



Integrated Environmental Management Information Series

Cost Benefit Analysis 8



Department of
Environmental Affairs and Tourism

Other topics in the series of overview information documents on the concepts of, and approaches to, integrated environmental management are listed below. Further titles in this series are being prepared and will be made available periodically. Sequence of release and titles are subject to change.

Information Series 0:	Overview of Integrated Environmental Management
Information Series 1:	Screening
Information Series 2:	Scoping
Information Series 3:	Stakeholder Engagement
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PREFACE

This document is one of a series of overview information documents on the concepts of, and approaches to, Integrated Environmental Management (IEM). IEM is a key instrument of South Africa's National Environmental Management Act (NEMA). South Africa's NEMA promotes the integrated environmental management of activities that may have a significant effect (positive and negative) on the environment. IEM provides the overarching framework for the integration of environmental assessment and management principles into environmental decision-making. It includes the use of several environmental assessment and management tools that are appropriate for the various levels of decision-making.

The aim of this document series is to provide general information on techniques, tools and processes for environmental assessment and management. The material in this document draws upon experience and knowledge from South African

practitioners and authorities, and published literature on international best practice. This document is aimed at a broad readership, which includes government authorities (who are responsible for reviewing and commenting on environmental reports and interacting in environmental processes), environmental professionals (who undertake or are involved in environmental assessments as part of their professional practice), academics (who are interested in and active in the environmental assessment field from a research, teaching and training perspective), non-government organisations (NGOs) and interested persons. It is hoped that this document will also be of interest to practitioners, government authorities and academics from around the world.

This document has been designed for use in South Africa and it cannot reflect all the specific requirements, practice and procedures of environmental assessment in other countries.

This series of documents is not meant to encompass every possible concept, consideration, issue or process in the range of environmental assessment and management tools. Proper use of this series of documents is as a generic reference, with the understanding that it will be revised and supplemented by detailed guideline documents.

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SUMMARY

This document provides an introduction to the theory and methods of Cost Benefit Analysis (CBA). In particular it attempts to answer a series of commonly asked questions:

- * What is CBA?
- * Where is CBA applied (e.g. policy, industrial and other applications)?
- * When is CBA applied?
- * What is CBA's role within environmental decision-making?
- * How is CBA applied?
- * Why use CBA? (what advantages does it offer)

In the private sector, economic profit is often used as an indicator of economic efficiency. This need not be valid; the market may be distorted or the decision may involve non-profit projects or the introduction of new government policies. CBA offers an alternative test of efficiency for such situations.

As its name suggests, CBA simply compares all the expected present and future benefits of a project or policy with its present and future costs. In general future costs and benefits appear less important than present ones, for this reason CBA attaches a progressively lower weight to costs and benefits the further in the future they appear. It is this practice of discounting that forms the basis of the opposition to CBA by some environmentalists.

When a CBA study is conducted the data is extracted from the specialist reports produced during the EIA process. It is entered on a spreadsheet and can then be tested for its sensitivity to amongst other things different discount rates and impacts on income distribution. At least one decision rule is applied. This, together with the sensitivity analysis, then forms the basis for the production of a report.

CBA has a number of advantages, which includes:

- * the decision rules it uses are standard and well known.
- * it provides non-prescriptive information in a standard format that informs decision makers and stakeholders.
- * it is adaptable and flexible enough to reflect income distributional impacts, intergenerational sustainability, financial efficiency and the effects of externalities.
- * it can be extended to match the EIA process. A CBA report can be adapted to include a stakeholder analysis showing a project's downstream impacts on interested and affected parties. Where projects are large enough to affect macroeconomic variables (e.g. wage levels and exchange rates) the CBA accounts for these. The report can be further enhanced to include other economy wide effects such as multiplier based impacts on employment and GDP (using input-output tables or computable general equilibrium models).
- * it has a logical place in the Integrated Environmental Management (IEM) process. In Environmental Impact Assessments (EIA), for example information on project impacts are generated. The economic and social relevance of these is not always clear. Also the data is not always comparable and easily integrated. CBA can reduce most impacts to a single number which describes either a benefit/cost ratio, an internal rate of return or a net present value (NPV). The CBA format establishes a clear link between data collection and the information provided for decision-making.

One of the key weaknesses of CBA is that it can oversimplify, reduce complex cause and effect linkages to a single number like the NPV or the Benefit/Cost ratio. This potential problem can be overcome by either ensuring that the sensitivity analysis performed captures the effects of variations in key variables (such as discount rates and income distributional weights) or by combining CBA with one of the multi-criteria decision analysis methods which allow weights to be attached to concerns and impacts identified by specific stakeholders as significant.

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1. WHAT IS COST BENEFIT ANALYSIS

Cost benefit Analysis (CBA) is a tool used either to rank projects or to choose the most appropriate option. The ranking or decision is based on expected economic costs and benefits. The rule is that a project should be undertaken if lifetime expected benefits exceeds all expected costs. The art of the analysis process comes in the measurement of these impacts, their adjustment for market failure, and for the effects of time, income distribution, incomplete information and potentially irreversible consequences.

A principle of western economics since Adam Smith is that 'the market knows best'. In a perfect world, the market would ensure that land, labour and capital were allocated in a way that would maximize both profits, and the welfare of society. Ours is an imperfect world, but CBA is a tool that allows the analyst to mimic the welfare optimising behaviour of the market.

Although complexities arise when costs and benefits are being measured and corrected, CBA is a simple tool with numerous uses and applications, especially in the environmental assessment sphere. Its use increases accountability and consistency in decision-making.

2. PURPOSE OF THIS DOCUMENT

This document has been written for a wide audience. Its objective is to serve as an initial reference text. The aim is to provide an introductory information source to government authorities, environmental practitioners, non-governmental organizations (NGOs), industry, project proponents, academics, students and other interested and affected parties (I&APs).

This document provides an overview of the theory and methods of CBA. The process on how to perform CBA is provided. The advantages and disadvantages of CBA is explained. Key issues that complicate the application of CBA are highlighted. This document is not prescriptive but rather provides an overview of the key criteria to consider when applying CBA.

3. APPLICATIONS OF COST BENEFIT ANALYSIS

CBA is used at two basic levels. In the private sector financial CBA is used to justify equipment and technology investments; measure life cycle costs; meet regulations cost-effectively; and quantify hidden costs and intangible benefits. It is also a useful tool to show how outsourcing and leasing can result in cost savings, and how quality improvements can affect returns.

