**Project N°: 036992**

**ACRONYM** : **S**cience **P**olicy **I**ntegration for **Co**astal **S**ystems **A**ssessment

# REPORT

## COST BENEFIT ANALYSIS
## SPECIFICATION SHEET AND SUPPORTING MATERIAL

Hadley, D., and D'Hernoncourt, J.

January, 2011

University of East Anglia CSERGE, Norwich
Université Libre de Bruxelles – CEESE, Brussels

**How to cite:** Hadley, D., and D'Hernoncourt, J. (2011), Cost benefit analysis – Specification sheet and supporting material, *Spicosa Project Report*, University of East Anglia CSERGE, Norwich.

**Integrated Project funded by The European Community**
**Under the Sixth Framework Programme**
**Priority 1.1.6.3**
**Global Change and Ecosystems**

**Note to the reader - How to use this material**

This report has been designed as a hyperlinked pdf document.
The main text in the specification sheet synthesises the economic assessment method, its relation to systems approach and the appropriate use of the method. It also gives some hints on how to best present the results of your assessment to stakeholders, along with an example of the use of the method.
In the text and in the “further information” section, you will have access to links to the accompanying material available in the rest of the report (page numbers are also provided along the links in case you would like to print this report).
A back button on the bottom of each page of supporting material helps you go back to the main text.

# SPECIFICATION SHEET

## Cost benefit analysis

### Method and assumptions

Cost benefit analysis (CBA) is a means of project or policy appraisal. It involves identifying and measuring, in monetary terms, as many of the costs and benefits as possible that relate to a particular project. In a CBA, one thus also needs to establish how ecosystem services are valued by individuals (learn more on how in the specification sheet on economic valuation). To monetise helps to determine whether the project or policy will produce a net gain or loss in economic welfare for society as a whole. CBA attempts to capture the trade-off between the real benefits to society of a given alternative and the real resources that society must give up to obtain those benefits. Used appropriately CBA should then help facilitate the efficient allocation of society's scare resources to those uses that create the greatest net social benefit. More generally it can be used as a framework for organising information, listing the advantages and disadvantages of the alternatives under consideration, determining the relevant economic values and then ranking those alternatives on the basis of their economic worth.

The methodology is rooted in the theory of welfare economics, which consists of a large body of well developed theory. To learn more on this theoretical background, follow this link (p. 6). Hence CBA has a sound theoretical basis. This is both a strength and a potential weakness of the method. It is a strength if the theory upon which it is based can be viewed as being a valid representation of the real world and a weakness if it cannot. It should be remembered that CBA only provides an aid to decision making and that the most economically efficient option may not be the most appropriate on other grounds (for instance in terms of social distribution of benefits and costs e.g. from ecosystem services, learn more here, p. 7).

### Relation to systems approach

Whether they cover costs or benefits, the components of CBA are valued at one point in time. Hence, the technique is not especially well suited to inclusion in dynamic simulation models and is mostly used as a one shot assessment to compare policy responses to a given issue, the outcomes of different scenarios…

In general, economic data is collected on a yearly basis, so most economic assessment methods are organised in terms of annual increments. This generally does not lend itself well to incorporation into biophysical simulation models that may operate on a daily (or even shorter) time step. Economic data is also usually only collected for quite large regional administrative units and there may be issues in scaling this data down to the (often) very localized areas which the biophysical simulation models are attempting to represent. Learn more on spatial and temporal scales of benefits and costs derived from ecosystems services here (p. 8).

**When this method is especially to be used**

Cost benefit analysis is most appropriately used when there are a range of alternative options to be compared. These alternatives could be:

- different policy responses to an issue, e.g. eutrophication problems in a water body could be addressed by either the installation or upgrading of waste water treatment from sewage works, by legislation that restricts the amount of fertiliser that farmers can use on their land, or by preventing run-off of livestock waste into watercourses by the provision of storage facilities on farms. All of these options entail costs which can be evaluated and compared to the benefits (in terms of reduced eutrophication impacts) that each action will result in;
- the outcomes of different scenarios;
- different technical options, e.g. different technological options for removing nutrients from water.

Keep in mind that though CBA is good to highlight trade-offs between alternative options, the role of the SAF is not to encourage stakeholders towards one particular solution (that would be the most effective on cost-benefit grounds) but to provide a panel of information to base decisions on.

CBA should not be used (or should be modified):

- when various options are being evaluated in order to meet some existing (or proposed) environmental standard, achieving a target or complying with a law, cost effectiveness analysis is a more appropriate economic assessment methodology to find the least cost way of achieving this;
- when the environmental aspects of the issue are very difficult to value in monetary terms, or where their valuation is particularly contentious. In this situation a partial CBA may be the best course of action. This partial CBA would evaluate all readily measurable costs and benefits and then employ sensitivity analysis in order to determine how large the cost (or benefits) of the environmental aspects of the issue would have to be so as to have an effect on the outcome of the analysis (learn more on this technique in the “Sensitivity analysis within cost benefit analysis” report). The use of other assessment methods, for instance multi-criteria analysis can also be envisaged.

