the monetary analysis is an extension that expands the definition of what benefits and costs are included, both in space and over time.

The expansion of project analysis can also be shown graphically (see Figure 1). The figure shows the transformation from **traditional project analysis** (A), to **qualitative** analysis, including environmental impacts (B), to monetary valuation of those impacts (C). At present, all projects have a traditional CBA (Figure 1, Alternative A). In addition, many projects also meet the second test and include qualitative (and sometime quantitative) discussion of environmental impacts (Figure 1, Alternative B). Fewer projects meet the third criterion of a fully comprehensive monetary analysis of both project and environmental benefits and costs (Figure 1, Alternative C). This more comprehensive monetary analysis is both the "intellectual frontier" and the "best practice frontier" of project analysis.

Figure 1. Different Levels of Project Analysis (Present Value in $)



Practical First Steps/Guidance for Enhanced Economic Analysis (with special emphasis on WWTP)

The following suggestions are offered for implementing the mandate found in OP-703 to carry out more comprehensive CBA of projects:

First, at the initial project identification and scoping stage, incorporate the economic analysis of environmental impacts as part of the process (not as something to be "added on" later). As a result, the necessary staff time and data collection will be included in the project preparation work plan and budget. This is particularly important for Category A projects.

Second, environmental impacts affect social welfare and the generation of net benefits to society, and these impacts should be included in the cash flow tables of benefits and costs over the life of the project. The CBA results can be presented in three ways: first, a standard project CBA can be calculated as seen from the perspective of the borrower (and ignoring all externalities). This is the same as Alternative A in Figure 1 and is referred to as CBA Result 1. Second, the same basic CBA is done, but, in addition, the costs of any negative externalities and the benefits from any positive externalities are included (e.g., externalities are calculated and added in as benefits or costs, as appropriate). This is the same as Alternative B in Figure 1 (except that all impacts are expressed in monetary terms) and is referred to as CBA Result 2. Third, an analysis is done from the perspective of the country or society in which the project is located and incorporates all benefits and costs, including both direct project variables and any environmental and/or social variables. This analysis includes any mitigation costs and any remaining environmental damage costs. The third analysis is referred to as the "comprehensive analysis" and is the same as Alternative C in Figure 1, or CBA Result 3.

CBA Results 1, 2, and 3 are found by adding different benefits and costs to the project analysis as seen in the following list of annual costs and annual benefits. The key intellectual challenge is in identifying the various environmental and social impacts and correctly placing monetary values on them. The actual process of calculating CBA Result 1, 2, or 3 is then rather mechanical.

Annual Costs A:	Normal project costs
Annual Costs B:	Project costs with environmental costs, unmitigated
Annual Costs C:	Costs of environmental intervention after project re-design
Annual Costs D:	Remaining environmental costs after re-design
Annual Benefits A:	Normal project benefits
Annual Benefits B:	Project benefits plus any positive environmental externalities
Annual Benefits C:	Additional benefits after mitigation, if any
CBA Result 1:	Costs A + Benefits A
CBA Result 2:	Costs B + Benefits B
CBA Result 3:	Costs A + Costs C + Costs D + Benefits B + Benefits C

The three analyses (CBA Results 1, 2, and 3) will usually produce different estimates of NPV. The only exception is when there are **no** environmental or social externalities of the project; in this case, the three CBA results will be the same.

It is not possible to say *a priori* in what direction the results will diverge. Although people usually assume that the comprehensive analysis (CBA Result 3) will show greater costs and lower net benefits than the project-only CBA Result 1, this is not always the case. For example, the project may generate positive economic externalities, and these will add to the net benefits estimated in the comprehensive analysis. If the project generates negative externalities, on the other hand, the impact on the results of the comprehensive analysis will depend on the size of the negative externalities and to what extent they are mitigated, and at what cost.

Using the NPV criterion, one would normally expect the first analysis (CBA Result 1) to have the largest NPV (since it ignores all externalities). The second analysis (CBA Result 2) will produce a reduced NPV (since the costs of negative environmental externalities are now included). The third analysis (CBA Result 3) should produce an NPV between the first two results—there will be increased costs for environmental protection but reduced costs from environmental damage. The third analysis also indicates the net benefits generated by a project **from the perspective of society.** It is, therefore, the correct measure to estimate the net benefits produced by any project.

As mentioned earlier, the actual mechanical calculation of the three results is not difficult once the required data have been collected and environmental benefits and costs calculated. In order to expand the analysis from CBA Result 1 to CBA Result 3, it is necessary to calculate the monetary values of the environmental benefits and costs associated with the project and the needed mitigation measures. Many economic valuation techniques exist that can be used in project preparation. Annex 2 briefly presents some of the techniques that a trained environmental economist has in his/her toolkit. Choosing the correct valuation technique depends on the type of externality being evaluated; the time, data, and resources available for the analysis; and the skill of the analyst. (See Dixon et al.[1994], Dixon [2011, 2012a], and Dixon and Pagiola [1998] for a fuller discussion of these techniques.)

