# Methods for assessing the economic values of biodiversity and ecosystem services

## The Brief in brief

Biodiversity and biodiversity related ecosystem services give rise to a wide range of different values of which some can be classified as economic while others are classified as non-economic. Both types of values are important, but the methods suitable for assessing the two types of values are fundamentally different and build on different ethical/theoretical approaches. In this brief the focus is restricted to methods relevant for assessing the economic values of biodiversity and biodiversity related ecosystem services. The brief provides an overview of available methods, and the pros and con of each of the methods are discussed. Which method to use in a given context is shown to depend on several factors including the type of value being assessed, data and resource availability and the intended use of the valuation results.

## Intended audience

The intended audiences of this brief are people with an interest in biodiversity conservation and biodiversity related ecosystem services in the context of land use management. The overview of valuation methods provided in the brief gives the reader an easy to read introduction to both the potentials and limits of economic valuation of biodiversity and ecosystem services. The information contained in the brief thereby gives an indication of the scope for including biodiversity related values in e.g. project appraisals and policy processes on equal terms with other aspects.

## Topic

There is widespread consensus that biodiversity and the ecosystem services it supplies represent significant value to individuals as well as to society as a whole. Issues less easy to reach consensus upon concern (***i***) the magnitude of the value (***ii***) the relative contribution of different values to total value and (***iii***) how to assess the different values. During the past decades environmental economists have put considerable effort into the development and application of methods for assessing the monetary value of biodiversity and biodiversity related ecosystem services. In Table 1 an overview is provided of the methods available for economic valuation. For each of the methods the types of values it can be used to assess are listed; it is also specified which ecosystem service category the values belong to. Examples are also provided of specific ecosystem services which can be valued by the different methods.

The first method listed in Table 1 is the ***Adjusted Market Price Method***, which can be used to assess the values of direct consumptive uses such as agricultural production and fisheries. In ecosystem service terms these uses and values refer to the provisioning services category. Using the Adjusted Market Price method values are assessed based on market prices that are subsequently adjusted for market distortions such as taxes, subsidies and non-competitive practices. In theory the method is quite simple, but in practice it may be difficult to identify the relevant prices and to quantify the distortions; also, it may be difficult to determine which share of the total value that can be attributed to biodiversity and ecosystems services.

The next 4 valuation methods listed in Table 1 can all be used to assess indirect use, insurance and option values, stemming from ecosystem services belonging to the regulating services category. Using the ***Production Function approach***, the value of ecosystem services is assessed by isolating their effect as an input to a production process. The method is suitable for valuing ecosystem services such as natural pest control, where such control can enter agricultural production functions on equal terms with other inputs to production. Using the Damage Cost approach an ecosystem service is valued by calculating the costs that would be incurred in case the ecosystem service was lost/degraded. The approach is suitable e.g. in relation to valuing flood mitigation, where the value of the ecosystem service can be assessed as the flood related costs that are avoided due to the ecosystem service being delivered. The Averting Behavior approach is somewhat similar to the Damage Cost approach in the sense that ecosystem services are valued with reference to the negative consequences that are expected to occur in case the services are degraded or disappear. But where the damage cost approach propose that the value of the ecosystem service is equal to the avoided damage cost, the Averting Behavior approach proposes that expenditures incurred in order to avoid damage from the loss of an ecosystem service can be used as an estimate of the value of the service. An example of how the Averting Behavior approach may be used is pollution control. According to the ***Opportunity Cost approach*** the value of an ecosystem service can be estimated by calculating the costs associated with obtaining similar services elsewhere or by other means; an example is water quality, where the value of ecosystem services contributing to maintaining a naturally clean supply of drinking water may be estimated by calculating the costs associated with e.g. chemical treatment of water for drinking purposes.