Social CBA is used to appraise the social merit of projects or policies. The projects may be public or private, and the analysis is typically used to inform public decision makers. This type of CBA is the form typically used in EIAs.

It can be used to:

1. *Evaluate or rank the feasibility of projects.*
CBA is used by decision makers to determine whether a single activity or project should be undertaken, or to rank competing projects or policies.

2. *Analyse the effect of regulation.*

A typical purpose of new public regulations is to reduce or eliminate specified risks to environmental quality. While scientific and engineering estimates can indicate how and by what amount the proposed regulations will reduce the risk, the 'optimal' level of intervention still has to be established. CBA can help inform this process; it can also indicate whether the risk would be more effectively addressed through private action, new regulation, or stronger enforcement of existing statutes.

3. *Justify equipment and technology investment.*
CBA can be used to determine whether a new investment in equipment or technology for government is an efficient use of the taxpayers' money.

4. *Determine the most effective way to cut costs, especially in capital planning.*
CBA provides a simple method to implement cost-effective capital planning.

5. *Determine the relative benefits of outsourcing and leasing.*

A traditional function of the state is the provision of public goods. These are goods (such as lighthouses or public immunization schemes) that are not depleted by use and from whose benefits the public are not excluded if they refuse to pay. However, many of the goods and services provided by the state have a 'private goods' component. Where this is the case, outsourcing part of a project may reduce costs and improve quality. CBA can be used to identify such opportunities.

6. *Quantify hidden costs and intangible benefits.*
A common justification for the EIA process is that it may reveal possibilities that the internal planning process missed. While this is expected in the scientific studies of an EIA, it can also occur on the economic side. In the process of performing financial CBA, unanticipated costs and benefits may be uncovered. More importantly, the valuation of all costs and benefits reveals the full consequences of a project or policy decision. This is especially important in the public health and environmental spheres, where the relative magnitudes of impacts are central.

7. *Ensure accountability by public sector decision-makers.*
CBA presents its results after a sensitivity analysis. The output should be clear and its interpretation simple. Where it is part of an EIA, CBA provides information for the public, NGOs and the press, and in doing so increases the accountability of public decision-makers.

4. THE PROCESS OF CONDUCTING A COST BENEFIT ANALYSIS

The aim of CBA is to present the lifetime costs and benefits of a project as a single number that can be compared to either the interest rate prevailing (e.g. using the internal rate of return), or the costs and benefits of other (competing) projects (to give either a net present value or a benefit/cost ratio). To do this, the stream of net benefits (benefits minus costs) is discounted. The following seven steps provides a summary of the process of conducting a CBA.

Step 1: Identify and define the project.
This coincides with the opening stages of the EIA process. A question that the economist has to answer is whether or not the project definition is appropriate.

Step 2: Identify consequences of the project or policy, place them in time order and obtain monetary values for them.
Identifying the consequences of the project again coincides with the EIA process, as does placing these consequences into a temporal order. Converting these impacts into monetary costs and benefits is the first point at which the economist contributes separately to the process.

Step 3: Determine type of CBA
Many of the impacts are already in monetary form. A problem that will be identified later is that some of their prices have been distorted by market failure while others have no prices at all. If the prices are accepted at face value and no estimates are made of the unpriced impacts, the result is a simple financial CBA. If the distorted and missing prices are corrected for, the result is a social or extended or economic CBA.

Step 4: Identify incidence of costs and benefits in income distributional terms.

Even if nothing is done with the information it is central to the written report that presents the analysis to the public.

Step 5: If appropriate, adjust costs and benefits using weights based on the existing and desired distributions of income.
Consensus in the USA today is that such adjustment is not appropriate. Practice elsewhere still recognizes it.

Step 6: Discount the flows of costs and benefits and use the appropriate decision tool.
The techniques and decision rules such as net present value, benefit cost ratio or internal rate of return are described in detail below. Box 1 provides an explanation of the concept of net present value.

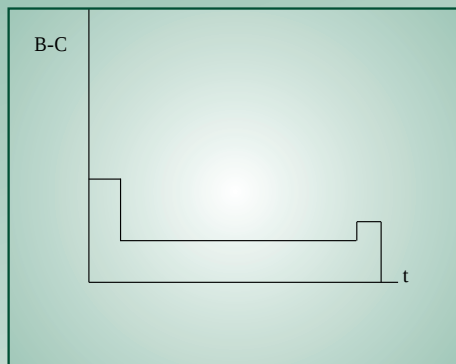
Step 7: Conduct a sensitivity analysis.
The aim is two fold: To test the robustness of the CBA outputs in terms of their underlying assumptions (in particular the discount rate and the income distributional weights) and to add to the information offered by the document. This makes the priorities of the final decision-maker visible and thus increases accountability.

Box 1: Explanation of the process of discounting that converts future values to present values

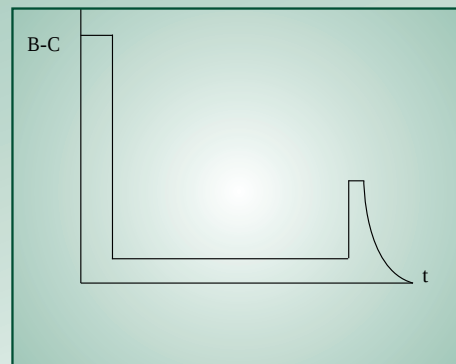
A project x is being evaluated; $B(x)$ are its gross benefits and $C(x)$ its costs:

A simple decision-rule would be that the project is acceptable if $B(x) > C(x)$.

A problem arises if the project's costs and benefits do not accrue in the same time periods. Most public and private projects involve an initial outlay of costs followed by a stream of running or operating costs, and a stream of benefits. The problem this presents for the comparison of projects can be shown by example. Imagine two power stations of identical outputs, total costs and life spans. Station A (thermal) is cheap to build but expensive to run. Station B (nuclear) is hypothetically more expensive to build, cheaper to run but more expensive to decommission.



Station A



Station B

In order to compare their costs and benefits, one discounts the stream of net benefits from each station. The result is a single number for each, its *net present value*. This will be the basic unit used in the comparison.