Analyzing WWTPs

The basic economic analysis of waste water treatment projects (WWTPs) is no different than other projects―the CBA compares benefits and costs over time and usually calculates an estimate of NPV and Economic Internal Rate of Return (EIRR). Project benefits are commonly measured by the willingness-to-pay of those receiving the enhanced services of either a WWTP or a potable water supply (PWS). Project costs include investments in infrastructure, operation and maintenance, and sometimes monitoring and training activities. Once direct project benefits and costs are identified, CBA Result 1 is (usually) easily calculated.

However, moving from CBA Result 1 to the intermediate CBA Result 2 and finally to CBA Result 3 for WWTPs is complicated by several sector-specific factors:

1. *Marginal and Cumulative Impacts*. Many WWTPs may have only a small or non-measureable impact on the external environment. For example, if disposal of treated waste water constitutes only a small percentage of the receiving body's flow, there may be no measureable impact. However, if several projects are being implemented at the same time or over a period of years, the cumulative impact may be substantial. This can be very important when determining the correct level of waste water treatment. We know that tertiary treatment is much more expensive than secondary or primary treatment. The question is always "do the potential benefits justify the costs?" If there are no marginal impacts measured, there are no benefits from higher levels of treatment. If marginal changes lead to cumulative results, however, higher levels of treatment may well make sense economically.

2. *Lack of Baseline Data (and monitoring).* Directly related to the first point is the common lack of good baseline data on water quality in the receiving waters. Without some idea of baseline numbers, and trends of change over time, it is almost impossible to carry out a with-project/without-project analysis and identify both marginal and cumulative impacts.
3. *Lack of "Actionable" Information*. If marginal or cumulative environmental impacts can be identified, the information has to be presented to the project economists in a way that the data can be quantified and included in the enhanced analysis. Merely saying that environmental impacts are potentially "large" or "significant" is not sufficient. Quantified data are required (e.g., a 15% increase in health impacts, or a 20% decrease in fishery production, or a 30% increase in downstream water treatment costs) in order to carry out the enhanced analysis.
4. *The Need for Broader Sectoral Planning*. Given that impacts may be cumulative and the result of many individual decisions or investments, a broader sectoral overview may be required to correctly identify and quantify cumulative impacts. This is especially true for WWTPs that are connected to large river or coastal systems—no individual project may have a measureable impact, but many projects over time may have major impacts (for good or bad). This issue highlights a basic underlying tension: projects are usually identified and funded on a narrow basis, while sound environmental management may require a much broader perspective.
5. *The Tyranny of Small Decisions*. A common outcome of the tension between project-level and sector-level planning and analysis is what economists refer to as "the tyranny of small decisions": many individual decisions (e.g., investments) make good sense by themselves but result in a cumulative impact that is costly and hard to reverse. One example of this is when coastal hotel resort development is beginning and each individual hotel uses a "package" WWTP since no individual hotel can pay for a more centralized system. However, when many hotels are developed and maintenance problems become more common, the benefits of a centralized system are obvious, but the costs of "re-engineering" and retrofitting become prohibitive. The result is that coastal waters are polluted, the environment is degraded, and the tourism industry suffers. Foresight and up-front capital investments in a more comprehensive waste water collection and treatment

system would have probably cost less and yielded better local and ecosystem environmental outcomes.

While there are no easy answers to these issues, being aware of them can help the water project people and the environmental safeguards people to work together and realize that each side has legitimate interests and data needs. The common goal, of course, is to have projects that maximize net benefits for society.

