Witteveen Bos

Valuation of Nature, Water and Soil in Socio-economic Cost Benefit

A supplement to the Dutch Guideline for CBA

English Summary

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1. INTRODUCTION

In the public decision making process in the Netherlands, it is becoming less and less acceptable to spend tax payer's money on projects that do not clearly have significant socio-economic benefits. Though a bit late compared to other countries, the Dutch Government decided that Socio-economic Cost Benefit Analyses (CBA) should be conducted prior to investment decisions in the year 200.

To ensure that CBA´s are executed similarly by different consultants, a national guidline for CBA was introduced. In this guideline impacts on nature, water, soil, landscape and cultural heritage were acknowledged as important aspects within CBA, but their values were not calculated due to a lack of a practically applicable methodology.

In December 2004 an extra guideline for the ´Valuation of Nature, Water and Soil in CBA´ was launched to fill the blank. As a result the Netherlands are the first country in Europe to make ecosystem valuation a compulsory component of CBA.

This brochure provides a summary of the contents of the guideline and information on the use possibilities for experts, policy makers and politicians.

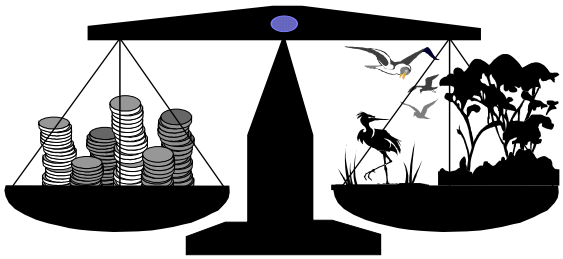
2. CONTENTS OF THE DUTCH GUIDELINE FOR THE VALUATION OF NATURE, WATER AND SOIL

In this section both socio-economic cost benefit analysis and the three values of the natural environment are defined. Essential concepts concerning ecosystem valuation, such as the ´goods and services´-concept and the ´functions of nature´-approach are described. The key of the guideline lies in the prevention of both omissions and overlap (i.e. under- and overestimates of values), the use of different valuation methods and the translation of physical impacts from the Environmental Impact Assessment into welfare effects incorporated in CBA. These key issues are also briefly described here.

2.1. Socio-economic cost benefit analysis

A socio-economic cost benefit analysis (CBA) is an assessment method that encompasses a trade off between all present and future advantages and disadvantages of a project by expressing them in monetary terms. Because the advantages, i.e. benefits and disadvantages, i.e. costs of all stakeholders are integrated, a CBA surpasses sectors´ interests. When the benefits of the winners outweigh the costs of the losers, a project is considered to be sound investment, as it generates a net welfare gain to society.

In a *nature- and environment inclusive CBA* not only the direct financial costs and benefits of a project, but also the positive and negative impacts on nature, water, soil and other environmental qualities are included. If these effects are not included in CBA, they will only reach decision-makers through the environmental impact assessment (EIA). In that case the fact that environmental impacts also lead to welfare losses (or gains) remains shaded.



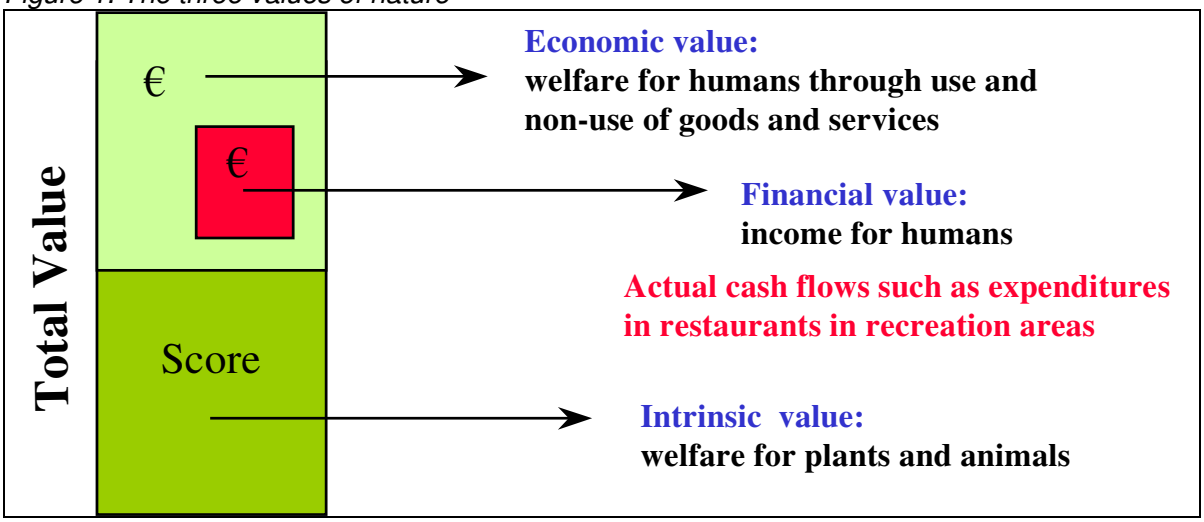
The Dutch guideline for the ´Valuation of nature, water and soil in cost benefit analysis´ is a supplement to the basic guideline for CBA´s, meant to ensure the inclusion of impacts on nature, water and soil in CBA´s for various types of projects.