The present value of a future benefit [say some amount of cash at a given date in the future] is the maximum amount that one would be willing to pay today for that promised future payment. i.e. It's the answer to the question, "how much would you pay today for a guaranteed cash delivery at a given date in the future?" The power of compound interest means that if interest rates are positive, the present value will naturally be less than the promised future payment.

If one invested R100 today, then at an interest rate of r , after t years it would be worth: $R100 \times (1+r)^t$. This is termed the 'future value' of that R100.

If one is promised R100 in the future, then the present value (PV) of this promise is:

$$\frac{R100}{(1+r)^t}$$

This means that, even in an inflation-free world, provided interest rates are positive, present money is worth more than future money. For this reason, r is often referred to as the *discount rate*, and $(1+r)^t$ as the *discount factor*.

When trying to find the present value of a stream of payments (say R100 annually for t years), one merely adds up the stream of present values:

$$PV = 100 + 100/(1+r) + 100/(1+r)^2 + 100/(1+r)^3 + \dots + 100/(1+r)^t.$$

Inflation: Normally CBA uses *real* costs and benefits, i.e. future costs and benefits that are free of inflation.

5. DECISION RULES

In all of the rules that follow the discount rate (r) clearly plays a key role. The higher the discount rate the greater the emphasis on start up costs and short term benefits and the shorter is the decision maker's effective time horizon. The lower the discount rate, the greater the emphasis on long term costs and benefits.

a) Net Present Value (NPV)

If one has two projects, x and y , then their net present values (i.e. the present values of their respective *net* benefit streams) are given by:

$$NPV^x = (B^x - C^x)_0 + (B^x - C^x)_1/(1+r) + (B^x - C^x)_2/(1+r)^2 + \dots + (B^x - C^x)_t/(1+r)^t$$

and

$$NPV^y = (B^y - C^y)_0 + (B^y - C^y)_1/(1+r) + (B^y - C^y)_2/(1+r)^2 + \dots + (B^y - C^y)_t/(1+r)^t$$

If projects x and y have to be compared, the *net present value criteria* are:

- * A project can only be acceptable if its present value is positive
- * If the two competing projects [x and y] are mutually exclusive, the preferred project is the one with the higher NPV. [Note, however, that the project with the greatest NPV is not necessarily the most efficient user of scarce resources]. If project x is half the size of project y , but twice as efficient, the two projects will have the same NPVs. For this reason, when a budget has to be rationed across a set of projects, NPV is no help and the Benefit/Cost ratio described below is the appropriate tool.

b) Internal Rate of Return

To a businessman, a project is only worth considering once the percentage return on the money he invests in it is greater than the interest rate he has to pay to borrow the money in the first place.

Turned into a decision rule this appears as the *Internal Rate of Return* (IRR) criterion. The IRR is the discount rate that makes the present value of a project just equal to zero. In other words, it is the ' r ' that solves the following equation:

$$NPV = (B-C)_0 + (B-C)_1/(1+r) + (B-C)_2/(1+r)^2 + \dots + (B-C)_t/(1+r)^t = 0.$$

A project can only be acceptable if its IRR is higher than the opportunity cost of the funds involved. If two mutually exclusive projects are being evaluated, the one with the higher IRR will normally be chosen.

The IRR is sometimes known as the 'hurdle rate' because it is usually the lowest acceptable rate of return. It is a useful tool that makes intuitive sense to decision-makers and includes all cash flow related to a project. It also considers the time value of money. However, its weaknesses include the following:

- * It assumes cash flows are reinvested at the IRR.
- * It can be deceptive, i.e. a single project can have multiple internal rates of return. This happens when net benefit flows vary widely from year to year. In this case, the IRR calculation may appear as a quadratic equation, hence the multiple IRRs.
- * Lastly, the IRR does not distinguish between projects that differ in size.

c) Benefit-Cost (B/C) Ratio

The Benefit-Cost Ratio offers a way of ranking projects. If one calculates the present values of a project's benefits and costs separately, then the benefit-cost ratio is

PVB/PVC. A project is acceptable if $PVB/PVC > 1$. Like the IRR, this is a conceptually simple method. However, when comparing mutually exclusive projects however, this method is ineffective (Rosen, 1995).

It's great advantage is in the allocation of a budget across a range of projects or where efficiency is crucial. An example may make this clear. A city can get its water from any combination of sources. While using NPV as a criterion would find the best single option capable of satisfying the city's needs, use of the B/C ratio would allow water engineers to establish the most efficient *portfolio* of sources (some of which might be very small).

d) Cost-Effectiveness Analysis (CEA) and Cost-Utility Analysis (CUA)

These are not so much decision rules but different approaches to decision making. CEA and CUA identifies the cheapest way to achieve a given outcome. If such a target outcome is specified (e.g. a given improvement in the life expectancy, drop in particulate emissions or construction of a specific number of new homes) CEA merely finds the method of achieving it that has lowest present value (PV) costs. It is particularly useful when it is difficult or impractical to monetize the benefits of alternative projects.

With CEA and CUA, benefits are seen as 'effectiveness measures' and are not valued in monetary terms, although costs are.

The idea can be used in the same way as a B/C ratio. If C refers to the cost of a project, and E to the effectiveness, then two ratios can be formed: C/E and E/C, and projects ranked accordingly. Using the C/E ranking, projects with the lowest ratio are the most effective (The average 'cost per unit of effectiveness' is at a minimum). Using the E/C ranking, projects with the highest ratio are the most effective. (The average 'effectiveness per unit of cost' is at a maximum) (Gorr, 1998).

If an explicit effectiveness goal, E_x , is desired, then the decision becomes a simple cost minimization subject to the constraint that effectiveness meets or exceeds the effectiveness goal. Alternatively, a cost constraint of C_x may be imposed, and the decision-maker merely has to maximize effectiveness subject to the cost of the program not exceeding C_x .

Cost utility analysis (CUA) is used when policy makers are interested in two or more effectiveness measures (e.g. upholding environmental quality and raising unemployment). Different projects have different expected impacts on these two measures and require an evaluation of the 'utility' of different combinations of the measures (Gorr, 1998).

Decision rules used by the private sector

The private sector utilizes a number of other project appraisal tools. These include: return on investment, payback period and economic value added.

Return on Investment (ROI) measures the business value of a project. It is simply profit divided by investment, expressed as a percentage. This is most useful when all costs are known and easily quantifiable. It is less beneficial where risks are significant and where costs are uncertain.