Matching the Valuation Technique to the Environmental Externality

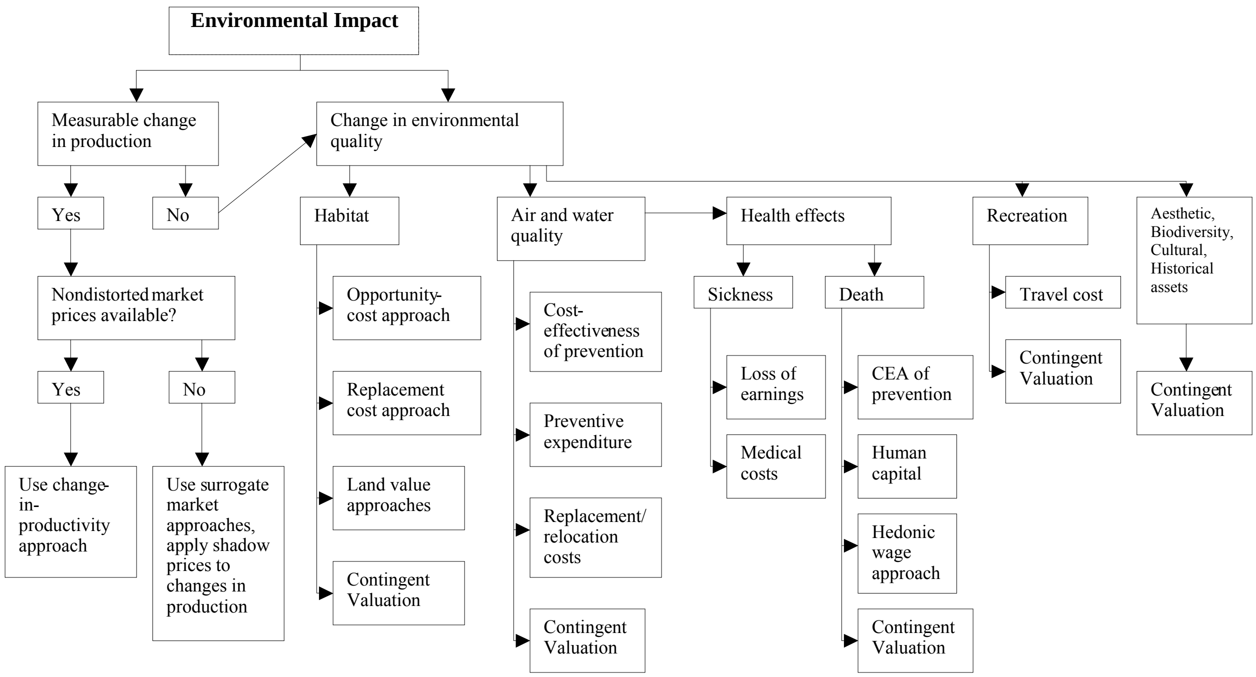
In order to complete the comprehensive analysis suggested here, it is necessary to decide which valuation technique to use for any given environmental impact. Although each project is unique, there is general agreement among environmental economists that certain valuation approaches are more likely to be suitable for valuing specific environmental goods or services. Figure 2 presents a "valuation flow chart" with suggestions regarding which valuation approach is most suitable for different environmental impacts. The matrix starts with a simple question: Is there a measurable change in production? If the answer is "yes," then the change-in-productivity approach is usually suitable. If the answer is "no," then one asks if there is a change in Environmental Quality. The four possible changes listed under this heading are changes in: (1) habitat; (2) air or water quality; (3) recreation; and (4) aesthetic, biodiversity, cultural, and historical attributes. Under each heading, there is a suggested "first best" valuation technique, followed by other economic valuation techniques.

Many WWTPs will produce external impacts on the aquatic ecosystem (either rivers or coastal waters), and these can result in impacts on production (e.g., fisheries) or on environmental quality (e.g., water quality and related impacts such as those on recreation and tourism). As seen in Figure 2, the impacts that result in a change in production are among those that can be valued with the most robust and frequently used valuation techniques. In most columns, the last technique suggested is the Contingent Valuation Method (CV or CVM).

As seen in the recent review of four WWTPs (Dixon [2012b]), the benefits from most WWTPs are valued using a CVM analysis of direct project beneficiaries. Willingness-to-pay for improved water and sanitary services is estimated by surveying those affected. This approach produces robust estimates of changes in welfare due to the projects and is usually the best way to estimate these benefits.

Although CVM is a powerful technique, it should not generally be applied if other valuation techniques are possible. Changes in health outcomes can be valued using a variety of techniques, as can changes in recreational or tourism services. However, for some environmental impacts—especially those in the far right-hand column (aesthetic, biodiversity, cultural, historical) ―CVM is usually the only valuation technique possible.

Figure 2. Economic Valuation Flow Chart



In summary, economic valuation is easier when an environmental externality results in a change in production of a good or service for which we can measure market prices. The more tangible and more direct the impacts are, the easier they are to value in economic terms. Examples of the "easier to value" environmental externalities include the following:

Changes in the production of crops, forestry, fisheries, and ecosystem services;

Air pollution and water pollution and their impacts on health and production;

Costs of alternative measures or mitigation actions (cost-side approaches); and

Recreational use of natural habitats and environmental resources.

Other types of environmental externalities are more difficult to value. The "more difficult to value" externalities include the following:

Biodiversity and/or pristine habitats;

Cultural or historical values; and

Human life (although much can be done to value morbidity and mortality).

Some of the external impacts of WWTPs fall in the "more difficult to value" category. This does not mean that economic valuation is impossible—just that it is often more challenging. Economic valuation techniques that can be used to place values on these "more difficult to value" resources exist, and there are many examples of such valuations in the literature. In addition, it is always possible to do an opportunity-cost analysis to see what development benefits are lost by re-designing the project to avoid the environmental impact. If there are important recreational and/or tourism uses of the resources, the travel cost approach and CVM can both be used to assess economic values. Ecosystem-service values can be measured by using combinations of change- in- production and various cost-side approaches.