**How to best present results to stakeholders?**

Cost benefit analysis results are probably best presented to stakeholders on two levels. A simple overview of the main results on one or two sides of A4 paper – or a as part of a 15 minute presentation – with the detail of the analysis and results presented in more detail in a technical report. CBA results can usually be presented in terms of a few headline indicators, however **all** results should be presented within the context of a comprehensive sensitivity analysis (that should be detailed in the technical report) and any uncertainties surrounding the results should be highlighted. A sensitivity analysis concerning the implied discount rates (e.g. ranking between close to zero up to 5 percent) and the presentation of time dependent curves that show the development of costs and benefits over time will shed light on the effects of different time preferences. Where costs or benefits are difficult to value and hence cannot be included in the

"bottom-line" figures it is very important that these omissions are underlined and their possible implications discussed.

Note that one of the reasons for the prevalence of CBA in government economic evaluations is because it can provide a single monetary figure upon which decisions can be made. This single figure has the benefit of simplicity, but can hide a multiplicity of uncertainty, simplifications and assumptions – it is your task to bring these out into the open and make them obvious to stakeholders.

**Example of use of the method**

An example of integration of cost benefit analysis into the SAF is Himmerfjärden in Sweden. The team designed a tool to assess policy options to mitigate eutrophication/ manage nitrogen loads. Along the ecological dimension, showing the results of the measures on the environment, the economic dimension of the simulation model included a cost benefit analysis module.

The costs were the ones incurred by the implementation of combinations of technical options (waste water treatment plant, sewers, wetland creation,…). Benefits of increased recreational activities thanks to improved water clarity were considered. A demand function for recreation was constructed. It was determined by the cost of travel, the accessibility by public ferry, the secchi depth (water clarity) and other social, economic and environmental factors such as income and weather. This demand function was used to assess how the number of visitors would increase if water clarity is improved. This function was then coupled with a travel cost method (random utility model), in order to ascertain a monetary value to water clarity improvement. Benefits and costs were aggregated over time to get present values.

The Swedish team also approached the cost effectiveness analysis by including the cost per kilogram reduced nitrogen in the simulation model.

Along with environmental and social variables coming from other parts of the simulation model and qualitative values, benefits and costs (and cost effectiveness) contributed to this management tool that helped stakeholders explore scenarios for improved water quality.

Learn more on how the travel cost method was implemented in this study site in the specification sheet on economic valuation.

**Further information**

More information on the theoretical foundations of CBA can be found here (p. 9-11).

A core reference is: Pearce, D. W., G. Atkinson and S. Mourato. 2006. Cost-benefit analysis and the environment: recent developments, Paris: Organisation for Economic Co-operation and Development. Available online at:

http://www.lne.be/themas/beleid/milieueconomie/downloadbare-bestanden/ME11_cost-benefit%20analysis%20and%20the%20environment%20oeso.pdf, accessed 01/20011

## Welfare, utility or human well-being as benefits or costs

The effects of changes in ecosystem services on human society in terms of increases or decreases in benefits, costs, welfare, utility or human well-being require some definition. When we refer to benefits of a policy or project we mean that there has been (or, will be) some increase in human well-being or welfare associated with implementing that policy or project. Economists measure this increase in human well-being or welfare using the concept of utility. Utility is a measure of satisfaction: the more utility we have the more satisfied we are, or, alternatively the greater is our welfare or well-being.

Costs are the opposite of benefits. If the overall effects of a policy or project represent a cost to society this would mean that implementing that policy or project would result in a decrease in society's welfare or well-being and hence in the overall utility that society enjoys.

The problem with the concept of utility is that it is not directly measurable – so, how then do we compare situations where utility has been changed as the result of the implementation of some project or policy? Consider a simple example where we have one individual who enjoys a particular level of utility – we will call this $U_0$ – that is attained with an income of $Y_0$, and which is associated with a given level of environmental quality – $E_0$. Suppose then that the implementation of a new policy or project causes an improvement in the environmental quality that the individual experiences from $E_0$ to $E_1$ and that this improvement increases their utility from $U_0$ to $U_1$: so they move from a state $U_0(Y_0,E_0)$ to $U_1(Y_0,E_1)$. As we have said we cannot directly measure this increase in utility, but we can indirectly by considering how much income this individual would be willing to give up in order to bring about this change. Hypothetically, the individual is considering two combinations of income and environmental quality that both give her/him the same level of utility, i.e. $U_0$. In the first combination, income is reduced and environmental quality is increased, and in the second, income is not reduced and environmental quality is not increased. The reduction in income that is required to make these two combinations equal represents what the individual is willing to pay for the change in environmental quality, i.e.:

$$U_0 (Y_0 - WTP, E_1) = U_0 (Y_0, E_0)$$

Alternatively an individual could be asked to consider how much additional income they would be willing to accept in order to give up the improvement in environmental quality, but still remain at the increased utility level $U_1$, i.e.:

$$U_1 (Y_0 + WTA, E_0) = U_0 (Y_0, E_1)$$

Similar measures of change in utility can be developed for policy or project effects that cause deteriorations in environmental quality.

The basic principle that is at work here is that utility (or alternatively, welfare or well-being) can be indirectly measured in terms of the income that people are willing to give up in order to achieve some improvement; or, what they are willing to accept in compensation for foregoing some improvement. Willingness to pay (WTP) and willingness to accept (WTA) represent the monetary equivalents of changes in utility.

---

Back to the main text, p. 3

## Social distribution of the benefits and costs derived from ecosystem services

To whom the benefits of ecosystem services accrue is an important question. It is often the case that neither the benefits nor costs of land conversion, for example, are distributed equitably among social groups. These considerations, however, become especially important when trying to make choices about ecosystem management in line with the equity issues that are embedded within the concept of sustainable development.

Such equity issues can be addressed via modified cost benefit analysis or by regional economic accounting methodologies such as Input-Output analysis and environmental accounting. The latter techniques take the form of a matrix where the various affected economic sectors are explicitly represented, allowing for the distribution of costs and benefits amongst sectors to be analysed. However, both of these techniques may be too aggregated to distinguish other categories than economic sectors (such as gender or socio-economic groupings). For analysis at this level, a social accounting matrix might be more appropriate.

If public and private interests are distinct, conflicts of interest can arise. Commercial interests tend to have a reputation for reaping the reward of harvesting natural resources at the expense of local users, even though blame is often shared with national governments which can suffer from corruption, lack of capacity or lack of political will to enforce better controls on resource extraction. The ability of national governments to collect tax and foreign revenue related to resource rents, concessions and tourism, and to redistribute this revenue to the benefit of the general public, is also prey to these weaknesses. Addressing issues of governance and corporate social responsibility can help ensure the equitable distribution of the benefits of ecosystem exploitation.

---

Back to the main text, p. 3

## Spatial and temporal distribution of the benefits and costs derived from ecosystem services

Ecosystem services operate at a variety of spatial and temporal scales such that their benefits are realised locally, regionally and even globally. The costs of lost ecosystem services are also expressed at several scales, and it is the perception of the magnitude of costs and benefits at different scales and across a variety of temporal horizons that shapes decisions, especially about land-use.

Short-term local ecosystem service degradation resulting from a particular land-use activity may be perceived as cost-effective in the context of short-term local economic returns, but the cumulative impact of many similar local decisions may, in the long term, lead to regional ecosystem service failure, with consequent economic costs for society that far outweigh previous benefits. Therefore, a consideration of the scales at which ecosystem services function is central to the development of integrated and sustainable land-use policy for human-dominated ecosystems.

The results of a cost benefit analysis are also highly dependent on the discount rates implied. A short-sighted time preference (high discount rate) will weight short term cost higher than long term benefits. A time preference taking into account also the interests of future generations would put more weight on the long term benefits – the current investment costs thereby loose much of their prominence. The consequences of different time preference assumptions should be made transparent while presenting the results.

---

Back to the main text, p. 3

## Theoretical foundations of cost benefit analysis

Cost benefit analysis (CBA) is a means of project or policy appraisal. It involves identifying and measuring, in monetary terms, as many of the costs and benefits as possible that relate to a particular project. This helps to determine whether the project or policy will produce a net gain or loss in economic welfare for society as a whole. As a rule, a project deemed to be efficient if total benefits exceed total costs. A simplified overview of CBA methodology is outlined in the box below.

A CBA compares the costs and benefits of different policy options in monetary terms. The results of this analysis can be interpreted as a benefit-cost ratio, i.e. total benefits divided by total costs, where a ratio larger than one indicates that the policy measure is economically beneficial, or as a net present value, that is the present value of the net benefits where a positive net present value indicates a welfare improvement. Strictly speaking, only those costs and benefits are included in a CBA that can be quantified in monetary terms. However, it will hardly ever be possible to monetise all impacts all the time: those impacts that cannot be monetised are often left out of the analysis. Non-monetised impacts, if considered relevant, can nonetheless be included in a qualitative discussion accompanying the discussion of the CBA results.