Payback Period refers to how long an investment takes to 'pay for itself'. It is calculated by dividing the initial project investment by the annual cash inflows. Although this tool is simple and easy to understand, it does not recognize the time value of money. It also ignores cash or other benefits received after the payback period.

Economic Value Added (EVA) measures true economic profit. Although it precisely defines value in terms specific to an organisation, it is quite a complex tool and as such, rarely used (King, 2002).

Box 2 provides an explanation of the difference between financial CBA and social CBA.

Box 2: Explanation of the difference between financial CBA and social CBA

The difference between the two types of CBA is important. For any given project, *financial* CBA looks at the costs and benefits to an individual stakeholder. *Social* CBA looks at the costs and benefits to society as a whole, trying to determine whether the project will make society better or worse off. An example will help clarify the difference. Say a hotel chain was thinking about building a luxury hotel in a wilderness area. The hotel chain would effectively perform a *financial CBA*, looking at the direct costs and benefits to the chain. They would consider the capital, financial and labour costs incurred during the actual construction of the hotel, as well as the expected costs of running the hotel. On the benefit side they would consider the expected revenue stream from the new hotel as well as benefits such as increased prestige etc. If they considered environmental aspects at all, these would most likely be the costs of adhering to current government standards. They may also factor in an 'insurance cost' in the event of an environmental lawsuit. They would discount the CBA using the opportunity cost of their financial capital (i.e. the market rate of interest).

A CBA performed by the government would necessarily go further in order to consider the implications of the project on the whole of society. The prices of land, labour and capital would be corrected to address any implicit subsidies, distorting taxes or market imperfections. The exchange rate would be checked to ensure that over or under valuation was not generating a spuriously high or low net earnings flow. It would consider all stakeholders, looking not only at the direct costs incurred in the new hotel's construction and running, but also at the costs to the rest of society. This could include things like an estimation of the cost of environmental destruction, the effect of noise pollution, the impact on local communities etc. They would also have to consider a broader range of benefits (e.g. increased tax revenue, an increase in foreign exchange, a reduction in unemployment etc). A complete *social CBA* should also consider the needs of future generations and adjust the discount rate accordingly. The two types of CBA can therefore yield substantially different outcomes.

6. COMMON ERRORS IN MEASURING COSTS AND BENEFITS

As mentioned before, the method of CBA is quite simple (i.e. the complexity arises in the calculation of costs and benefits). This is especially true for environmental decision-making and the public sector. Below are a number of common errors that can be made when measuring costs and benefits.

6.1 Ignoring Implicit or Opportunity Costs

Some project expenses are obvious, start up, operation and decommissioning costs are examples. To these obvious costs, one should add the implicit or opportunity costs of resources owned by the enterprise. A project may use resources that are already in place, but which could be either sold, or used for some alternative purpose. Their best alternative value is called their 'opportunity' cost. The implicit or opportunity cost of any activity or resource is the value of the foregone opportunities involved. A simple example is that of a self-employed individual, when working out his true or 'economic' profit he should subtract the amount he could have earned if he had sold his labour in the job market. The amount he could have been earning in his best alternative employment is his personal opportunity cost.

6.2 Failing to Recognize Sunk Costs

Some expenditures should be ignored. The only relevant costs are those that depend on the existence of the project or policy. Among the irrelevant costs, the most problematic are 'sunk costs'. These are costs incurred irrespective of whether the project proceeds or not. An example is the cost of a project EIA. When deciding whether continuing with a project is feasible or not, the cost of the EIA (which was incurred in the past) is irrelevant. That cost was sunk, cannot be recovered, and has no bearing on the viability of future decisions. Another example might be an NGO deciding whether or not to host a conference using their own offices or at a rented venue. They should not include the office rent as part of the costs of hosting it 'on-site', as the rent has to be paid irrespective.

6.3 Failing to Include External Costs

Not all impacts of a project or policy are directly captured in a market. Some are reflected indirectly in other markets (e.g. though there is no market for clean air, property prices reflect the problem when air is polluted), in other cases the market is simply missing (frequently the case where biodiversity is negatively affected). An external cost is a cost that is borne by parties not directly involved in the activity. It reflects missing or imperfect markets. The individual whose property loses value because a coal-fired power station is built in the area is a typical example. No matter whether he gets electricity from the station or not, he still incurs costs through air pollution. The lesson is that, when reviewing a project, decision makers need to include all costs on surrounding communities (including damage to human health, decreased life expectancy, aesthetic and environmental impacts etc.)

Note that externalities may also be positive. An example is the training of workers hired during project construction.

Their increased productivity when hired elsewhere should be accounted as a benefit of the project.

6.4 Secondary Benefits and Multiplier Effects

When a project generates secondary benefits, it is tempting to include as many of these as possible. Unfortunately, if enough secondary benefits are added to a CBA calculation, any project will become acceptable. Only undisputable secondary benefits that would not be induced by alternative project or policy should be included. If they are going to be counted, so should secondary losses.

Macro-economic studies frequently mention "multiplier effects". A large project has linkages to the rest of the economy, buying materials and inputs, paying workers etc. These in turn have links elsewhere and as the original expenditure on the project is respent, over and over again, so the national product continues to increase. This multiplier effect is of interest in an economic report, but has no place in a CBA. Only the first round expenditures should be included.

6.5 Double Counting

It is important that neither costs nor benefits be double counted. For instance, a road passing through a farm will involve expropriation of land and payment of compensation. Provided the compensation is properly calculated one should not then also include the loss of agricultural output on the farm

7. KEY CONSIDERATIONS IN COST BENEFIT ANALYSIS

The Discount Rate

Although there is consensus that the appropriate discount rate for the private sector is the market rate of interest i.e. the opportunity cost of funds, it is not clear what this means. The cost of capital facing an individual firm is not a single number. The prime overdraft rate, the long-term rate on corporate bonds and the post-tax savings rate are all possibilities. There is even more disagreement as to the appropriate discount rate for the public sector.

For state funded projects the cost of long-term state borrowing offers one possible rate. Another suggestion is that the state's borrowing is crowding out the private sector, so the rate should be the private sector's pre-tax marginal rate of return on capital. Yet another suggestion is that the "social rate of time preference" (a non-market concept) should be used. There is currently no real consensus.