Genetic values and potential loss of species (e.g., extinction) are two areas not handled easily by economic valuation. These environmental impacts are usually valued using CVM approaches, but these may be only partial estimates of the true (total) economic value of the impacts.

Expanding the CBA Analysis of WWTPs

The present "best practice" examples of project CBA for WWTPs do an excellent job of capturing beneficiaries' willingness-to-pay for improved water supply and sanitation services. In some cases, external environmental impacts have also been taken into account in the CBA. The challenge is to correctly identify these external effects—both benefits and costs—and bring them into the enhanced analysis. This requires input and cooperation from both sides—project analysts and the environmental safeguards team. The following thoughts are offered to advance this process:

The expansion of a traditional CBA to include the environmental dimension is a **specialized task**. As with any specialized task, the person doing the work must have the proper training and experience. In this case, an environmental economist, or an economist with experience in addressing environmental issues, is needed to help incorporate any measureable environmental impacts into the CBA. Experience is very important because a major responsibility is to decide which impacts to include and which to exclude, which techniques to employ, and when results are reasonable and when they are not. Conducting an expanded CBA is not a mechanical exercise.

The individuals responsible for identifying the environmental impacts and their economic analysis should be **part of the project preparation team from the start** (particularly for Category A projects.) This will facilitate data collection, working together as a team to better understand the full range of potential impacts, and analyzing alternatives and options as part of project preparation, not merely as an added chapter after all of the work on design has been completed. This is not an unreasonable demand. Just as any project that will lead to re-settlement (e.g., dam or port construction) should have an individual with sociological expertise on the project team, any project that has a potentially important impact on the environment should have an environmental economist as part of the team. This also assumes that the IDB's Environmental Safeguards Unit (ESG) and/or the EIA studies are providing the required EA information.

Taking the previous statement into account, we can say that the "optimal" approach does not necessarily require major additional resources or a long time to implement. A trained and experienced economist, working with the project development team, can often produce useful results with a minimum investment of effort if the economist is efficient in using his/her time and resources. A "quick and dirty" study may yield a result with an 85% to 90% confidence level, whereas a much larger investment in time and effort may be needed to add an additional 10% to the level of confidence. As with many things in life, the optimal tradeoff between time/effort and results will be determined by numerous "it depends" type questions.

Since the use of the survey-based CVM is common in WWTPs, it requires only **modest changes to the survey instrument** (questionnaire) to capture additional information useful for the enhanced analysis. Obviously, carrying out one slightly expanded survey is much more cost-effective than conducting two different surveys.

One potential option for implementing this approach is to have an experienced, and available, **review team of environmental economists** (with at least one person, but two or three are better) that can give guidance and intervene if needed but is not responsible for the day-to-day analysis work. The review panel members can do their work from remote sites (e.g., online) and use their experience in other projects and training to determine when the analysis is going off-track. A good, and small, review panel can be a very cost-effective way to improve the overall quality of the analysis. It can also add a measure of legitimacy to the final results.

With the previous points in mind, the final messages to the ESG include the following:

First, **do not let "the perfect" be the enemy of "the good**." Although a full, expanded, comprehensive CBA that includes both project as well as environmental and social impacts is the ultimate goal, a more modest approach may be an acceptable first step. By combining the insights from the EA and the Total Economic Value (TEV) approach (see Annex 1), the project analyst can identify and begin to incorporate the most important externalities into an expanded project analysis. Having the environmental economist as part of the project team facilitates this integration, which can be advanced by including these previous points in the terms of reference (TORs) for project preparation.

Second, those concerned with the environmental agenda have a responsibility to **provide timely, "actionable" information** to the project team, if this process is to be a success. Close and timely communication is essential, and working together will facilitate this process. On occasion, this may require that a broader framework of analysis (or longer time horizon) be adopted so that cumulative impacts can be correctly identified. Establishing baseline data and monitoring them over time is crucial to correctly identifying with-project and without-project impacts. The requirement for baseline information and studies should be part of the TORs for the EIA/EA process.

Third, **apply what is already known**. Present WWTPs offer excellent examples of the application of various economic valuation techniques (especially CVM). In some cases, ecosystem impacts have also been valued. By building on present work and the broader conceptual insights gained from the EA process, one can begin to identify additional major environmental externalities that might be valued and included in the analysis. These externalities include such diverse values as the benefits from recreation and tourism, the health costs of water pollution (or the benefits from improved water quality), or the effects of treated waste water discharge on natural systems such as rivers, lakes, mangroves, or coastal areas.

Fourth, **start to develop additional "best practice" examples, one project at a time**. By expanding on existing work, adding additional environmental externalities to project analysis will begin the process of developing region- and resources-specific examples. This, in turn, helps make future project analysis both easier and more robust. It also has the benefit of "embedding" the learning in IDB staff so that the knowledge of how to conduct the expanded analysis becomes part of the institutional memory. Although this process of "learning by doing" can be slow and indirect, the long-term benefit can be major, both for the projects themselves and for the institution.