The theoretical foundations of CBA can be summarised as follows (Pearce *et al*., 2006):

- Benefits are defined as increases in human well-being (utility).
- Costs are defined as reductions in human well-being.
- For a project or policy to qualify on cost-benefit grounds, its social benefits must exceed its social costs.
- "Society" is simply the sum of individuals.
- The geographical boundary for CBA is usually the nation but can readily be extended to wider limits.
- Aggregating benefits across different social groups or nations can involve summing willingness to pay/accept (WTP/WTA) regardless of the circumstances of the beneficiaries or losers, or it can involve giving higher weights to disadvantaged or low income groups. One rationale for this is that marginal utilities of income will vary, being higher for the low income group.
- Aggregating over time involves discounting. Discounted future benefits and costs are known as present values.
- Inflation can result in future benefits and costs appearing to be higher than is really the case. Inflation should be netted out to secure constant price estimates.
- The notions of WTP and WTA are firmly grounded in the theory of welfare economics and correspond to notions of compensating and equivalent variations.
- WTP and WTA should not, according to past theory, diverge very much. In practice they appear to diverge, often substantially, and with WTA > WTP. Hence the choice of WTP or WTA may be of importance when conducting CBA.

Back to the main text, p. 3

**Box 1: An outline of CBA methodology**

The main stages of a CBA are as follows.

1. Definition of the details of each feasible project, policy or management option including the 'do nothing' option.

2. Determining the spatial and temporal scales of the analysis, i.e. over what population is it appropriate to sum the costs and benefits? and, over what time period do the costs and benefits arise?

3. Identification of the costs and benefits and their monetary values. Monetary value may be based on the market value of a good or service or on its replacement cost (if that can be calculated), or, in the case of some ecosystem services, by use of various valuation techniques. To enable valid comparisons, all monetary values must refer to a common point in time – the base year – to give 'present' values. A standard 'discount rate' is applied so that costs and benefits of projects with varying time scales can be compared.

4. The economic efficiency of various options are assessed through comparing either their 'benefit-cost ratios', i.e. the present value of benefits divided by the present value of costs, or their 'net present values', i.e. the present value of benefits less the present value of costs.

5. A sensitivity analysis should be included within a CBA, to assess the impact on the benefit cost ratio and/or net present value of changes in the values of central parameters, e.g. the value of costs and benefits or the discount rate. By examining the impact that increasing costs (or reduced benefits) may have on the net present value, the break-even point can be determined whereby the scheme would be no longer justifiable.

There are numerous critiques of CBA. Perhaps some of the more important are:

- The extent to which CBA rests of robust theoretical foundations.
- The fact that the underlying "social welfare function" in CBA is one of an arbitrarily large number of such functions on which consensus is unlikely to be achieved.
- The extent to which one can make an ethical case for letting individuals' preferences be the (main) determining factor in guiding social decision rules.

CBA can provide a very useful and reliable input into the decision-making system, provided that it is carried out fully and impartially. However, translating all the costs and benefits of a project, policy or management scenario into monetary terms can be impractical or not meaningful. It should be remembered that CBA only provides an aid to decision making and that the most cost efficient option may not be the most appropriate on other grounds. In these situations multi-criteria analysis can provide an alternative as it permits the inclusion of measurable non-monetary criteria into the assessment.

Finally, the whole history of neoclassical welfare economics has focused on the extent to which the notion of economic efficiency can or should be separated out from the issue of who gains and loses – the distributional incidence of costs and benefits. Various "schools of thought" have emerged. Some argue that distributional incidence has nothing to do with CBA: CBA should be confined to "maximising the cake" so there is more to share round according to some morally or politically determined rule of distributional allocation. Others argue that notions of equity and fairness are more engrained in the human

Back to the main text, p. 3

psyche than notions of efficiency, so that distribution should be considered as a prior moral principle, with efficiency taking second place. Yet others would agree with the second school but would argue that precisely because efficiency is "downgraded" in social discourse that is all the more reason to elevate it to a higher level of importance in CBA. Put another way, one can always rely on the political process raising the equity issue, but not the efficiency issue. Certain minimum requirements for practice emerge. At the very least, a "proper" CBA should record not just the aggregate net gains from a policy, but the gains and losses of different groups of individuals.

**References**

Pearce, D. W., G. Atkinson and S. Mourato. 2006. Cost-benefit analysis and the environment: recent developments, Paris: Organisation for Economic Co-operation and Development. Available online at:

http://www.lne.be/themas/beleid/milieueconomie/downloadbare-bestanden/ME11_cost-benefit%20analysis%20and%20the%20environment%20oeso.pdf, accessed 01/20011

Back to the main text, p. 3