Since the discount rate can have a significant impact, it is important to see how sensitive the recommendations of a CBA are to the discount rate. For this reason, rather than being prescriptive, it is customary to replicate the analysis using a range of rates, and to use a sensitivity analysis to check its robustness.

The standard real rate used in South Africa is 8%, but it is sensible to replicate the analysis at rates of 3% and 12% to test for sensitivity (Conningarth, 2002) recommend 6% and 10% in their current guide to CBA in South Africa. The

conservatism of an 8% discount rate becomes clear when it is understood that the state currently borrows money at a long-term real rate of approximately 3%.

In evaluating the sensitivity analysis two points should be recognized:

- i. a low discount rate means a long time horizon and consequently an increased awareness of the distant future. It sounds more appropriate when “sustainability” is an issue.
- ii. on the other hand, a low discount rate means that the hurdle a project has to cross before it is judged ‘viable’, is set relatively low. Projects that have low benefit cost ratios can nonetheless be passed. This may be at odds with the search for sustainability.

Discounting is especially problematic for *environmental* projects because the nature of these projects often involves long-term benefits but short-term costs, consequently CBA is biased toward the current generation. Arbitrary lowering of discount rates is no solution. In many cases this merely lowers the apparent cost of capital and thereby encourages *resource intensive* projects that would otherwise have negative net present values. Where project impacts are irreversible and information is increasing, the longer time horizon associated with a low discount rate can, however, be useful. The problem is how to use it without distorting the analysis? Krutilla and Fisher (1975) argued that the benefits of preservation increase over time as household incomes rise, new technologies arise and the supply of scarce environmental resources decreases. They suggest including preservation benefits forgone within the costs of the project, allowing these costs to increase through time at the same rate as the growth of the economy. This can be represented as a lowering of the discount rate, but avoids the distortions caused by arbitrary manipulation.

Getting Prices Right

Shadow Prices

Real-world markets have many imperfections (e.g. subsidies, price fixing, monopolies and externalities). As a result prices do not always reflect marginal* social costs and benefits accurately. On the other hand, although market prices are imperfect, they may still be the most cost-effective measure of value available.

When distortions are evident, *shadow prices* can be used. These are estimates of the underlying marginal opportunity cost of goods, services and factors of production.

An economist practicing shadow pricing corrects market prices of goods and factors to reflect their true marginal costs. This is especially true when exchange rates are distorted by government intervention. If, for example, The Reserve Bank is intervening to keep a particular currency weak, it is favouring the tradable sector (producers of goods that are meant for export or as substitutes for current imports) over the non-tradable sector (firms that produce goods and services strictly for local sale and that face no competition from abroad).

Labour is another tricky issue. South Africa has recently suffered high levels of structural unemployment. In other words there are large numbers of aspirant workers, seeking jobs, but unlikely to ever get them. Unskilled labour is not a scarce resource in the economy at present.

Commodities and factors that are not scarce have no price in a free market. That unskilled labour earns the low wage it does, reflects state intervention and not its scarcity. When performing a financial CBA the wage bill actually paid is the relevant cost. In an economic CBA, it is the shadow price of the labour involved that should be used. Given that the unskilled labour is local, it should be the minimum wage that would be needed to persuade a worker to take up the job involved if there were no minimum wage legislation. It will vary from place to place, changing with local costs of living, and opportunity costs of time.

A problem less commonly observed is that of projects so large that they change the market prices of goods and factors of production. These are corrections available to deal with this problem.

When No Market Price Exists

When a good is not traded, no market price for it exists. This does not mean that the good has no value. The values of such goods and services can often be inferred from economic behavior and from a study of other (related) markets. A simple example of such an intangible is the enjoyment of scenery.

In CBA two common and problematic examples of missing markets are seen when the analyst has to put values to time and to human life. The value of time is often estimated by observing how much people are prepared to pay to ‘save time’. The value of life is more difficult but economists estimate it either by looking at foregone earnings or by estimating the value that individuals place on changes in the probability of death (A good synopsis of current thinking is offered in Pearce and Howarth, 2000). Both issues often appear when analysing new roads. A shorter, straighter, safer road saves driver time and reduces risk of accident. The amount a driver is willing to pay to use the new road should reflect the value he attaches to his time and his life. The potential use of the approach in CBA is immediately apparent; also apparent is the likelihood that the outcomes of such ‘revealed preference’ approaches will be distorted by respondents’ myopia in such matters. Other alternatives include contingent valuation (asking people about their hypothetical willingness to pay), human capital theory (looking at the present value of future earnings to get a value of life, and at sacrificed earnings to get a value of time), and benefits transfer finding a valuation that has been recognized as worth while elsewhere, and transferring it to the local situation after making appropriate corrections based on differences in mean incomes, education, etc).

Many benefits and costs are almost impossible to quantify. Examples of these include:

- * Improvements in human health and safety.

*Marginal refers to the incremental costs and benefits incurred when one more unit of a good is produced.

- * Impacts on quality of life (visibility; noise level etc.).
- * The market-related economic productivity of ecological systems (for example, its contribution to the viability of farming, forestry, and fishing).
- * Ecological stability and biodiversity.
- * Improvements in economic productivity (administrative flexibility; reductions in paperwork, etc.) (Gorr, 1998).

As is evident, many of these benefits and costs have environmental aspects. A number of valuation methods are available, some of the commonly used will be briefly described below.

When it is impossible to measure such benefits, or when the measurement seems prone to error, a way out of the problem is to identify a target benefit (say some number of statistical lives saved per annum) and use Cost-Effectiveness Analysis to find the cheapest way to achieve it.

Distributional Considerations

The impact of a project on income distribution can make it look more or less attractive. . An example illustrates the problem. Imagine two projects. One involves a dam on a rich man's land providing irrigation water for poor farmers downstream. The other involves an identical dam on a poor man's land providing irrigation water for the rich plantation owners downstream. If the two are in other ways identical, but cash shortage dictates that only one be built, we can see the case for building the one that benefits the poor. But what if they are not identical, what if the dam that benefits the rich is slightly more efficient? Many economists caution against taking distributional effects into consideration and use the *Hicks-Kaldor criterion* as a defence. According to this criterion, if the present value of a project is positive, and those who gain from it can compensate those who lose and still enjoy a net increase in their utility, the project is worthwhile. Taking this a bit further, when there is a given budget to be spent on a variety of projects, one should rank projects in order of their efficiency alone; they should then be adopted in this order until the budget is exhausted. The redistributive instruments of the state (such as progressive taxation, old age and unemployment benefits) will then be used to correct any social imbalances that emerge.