Annex 1
Definitions

Cost-Benefit Analysis (or Cost-Benefit Assessment) (CBA): CBA is an **economic evaluation technique** that analyzes the generation of economic benefits and costs from a project or policy by comparing the discounted flows of benefits and costs over a prescribed time horizon. The following data are required to complete a CBA: the number of years to include in the analysis (the project life, or time horizon); the values of project benefits and costs (all expressed in monetary terms) for each year included in the analysis; and the discount rate. Benefit-Cost Analysis (BCA) is the same as CBA. All benefits and costs are discounted back to the base year.

The flows of benefits and costs are usually compared using one of three evaluation measures: Net Present Value (NPV), Benefit-Cost Ratio (B/CR), or Internal Rate of Return (IRR). The third measure is also referred to as the Economic Internal Rate of Return (EIRR) when the analysis is done using "economic" prices that remove any policy distortions (such as government interventions in the markets for inputs [e.g., labor/fuel/energy] or outputs [e.g., when price boards affect commodity prices]).

The formulas for these three measures are as follows:

Net Present Value (NPV) Equation → $NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$

Benefit-Cost Ratio (B/CR) → $\text{B/C ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$

Economic Internal Rate of Return (EIRR) Equation → $\sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t} = 0$

Note that all three measures—NPV, B/CR, and EIRR—use the same input information on benefits and costs (Bs and Cs), and the same project time horizon, usually measured in years (t). To carry out an NPV and B/CR analysis, the discount rate (r) is pre-determined. For an EIRR analysis, the discount rate (r) is the answer calculated by the analysis; it is the discount rate when the present value of project costs is just equal to the present value of project benefits.

The three economic evaluation measures provide different pieces of information: an NPV analysis results in a monetary estimate (in $) of the generation of *net* benefits over the life of a project. The B/CR analysis produces a result that is a ratio of net benefits divided by net costs. A BC/R of 1.0 means that the project produces net benefits of "0"—and the present value (PV) of benefits and costs are exactly equal. A B/CR of more than 1.0 means that a project produces positive net benefits. A B/CR of less than 1.0 indicates a project where the net benefits are negative (the PV of costs is larger than the PV of benefits). When the B/CR is equal to 1.0, the discount rate calculated in the IRR will be exactly equal to the discount rate used in the NPV and B/CR calculation.

Economic externalities: An externality occurs when a project or an activity has an impact on someone who is not part of the decision-making process. The important determinant of what externalities are (and what they are not) is the involvement (or not) of those affected by an externality in the decision-making process. For example, if a factory produces smoke emissions (or water effluent discharges) that affect someone outside of the project boundaries, then we say that an externality exists. Externalities can be both positive and negative—although we usually think of them as negative. Once an externality is identified and those who are affected are consulted, one of three things can happen: First, the producer of the externality can eliminate it by (in this example) stopping the pollution. Second, those affected can be compensated by money or other actions that make them feel equally well off with the compensation and the pollution. Third, the creator of the externality can ignore the impacts and go on as if it were "business as usual."

Note that if compensation is paid, or appropriate consultation is practiced, the externality is said to be "internalized" and goes away. The pollution may still take place, but the act of consultation and/or compensation eliminates the externality. Since many of these externalities occur off site or later in time, issues regarding properly estimating the economic size of the damage created and designing appropriate compensation measures become important. Much of environmental economics is concerned with the identification of externalities and their economic valuation.

Monetary valuation (economic valuation): Monetary valuation (as opposed to economic evaluation—the CBA discussed above) is the placing of monetary values on benefits and costs. The economic or monetary valuation of resources, especially when markets do not exist, is an expanding area for economic research. Different **valuation techniques** exist whereby most goods and services can be valued in monetary terms. Dixon (2011) presents an overview of many of these techniques.

Social welfare: Social welfare, or well-being, is a measure of an individual's or society's sense of how well they are doing. The goal of most individuals, societies, and governments is to increase social well-being/social welfare. Social welfare includes both monetary and non-monetary dimensions. Accordingly, environmental externalities that impose “costs” on others lead to a decrease in social welfare, even if those “costs” are not formally priced or even measured. Since the goal of development projects is to lead to a net increase in social welfare (all benefits minus all costs, measured or not), it is entirely appropriate to include costs and benefits associated with externalities—environmental, cultural, social—in the analysis of the project.

Total Economic Value (TEV): The TEV concept states that the economic “value” (or “price”) for marketed goods and services is composed of a series of attributes, some of which are more tangible than others. As seen in the standard TEV chart (Figure 1) in this Annex, the TEV is composed of **Use Values** and **Non-Use Values**.