| **Valuation method** | **Types of values** | **Ecosystem service categories** | **Examples** |
|---|---|---|---|
| Adjusted market prices | Direct consumptive use | Provisioning services | Crops, livestock, timber |
| Production function approach | Indirect use, insurance, option | Regulating services | Natural pest control, pollination, flood mitigation |
| Damage costs | Indirect use, insurance, option | Regulating services | Flood mitigation, natural pest control |
| Averting costs | Indirect use, insurance, option | Regulating services | Pollution control |
| Opportunity costs | Indirect use, insurance, option | Regulating services | Water quality |
| Revealed preference methods | Direct non-consumptive use | Cultural services | Recreation, peace and quiet, landscape aesthetics |
| Stated preference methods | Use and non-use | Provisioning, regulating and cultural services | Water quality, species conservation, flood prevention |
| Benefit transfer | Use and non-use | Provisioning, regulating and cultural services | Transfer of results from hedonic or stated preference studies |
| Deliberative valuation | Use and non-use | Provisioning, regulating and cultural services | Conservation priorities |
| Expert valuation | Use and non-use | Provisioning, regulating and cultural services | Issues where scientific knowledge is essential |
| Multi-criteria evaluation | Use and non-use | Provisioning, regulating and cultural services | Conservation and environmental policy priorities |

**Table 1.** Overview of economic valuation methods available for valuing biodiversity and biodiversity related ecosystem services.

***Revealed Preference methods*** refer to valuation methods based on analysis of individuals' revealed preferences. The methods are used to assess direct non-consumptive use values related to ecosystem services within the Cultural ecosystem services category. The analysis of preferences concerns individual's expenditure on goods whose consumption is complementary to the demand for the ecosystem services. The most common Revealed preference methods are the Travel Cost Method and

Hedonic Price methods, which are typically used to assess the values of areas used for recreation and landscape features, respectively.

***Stated preference methods*** is also a collective term used for several different methods, which all share the common characteristic that they are based on stated (i.e. hypothetical) preferences rather than actual revealed preferences. Some of the most commonly used Stated Preference methods are Choice Experiments and Contingent Valuation. An advantage of Stated Preference methods compared to Revealed Preference methods is that they can be used to assess all types of values that are based on human preferences; hence they can be used to value provisioning, regulating as well as cultural services. Another advantage of this group of methods is that they can be used to assess the value of future hypothetical scenarios, and this makes their use particularly relevant in relation to the evaluation and design of different policy and land use management initiatives. Using Stated Preference methods individuals' are asked to indicate (either directly or indirectly) their willingness to pay for different quantities or qualities of an environmental good or service. Seen from a theoretical point of view it is fairly straightforward to obtain value estimates for almost all services using these methods. In practice, however, it is complicated; it is a complex and difficult task to describe the good or service subjected to valuation in a way that both makes sense to those valuing the good and reflects the economic, social and environmental context of considered quantity or quality changes. Although Stated Preference methods can be used to value all types of ecosystem services, in practice they are primarily used in contexts where it is not feasible to use other methods.

***Benefit Transfer***, despite being listed in Table 1, does not qualify as a valuation method as such. Instead it represents an approach where value estimates derived for one site are transferred to other similar sites. Benefit Transfer thus represents a fairly cheap and easy way of obtaining information on the value of ecosystem services. An evident prerequisite for using the method is that estimates suitable for benefit transfer can be found, and this may often be difficult. Hence even though the number of ecosystem service related valuation studies is rapidly increasing the chance that studies conducted in sufficiently similar contexts can be found remains small.

The last three valuation methods listed in Table 1 differ from the other methods in the sense that they do not represent strictly economic valuation methods. Hence they can also be used for non-economic valuation exercises such as rankings. Common to all three methods is that they can be used for all types of values and most types of ecosystems services. ***Deliberative Valuation*** refers to approaches where values are elicited by asking focus groups to choose between different qualities/quantities of environmental goods. Depending on how the choices are framed information may be obtained either about the monetary value of the good or about the relative importance/value of different quantities/qualities of either the same good or different goods. The method may be particularly suitable for prioritizing conservation efforts where forms of values are being assessed. ***Expert Valuation***, as the name indicates, refers to approaches where value estimates are obtained from experts, usually a group of experts. The approach is mainly applicable to situations where scientific knowledge is essential for the valuation (either quantitative or qualitative) of alternatives. The last of the methods, ***Multi-Criteria Evaluation***, is particularly relevant in situations where many attributes need to be considered simultaneously. An example is evaluation of policy actions which affect the provision of several ecosystem services, and where some are positively affected, while others are negatively affected. Using the method, weights are assigned to the factors affected by the considered policy. These weightings can be used to calculate an aggregate criterion for different policy scenarios, which subsequently can be used as a base for ranking the different scenarios. The approach can be used as input to the design of conservation and environmental policies where it is necessary to prioritize between different focus areas.