The opposing view points out that those who lose by a project are unlikely to ever receive any compensation. If the problem is not just one of efficiency, but also one of social justice, then distributional considerations should be explicitly considered within a CBA. A common method of doing this is to assign a positive weighting to benefits received by the poor. A problem is keeping this process objective. One way out is to incorporate the income distributional weights (and the alternative discount rates used) into a sensitivity analysis matrix. This can then be placed in the conclusion of the CBA. The decision-maker's choice provides an explicit statement of views on current inter-personal and ongoing intergenerational equity.

Uncertainty

When the benefits and costs of a project are uncertain, it is sometimes necessary to calculate their *certainty*

equivalent. The certainty equivalent for an individual is the amount of certain income that he/she is willing to trade for a set of uncertain future outcomes. Since the majority of people are risk-averse, the certainty equivalent normally includes a risk premium. This requires information on both the expected benefits and cost of a project, and the level of risk aversion of individual affected. The risk premium is not always necessary. Just as an insurance company reduces risk by spreading it across its members, so when projects spread risk over large numbers of people, the expected benefits and costs alone may become adequate measures. However, where a large risk falls on a specific social group, it is prudent to calculate a certainty equivalent.

It is important to note that even when the expected benefits and costs alone are sufficient measures, valuation is often difficult. This is because the probability of occurrence of these benefits and costs is rarely known with certainty. Sometimes only a 'cost-range' is possible. If this is the case, the ranges must be explicitly noted, along with any important geographic dimensions of these costs.

Disclosure

All important assumptions and major points of uncertainty need to be disclosed. If certain benefits or costs are not included or valued in any way, then this omission should be noted in a caveat. Any significant cost elements that have not been quantified, should be clearly stated and discussed. Where costs cannot be precisely annualised, the time frames within which these costs will be incurred also need to be recorded.

8. ENVIRONMENTAL CONSIDERATIONS IN COST-BENEFIT ANALYSIS

8.1 The Valuation of Environmental Impacts

The environment often displays the characteristics of a public good, in these cases there is open access (as when the public cannot be precluded from enjoying fresh air because they have not paid for it), and is not apparently depleted (there is no less water at a seaside resort because someone has swum in it). These public goods aspects of the environment are obvious sources of social utility, but they appear to command a price of zero in the market. Even where the environment can be depleted (fish stocks decline) and the public can be excluded (no access to a beach spot unless one pays the entry fee), the prices that result often reflect administered powers rather than market forces.

Conventional CBA operates on the premise that market efficiency is a pointer to social efficiency if one can simply spot the market's failures and correct for them. Environmental impacts are one source of missing markets (i.e. externalities). In evaluating a project or policy, the environment can be treated as a free factor of production, even though real costs may be involved. An example is the use of the air or nearby rivers, as waste sinks – emissions are simply released through smoke stacks or outfalls. The less the constraints on these emissions, the lower the production costs involved. There are two key points that emerge: (a) Both the true value of the environmental services provided, and the external costs imposed on others, have to be counted in an economic CBA; and (b) The values mentioned above have to be included without any double counting.

There is increasing pressure on current EIA practice to place a real value on the environment, and force public and private enterprises to take cognisance of it. The costs of the EIA appear in the financial CBA. The true value of the damage done, however, only appears at the level of economic CBA. Environmental regulations may impose costs on polluters, but may not put pressure on them to emit the socially 'optimal' amount of any pollutant.

Some environmentalists oppose the monetary valuation of natural resources that have 'immeasurable' intrinsic and aesthetic values. However, in today's monetised global economy, valuing resources (even if the figure attained is imprecise) can suggest the worth of protecting them.

"Although ecosystem valuation is certainly difficult and fraught with uncertainties, one choice we do not have is whether or not to do it. Rather, the decisions we make as a society about ecosystems imply valuations (although not necessarily expressed in monetary terms). We can choose to make these valuations explicit or not; we can do them with an explicit acknowledgement of the huge uncertainties involved or not; but as long as we are forced to make choices, we are going through the process of valuation" (Costanza, et al., 1997).

Fortunately this issue can often be circumvented. Valuation of environmental impacts is both costly and

controversial. Assuming negative ecological impacts, if a project fails the cost benefit tests before these impacts are taken into account, there is obviously no need to proceed with valuation. Similarly, if the project is viable, and the environmental externalities are positive, there's no need to measure them. Where a project is positive but the environmental impacts negative, inspection of the EIA reports may indicate the relative magnitude of the problem, and whether or not it can be mitigated. Again it may be possible to avoid valuation of impacts. Only if valuation of environmental impacts is likely to influence the outcome of the analysis should it be carried out.

8.2 Valuation Expounded

A general 'checklist' of environmental values can be useful to ensure that all 'uses' of an environmental good are accounted for in its valuation.

'Total Economic Value' is generally broken down into:

- * Direct Use Value – can be commercial or non-commercial e.g. output of a forest would include both lumber (commercial) and recreational amenity value (non-commercial)
- * Indirect Use Value – e.g. the ecological functions of the ecosystem such as climate stabilization
- * Option Value – the premium that people would be willing to pay to ensure the future supply of an environmental resource whose existence could be threatened.
- * Existence value – the values conferred by humans on the ecosystem regardless of its use. It captures the idea that an environmental good may be valuable merely because the public are happy that it exists, quite apart from any future option to consume it, visit it or otherwise use it.

In even the best of EIAs, information on impacts may be incomplete. If such 'unknown' impacts will be irreversible, the significance of such information is increased. This increase is reflected as 'quasi-option value' – the premium decision makers would be willing to pay to know more about a project's impacts. It is the cost of the time required to accumulate the information needed to make an adequately informed decision. As an example, take a dam that will flood an area of high endemism. If the fauna and flora remain incompletely catalogued the 'quasi-option value' reflects the cost of deferring construction till the relevant information is complete. It gives CBA an alternative to the vague 'precautionary principle' commonly cited when scientific evidence is inconclusive or preliminary scientific evaluation indicates grounds for concern (Iaccarino, 2000). It is also a logical corollary to the discounting based Krutilla and Fisher (1975) approach mentioned earlier.