Use Values are economic values that come from the direct or indirect use of a resource. Use Values are usually divided into **Direct Use Values** and **Indirect Use Values**.

- **Direct Use Values**: Direct Use Values, also known as extractive, consumptive, or structural Use Values, derive from goods that can be extracted, consumed, or directly enjoyed. In the context of a forest, for example, Direct Use Values include the harvesting of timber; the collection of minor forest products such as fruit, herbs, or mushrooms; and game and fish derived from hunting and fishing. In addition to these *directly consumed goods*, Direct Use Values can also be *non-consumptive*. For example, people who enjoy hiking or camping in the same forest receive a Direct Use Value, but do not actually “consume” any of the forest resources. Similarly, in a coral reef, Direct Use Values can include the harvesting of shells and catching of fish, or the non-consumptive enjoyment of the reef by scuba divers. All of these benefits are tangible, can be measured, and have economic values, even if the consumption by one individual does not reduce the consumption by another (economists call this non-rival consumption, and these goods are classified as public goods).
- **Indirect Use Values**: Indirect Use Values, also known as non-extractive Use Values or functional values, derive from the *services* that the environment provides. Many ecosystem services are examples of Indirect Use Values. For example, wetlands often filter water, thereby improving water quality for downstream users, and national parks provide opportunities for recreation. These

services have value but do not require any good to be harvested, although they may require someone's physical presence.

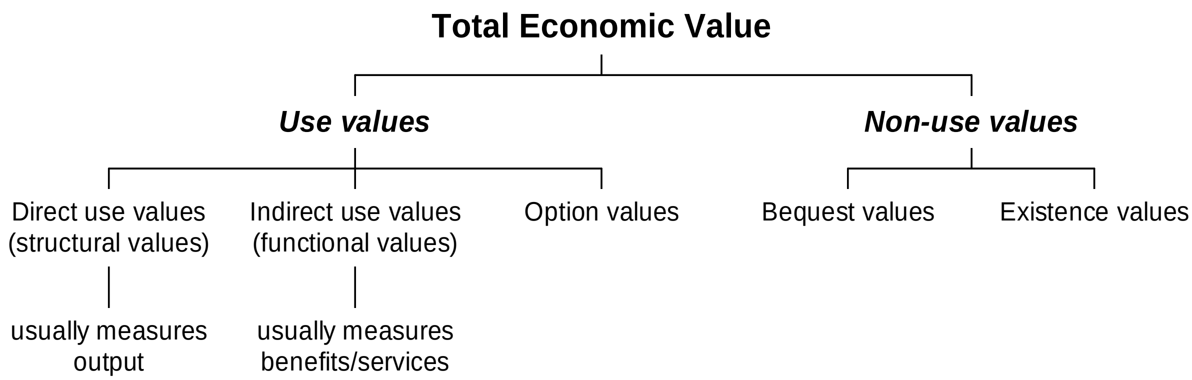
Measuring Indirect Use Value is often considerably more difficult than measuring Direct Use Value. The "quantities" of the services being provided are often hard to measure. Moreover, many of these services often do not enter markets at all, so their "price" is also extremely difficult to establish. The visual aesthetic benefits provided by a landscape, for example, are non-rival in consumption, meaning that many people can enjoy them without detracting from the enjoyment of others.

Non-Use Values are economic values where no direct interaction with the resource occurs. For example, in a coral reef, one finds Direct Use Values (fishing/coral collecting) and Indirect Use Values (shoreline protection/serving as a nursery area for juvenile fish). There may also be important Non-Use Values whereby people who do not visit or use the coral reef still value knowing "that it is there" or seeing photos of and films about the reef. The main Non-Use Values include the following:

- **Option Value**: Option Value is a deferred Use Value. This value occurs when people are willing to pay something to have the "option" of using the resource themselves in the future.
- **Bequest Value**: When the Option Value is for the next generation (e.g., I want my children to be able to see the coral reefs, or the pandas), this is called a Bequest Value. It is the potential use of a resource by the next generation or future generations.
- **Existence Value**: Individuals also derive a benefit from knowing that a resource is there—whether or not they plan to visit it themselves (a Use Value) or think that they might want to visit it in the future (an Option Value), or want to ensure its survival for future generations (a Bequest Value). An Existence Value is a benefit that comes from just knowing that the resource in question (e.g., blue whales, pandas, orangutans) exists—hence, the term "Existence Value."

Note that both Bequest Values and Existence Values imply no use—either direct or indirect—by the present generation. The size of these values may be small per person (in monetary terms) but may be large in the aggregate since many people in a country may have these values.

Figure 1. Total Economic Value



Annex 2
Economic Valuation Techniques

The following survey of major valuation techniques starts with the most direct, robust economic valuation techniques and proceeds to techniques that are more hypothetical or subjective. (See Dixon et al. [1994], Dixon and Pagiola [1998], and Dixon [2011] for an expanded discussion of these techniques.)