## Usefulness

Knowledge of the economic value of biodiversity and biodiversity related ecosystem services can be useful in a number of different contexts such as raising awareness, accounting, priority setting, design of policy instruments and litigation. It is however, important to be aware that value estimates obtained by the use of the methods described in this brief are subjective in the sense that they are conditional upon the context in which they have been derived. As an example, values obtained by the Production Function approach are conditional upon the assumptions underlying the production function, and if e.g. other variables had been included in the function, then the value estimates might have looked different. Similarly, value estimates obtained by the use of Stated Preference methods are very much dependent not only on how the scenarios are constructed by the researcher but also on how the scenarios are perceived by the individuals who state their willingness-to-pay. Also, the results from e.g. Expert Valuations or Deliberative Valuations might have looked different had the participants been different. The essence is that it is important to acknowledge that valuation results are not 100% valid or reliable. However, this should not be taken to suggest that the value estimates are of little relevance as input to decision-making. To the contrary, estimates of the value of ecosystem services will in many cases constitute important input to decision-making and policy processes. As an example, they may serve to substantiate the widespread perception that biodiversity and ecosystem services are valuable to individuals and society. Likewise, they may contribute to making the often difficult trade-offs between ecosystem services and market goods more informed. Finally, they may facilitate the task of making the sometimes necessary trade-offs between different ecosystem services, as valuation results may serve to shed light on the relative importance of different ecosystem services.

The Damage Cost, Averting Cost and Opportunity Cost approaches distinguish themselves from the other methods by eliciting values based on cost of provision rather than on individuals' preferences. This means that the values obtained are based on the implicit assumption that the provision of the good or service is delivered at the optimal level. This is often a strong assumption and preference based valuations are likely to be quite different from cost based valuations. This is important to bear in mind when using the value estimates in further analyses.

It is important to recognize that most of the methods are quite demanding to apply both in terms of time and resources. The current scope for widespread application of the methods is therefore limited in this way.

However, as already mentioned, information on the value of biodiversity and ecosystem services can be useful in relation to raising awareness, accounting, priority setting, design of policy instruments and litigation. The validity and reliability requirements depend on the intended use of the valuation results. As an example, the requirements imposed on value estimates to be used for raising awareness are less stringent than those applying to estimates to be used for priority setting, and these – in turn – are less stringent than the requirements imposed on values to be used for litigation purposes. What is important to note here is that increasing the validity and reliability of valuation estimates often entail an increase in cost. The intended use of the estimates is therefore a relevant factor to keep in mind both when choosing between methods and in relation to how specific methods are implemented (e.g. sample sizes).

Finally, it is worth highlighting that the methods discussed in this brief focus on how to provide input to economic analyses. It is generally accepted that economic analyses play an important role in relation to biodiversity conservation and the management of ecosystem services. At the same time, however, it is also widely recognized that there are fundamental ethical arguments which also need to be considered

in relation to biodiversity and ecosystem service decision making. Accordingly, economic analyses should in most cases be supplemented by analyses based on more ethical considerations in order to optimize policies and management strategies with respect to all values rather than just the economic subset of biodiversity and ecosystem service values.

## Transferability

The economic valuation methods discussed in this brief have been developed within economics, but have been applied here to the more specific field of biodiversity and ecosystem services. Thus the methods are transferable across all aspects of non-marketed goods and services, with the limitations of the particular methods as described.

## Lessons learned

- **A range of methods exists for assessing the economic values of biodiversity and ecosystem services.**
- **The available methods differ in terms of the types of values and ecosystem services that they can be used to assess.**
- **Biodiversity and ecosystem value estimates are never truly objective as they depend on the context and assumptions underlying the methods used for obtaining the estimates.**
- **Economic valuation of biodiversity and ecosystem values may provide important input to decision-making and policy processes**

## Looking for more information on effective arguments for biodiversity?

Full results and analysis are contained in Part 1 of the BESAFE Work Package 4 deliverable: http://www.besafe-project.net/files/DOWNLOAD2/BESAFE_D4.1_Synthesis_Final.pdf.

For more BESAFE results, including separate briefs focusing on other case studies and various aspects of argumentation, see http://www.besafe-project.net and BESAFE toolkit http://tool.besafe-project.net.

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