An innovative new approach to the problem may be to use *Generational Cost Benefit Analysis* (GBA). This approach discounts net benefits from the perspective of all generations involved. For instance in environmental restoration projects, GBA accounts for the fact that current restoration efforts may produce benefits to future generations. These benefits therefore need to be valued using the respective discounting clocks of the generation receiving the benefits (Sumaila, 2003).

8.3 Valuation Techniques

Many of the impacts identified in the EIA process have no obvious financial value. CBA requires that all impacts be expressed with money as their common denominator. These non-marketed impacts therefore need to be valued.

A number of methods of environmental valuation exist. These are not strictly equivalent, some are better suited to particular problems than others, and some are notably expensive to use.

- a. *Contingent Valuation Method* [CVM]: This involves conducting a survey to establish the affected public's *willingness to pay* (WTP) to preserve a resource or *willingness to accept* (WTA) compensation for its destruction (the difference between these two is relevant when an allocation of property rights or a redistribution of income is a project feature). The survey method can be open ended (just asking people about WTP or WTA) or closed (using cards, larger samples and logit analysis). The latter is technically superior, but a properly run CVM study can be extremely expensive to conduct. CVM is normally used if existence and option values are regarded as important.
- b. *Travel Cost Method* [TCM]: The travel cost method is an alternative to contingent valuation and has the advantage of using observations of actual choices rather than hypothetical behaviour. This method assumes that the time and travel cost expenses that people incur when visiting a site represent a revealed willingness to pay for access to the site.
- c. *Hedonic Pricing*: uses real estate prices. The logic is that since house prices capture relevant amenities (is the house close to the shops, schools, bus routes etc), they should also reflect environmental amenities and disamenities ('goods' like open space close by, view of a pristine area, and "impacts" like traffic noise and air pollution). The characteristics of houses are collected and regressed against house prices, the result enables such characteristics to be valued.

It is important to remember that none of these three approaches measures the intrinsic 'value' of an environmental resource – they measure the public's preferences for changes in the state of their environment. They generate demand curves for environmental goods and services and show the values society attaches to the environment.

Another new valuation tool that shows promise is the 'Back to the Future' model (University of British Columbia, Fisheries Center). Although this model is mainly used with respect to marine ecosystems, particularly relating to the worth of restoration, it can be applied in many environmental scenarios. This model constructs 'past' and 'present-day' ecosystems and simulates the present-day ecosystem under a status quo and a restoration regime. It then compares the economic gains under both scenarios. This model has been used to provide insights into the economic effects of industry on biodiversity and food webs.

9. CONCLUSION

CBA is a tool that informs the decision maker and the public. Properly presented it is accessible and makes the issues involved succinct and clear. By doing so it increases accountability in the decision making process, and can help ease conflict. In this regard it may be introduced to inform interested parties involved in multi-criteria decision analysis. By applying CBA uncertainty can be reduced and the process of choosing the most beneficial project or policy can be optimised.

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11. GLOSSARY

Definitions

Affected environment

Those parts of the socio-economic and biophysical environment impacted on by the development.

Affected public

Groups, organizations, and/or individuals who believe that an action might affect them.

Alternative proposal

A possible course of action, in place of another, that would meet the same purpose and need. Alternative proposals can refer to any of the following but are not necessarily limited thereto:

- * alternative sites for development
- * alternative projects for a particular site
- * alternative site layouts
- * alternative designs
- * alternative processes
- * alternative materials

In IEM the so-called “no-go” alternative also requires investigation.

Authorities

The national, provincial or local authorities, which have a decision-making role or interest in the proposal or activity. The term includes the lead authority as well as other authorities.

Baseline

Conditions that currently exist. Also called “existing conditions.”

Baseline information

Information derived from data which:

- * Records the existing elements and trends in the environment; and
- * Records the characteristics of a given project proposal

Decision-maker

The person(s) entrusted with the responsibility for allocating resources or granting approval to a proposal.

Decision-making

The sequence of steps, actions or procedures that result in decisions, at any stage of a proposal.

Environment

The surroundings within which humans exist and that are made up of -

- i. the land, water and atmosphere of the earth;
- ii. micro-organisms, plant and animal life;
- iii. any part or combination of (i) and (ii) and the interrelationships among and between them; and
- iv. the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being. This includes the economic, cultural, historical, and political circumstances, conditions and objects that affect the existence and development of an individual, organism or group.

Environmental Assessment (EA)

The generic term for all forms of environmental assessment for projects, plans, programmes or policies. This includes methods/tools such as EIA, strategic environmental assessment, sustainability assessment and risk assessment.

Environmental consultant

Individuals or firms who act in an independent and unbiased manner to provide information for decision-making.

Environmental Impact Assessment (EIA)

A public process, which is used to identify, predict and assess the potential environmental impacts of a proposed project on the environment. The EIA is used to inform decision-making.

Fatal flaw

Any problem, issue or conflict (real or perceived) that could result in proposals being rejected or stopped.

Impact

The positive or negative effects on human well-being and/or on the environment.

Integrated Environmental Management (IEM)

A philosophy which prescribes a code of practice for ensuring that environmental considerations are fully integrated into all stages of the development and decision-making process. The IEM philosophy (and principles) is interpreted as applying to the planning, assessment, implementation and management of any proposal (project, plan, programme or policy) or activity - at the local, national and international level - that has a potentially significant effect on the environment. Implementation of this philosophy relies on the selection and application of appropriate tools to a particular proposal or activity. These may include environmental assessment tools (such as Strategic Environmental Assessment and Risk Assessment); environmental management tools (such as monitoring, auditing and reporting) and decision-making tools (such as multi-criteria decision-support systems or advisory councils).

Interested and affected parties (I&APs)

Individuals, communities or groups, other than the proponent or the authorities, whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. These may include local communities, investors, business associations, trade unions, customers, consumers and environmental interest groups. The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

Lead authority

The environmental authority at the national, provincial or local level entrusted in terms of legislation, with the responsibility for granting approval to a proposal or allocating resources and for directing or coordinating the assessment of a proposal that affects a number of authorities.

Mitigate

The implementation of practical measures to reduce adverse impacts.

Non-governmental organizations (NGOs)

Voluntary environmental, social, labour or community organisations, charities or pressure groups.

Proponent

Any individual, government department, authority, industry or association proposing an activity (e.g. project, programme or policy).