Valuing Changes in Production

Change in output of marketable goods. In many cases, the environmental effects of projects are reflected (at least in part) in changes in output of marketable goods and/or services. The biggest difficulty in valuing such impacts comes from being able to measure the amounts of goods being produced and in predicting how these amounts will change with and without the project. The Environmental Assessment (EA) can be very helpful in arriving at estimates of these changes. Once these estimates are in hand, valuing the changes in monetary terms is usually relatively simple since this approach relies on market prices and measured physical changes in outputs.

Cost of illness and human capital. Good health can also be thought of as a type of "productivity." Many environmental impacts, such as air and water pollution, have impacts on human health, both through illness and death. Valuing the cost of pollution-related morbidity (sickness) requires information on the underlying damage function (usually some form of a dose-response relationship), which relates the level of pollution (exposure) to the degree of health effect as well as information on how the project will affect the level of pollution. When this approach is extended to estimate the costs associated with pollution-related mortality (death), it is referred to as the *human-capital approach*. It is a form of the change-in-productivity approach in that it is based on a damage function relating pollution to productivity, except that, in this case, the loss in the productivity of human beings is being measured.

Other Cost-Based Approaches

When the benefits of a given environmental impact cannot be estimated directly, information on costs can be used to produce valuable information. For example, an order-of-magnitude estimate of the potential costs (or savings) to society from a change in an environmental problem can be obtained by using the cost of reducing or avoiding the impact, or the cost of replacing the services provided by the environmental resource. The major underlying assumptions of these approaches are: (1) that the nature and extent of physical damage are predictable (there is an accurate damage function available), and (2) that the costs of replacing or restoring damaged assets can be estimated with a reasonable degree of accuracy. It is further assumed that these costs can be used as a valid proxy for the cost of environmental damage; that is, the replacement or restoration costs are assumed not to exceed the economic value of the asset. These are strong assumptions and may not be valid in all cases.

However, note that even the most effective "preventive" expenditure may not be justified if we do not have any information on the expected benefits produced (or costs avoided). In some cases, it may cost more to replace or restore an asset than it was worth in the first place. There may also be more cost-effective ways to compensate for environmental damage than to replace the original asset or restore it to its original condition, and these substitution possibilities are ignored with the use of this technique. If substitutes are available, these methods will likely overestimate the value of the damaged or destroyed asset. Because of this, cost-based approaches are generally thought to provide an *upper-bound* estimate of the benefits of measures taken to prevent the damage from occurring.

*Replacement cost***.** The *replacement cost approach* is often used to estimate the cost of pollution. This approach focuses on potential damage costs as measured by *ex ante* engineering or accounting estimates of the costs of replacement or restoration if damage from pollution were to occur. The replacement cost technique is particularly useful for assessing the costs associated with damage to tangible assets, the repair and replacement costs of which can be estimated. This information can then be used to decide if it is more efficient to allow the damage to occur and pay the replacement costs or to invest in preventing the pollution in the first place. The technique is less useful, however, for very unique assets, such as historical or cultural sites and unique natural areas, which cannot be replaced and cannot easily be restored, and about which restoration costs are uncertain.

*Relocation cost***.** Similar to the replacement cost approach, the *relocation cost approach* uses estimated costs of a forced relocation of a natural or physical asset due to environmental damage. These costs can be compared to the alternative of changing or redesigning the project to avoid this expense.

*Opportunity cost***.** In some cases, it may be decided to protect a particular resource (e.g., a wetland or a protected area—see IDB Policy Directive B.9) and redesign or relocate the project to avoid the environmental impact. (Note that the desired project outputs are still produced, but presumably at higher costs due to the changes made to protect the environment.) The term "opportunity cost" refers to the size of this increased project cost due to changes to protect the environment. The additional costs of realigning a road, for example, to avoid a sensitive ecosystem is said to be the opportunity cost of protecting the ecosystem.

This is a very powerful technique, however, since it clearly identifies the expected economic cost of protection to society. In many cases, this amount is actually very small; in other cases, if the opportunity costs are large, this information can be used to mobilize other sources of funds to compensate individuals or society to compensate for the reduced project benefits. The Global Environment Facility (GEF) and other donors may be willing to provide grant funds to cover these types of costs, especially when the benefits produced are important at the global level.

Valuing Environmental Amenities: Recreation, Nature, and Biodiversity

Often, the environmental good or service being valued is not traded in the marketplace. Examples of these amenity-type services include recreational sites, nature more generally, and the preservation of biodiversity. A number of valuation techniques exist that can be used to place monetary values on these goods and services, and this information, in turn, can be incorporated into a more conventional Cost-Benefit Analysis.