Proposal

The development of a project, plan, programme or policy. Proposals can refer to new initiatives or extensions and revisions to existing ones.

Public

Ordinary citizens who have diverse cultural, educational, political and socio-economic characteristics. The public is not a homogeneous and unified group of people with a set of agreed common interests and aims. There is no single public. There are a number of publics, some of whom may emerge at any time during the process depending on their particular concerns and the issues involved.

Role-players

The stakeholders who play a role in the environmental decision-making process. This role is determined by the level of engagement and the objectives set at the outset of the process.

Scoping

The process of determining the spatial and temporal boundaries (i.e. extent) and key issues to be addressed in an environmental assessment. The main purpose of scoping is to focus the environmental assessment on a manageable number of important questions. Scoping should also ensure that only significant issues and reasonable alternatives are examined.

Screening

A decision-making process to determine whether or not a development proposal requires environmental assessment, and if so, what level of assessment is appropriate. Screening is initiated during the early stages of the development of a proposal.

Significant/significance

Significance can be differentiated into impact magnitude and impact significance. Impact magnitude is the measurable change (i.e. intensity, duration and likelihood). Impact significance is the value placed on the change by different affected parties (i.e. level of significance and acceptability). It is an anthropocentric concept, which makes use of value judgements and science-based criteria (i.e. biophysical, social and economic). Such judgement reflects the political reality of impact assessment in which significance is translated into public acceptability of impacts.

Stakeholders

A sub-group of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term therefore includes the proponent, authorities (both the lead authority and other authorities) and all interested and affected parties (I&APs). The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

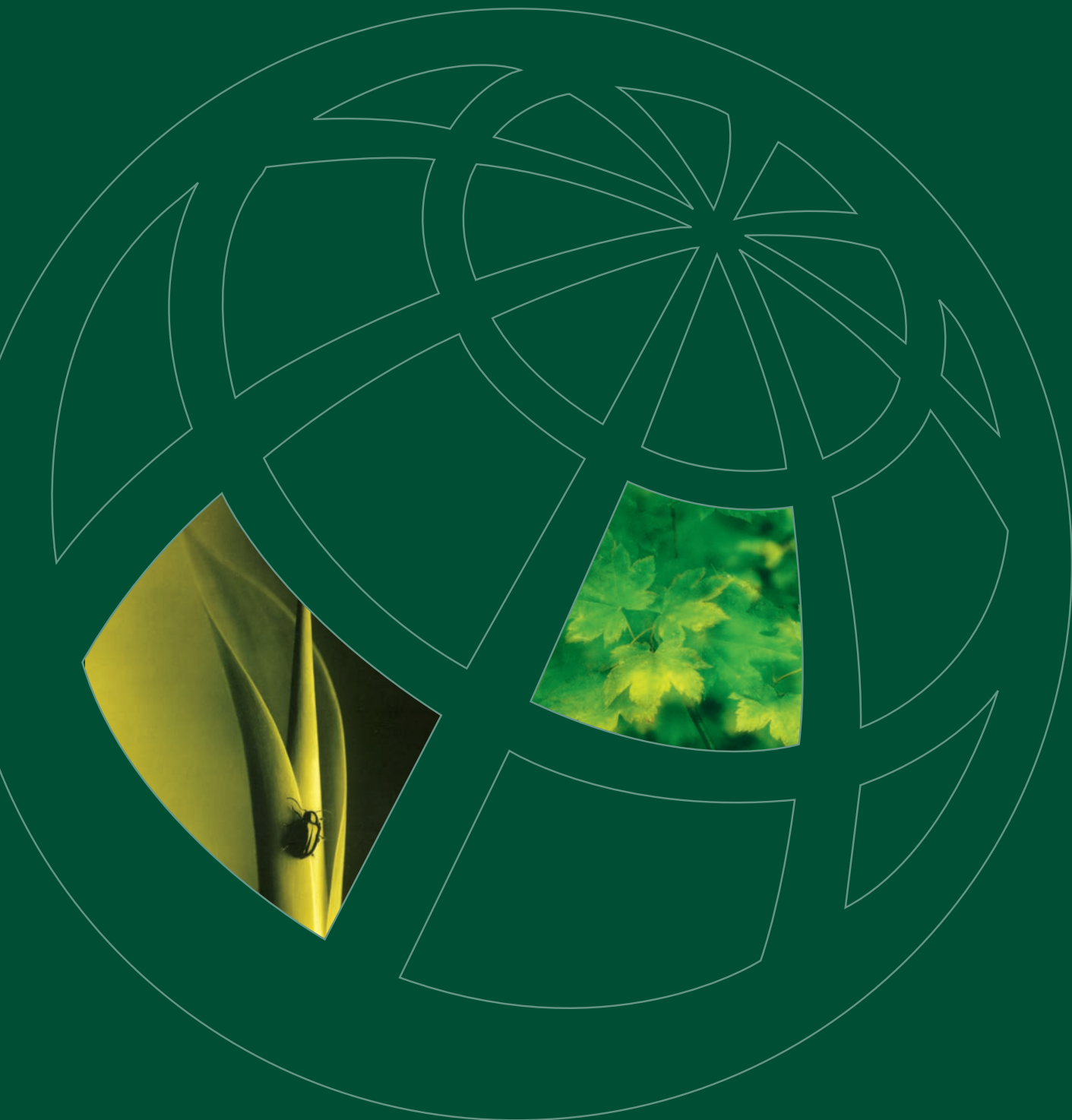
Stakeholder engagement

The process of engagement between stakeholders (the proponent, authorities and I&APs) during the planning, assessment, implementation and/or management of proposals or activities. The level of stakeholder engagement varies depending on the nature of the proposal or activity as well as the level of commitment by stakeholders to the process. Stakeholder engagement can therefore be described by a spectrum or continuum of increasing levels of engagement in the decision-making process. The term is considered to be more appropriate than the term “public participation”.

Stakeholder engagement practitioner

Individuals or firms whose role it is to act as independent, objective facilitators, mediators, conciliators or arbitrators in the stakeholder engagement process. The principle of independence and objectivity excludes stakeholder engagement practitioners from being considered stakeholders.

<i>Abbreviations</i>	
CBO	Community-based Organization
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management Systems
I&AP	Interested and Affected Party
IEM	Integrated Environmental Management
NGO	Non-governmental Organization
SEA	Strategic Environmental Assessment



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