Property value and wage differential approaches (hedonic analysis)

We know that environmental quality affects the price that people are willing to pay for certain goods or services (or demand as compensation to do certain jobs or work in certain places). Ocean front hotels, for example, charge different rates depending on the view. Workers in riskier occupations demand a "wage premium." Hedonic models have been widely used to examine the contribution of different attributes to prices for housing and to wage levels, including the contribution of environmental quality. When applied to housing or land-value data, this approach is often referred to as the *property value* approach; when applied to wage data, it is generally referred to as the *wage differential* approach.

Travel cost approach

The Travel Cost (TC) Method estimates values for un-priced goods and services from observed behavior. As commonly applied, it uses information on visitors' total expenditure to visit a site to derive their demand curve for the site's services. The technique assumes that changes in total travel costs are equivalent to changes in admission fees. From this information, a demand curve can be constructed, and the total benefit to visitors can be calculated. (Note that the costs of travel are used to derive a demand curve from which consumers' surplus can be estimated. The travel costs, *per se*, do **not** represent the value of the resource being visited. A fuller explanation of this approach would take more space than is available in this note.)

The Travel Cost Method is an example of a "revealed preference" technique since information on actual expenditures (in time and money) is used to estimate demand curves and consumers' surplus. It should also be noted that the resulting estimates are site-specific. Travel cost analysis has been widely applied in both developed and developing countries, and an extensive literature exists on the Travel Cost Method.

Contingent valuation methods

Contingent Valuation Methods (CVs) are examples of "stated preferences" techniques—consumers answer a survey designed to elicit their willingness-to-pay for an environmental good or service. A CV is not based on observing actual behavior (as in the case of travel cost studies). A CV can, in principle, be used to value *any* environmental benefit. Moreover, since it is not limited to deducing preferences from available data, it can be targeted quite accurately to ask about the specific changes in environmental quality that the proposed project would produce. This also means that, with appropriately worded questions, a CV can provide an all-encompassing estimate of the perceived costs and benefits of environmental changes, in contrast to most other valuation techniques that only provide a partial estimate of environmental costs and benefits. A CV is also the technique used most often to estimate certain Non-Use Values—especially Bequest Values and Existence Values.

In the case of recreational use of natural or cultural resources, it may be possible to do both a CV and a travel cost analysis for the resource being valued. This allows the analyst to "cross check" the two estimates and gives an idea of the robustness of the results. For example, this approach has been used a number of times in determining the consumers' surplus of safari visitors to game parks in East Africa with surprisingly consistent results. It is particularly useful since one measure is based on observed behavior (the travel cost approach), while the other is based on hypothetical survey information (the CV approach).

Benefits transfer

Benefits transfer is not a methodology *per se*, but rather refers to the use of estimates obtained (by whatever method) in one context to estimate values in a different context. The main attraction of benefits transfer is that it provides a low-cost way of estimating values when time or resources do not allow fuller valuation studies. Also, benefits transfer can be appropriate when the good or service to be valued has not yet been created (for example, a proposal to create a new nature-tourism destination national park) and there are no actual users to survey.

This approach has considerable risks. However, a consensus seems to be emerging that benefits transfer can provide valid and reliable order-of-magnitude estimates under certain conditions:

- The commodity or service being valued has to be very similar at the site where the original estimates were made and at the site where they are being applied; and
- The populations affected must be very similar (e.g., for recreational users, the people involved in recreation at the initial study site and at the destination "transfer" site must share many socio-economic characteristics).

Of course, the original estimates being transferred must themselves be reliable for any attempt at transfers to be meaningful. The benefits transfer technique should be used with caution, therefore, and only when no site-specific measures are possible.

Cost-Effectiveness versus Cost-Benefit Analysis: When Is Each Approach Appropriate?

Cost-effectiveness versus cost-benefit analysis. Most projects are analyzed in a cost-benefit framework. Cost-Benefit Analysis (CBA) is commonly used to compare alternative options and requires that the environmental impacts be identified and that monetary values be placed on the outcomes. Most WWTPs are analyzed within a CBA framework. In some cases, however, a traditional CBA may not be feasible or desirable, and it may not be possible to make monetary estimates of benefits. For example, some natural areas might be so unique that it might be determined that they should be conserved at all costs. In other cases, there might be substantial uncertainty about the benefits provided by environmental goods and services, either now or in the future, or difficulties in determining appropriate values in monetary terms. When loss of these goods and services would be irreversible, it might be desirable to choose the strategy that minimizes potential losses due to environmental damage (unless the social cost of doing so is unacceptably large); this is known as the *safe minimum standard* approach.

When benefits cannot be estimated, the appropriate approach is *cost-effectiveness analysis* rather than CBA; that is, the project is designed to find the cheapest and most effective way of achieving the conservation objective or some other goal. Many safeguard policies are analyzed using a cost-effectiveness approach. Note that the cost-effectiveness approach identifies the most *efficient* way of reaching a goal, but does not tell you if the expected benefits justify the costs. Answers to the latter question must rely on informed judgment and common sense.

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