2.2. The three values of the natural environment

In order to understand the way in which the benefits of the natural environment are valued the Dutch Guideline, it is important to note the definition of value that is used. The economic value of ecosystems is defined as the amount of both material and immaterial forms of welfare that nature generates for society. This means that the economic value is larger than the cash flows derived from nature. These cash flows, which can be rather limited for not exploited pristine nature areas, form the financial value. The broad welfare definition means that the economic value is a purely anthropocentric measurement. Economic value pertains strictly to human welfare. It does not capture the intrinsic value, as welfare for other organisms, plants and animals is not included[1]. Figure 1 shows the economic, the financial and the intrinsic value of ecosystems.

[1] If humans obtain welfare from the well being of other organisms, this is included in the form of a non-use value.

Figure 1. The three values of nature



Source: Ruijgrok et.al. (2004).

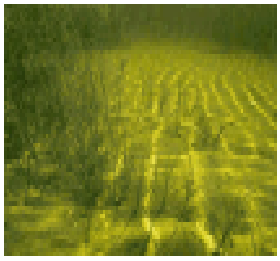
Unlike the intrinsic value, the economic value of ecosystems can be expressed in monetary terms by means of several economic valuation techniques (See figure 3). Once expressed in monetary terms, this value can be included in socio-economic cost benefit analyses, which are also in monetary terms.

2.3. Goods and services produced by the natural environment

Ecosystems generate human welfare because they produce goods and services that humans can use and/or simply enjoy without using it- the so called non-use function (Hanley and Spash (1997), Pearce and Moran (1994)). The use of goods and services can be direct or indirect through the use of other goods or services[2].

Examples of direct forms of use pertain to goods such as wood, clean water and fish or to services such as recreational opportunities, protection against flooding or climate change.

Examples of indirect forms of use are 'nutrient recycling' and 'fish nurseries' which result in respectively 'clean water' and 'fish production'. By using the clean water or the fish, we indirectly use the nutrient recycling service and the nursery service. In other words: the ecosystem´s nutrient recycling and the nursery function are conditional to the production of clean water and fish.



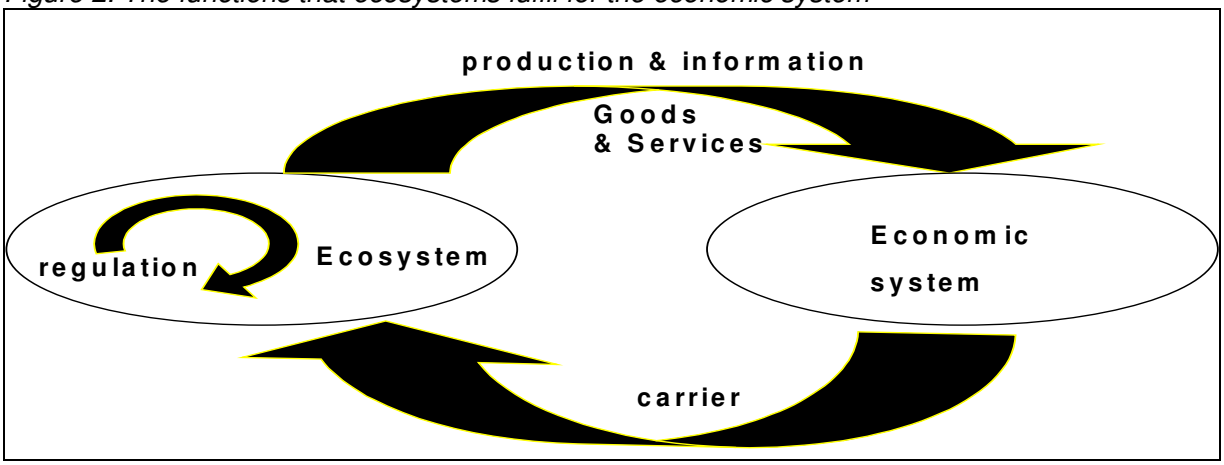
To capture the full value of an ecosystem it is important not to omit any goods and services that the ecosystem produces. At the same time it is also important not to value indirect forms of use in addition to direct forms of use, as this enhances overestimates. A way to solve the problem of potential under- and overestimates is to make a distinction between conditional functions that *indirectly* generate welfare and goods and services that people can *directly* use or non-use and to systematically link conditional functions to goods and services. To understand this solution, we shall take one step back and look at the original functions of nature approach.

[2] Sometimes the categories direct and indirect use are interpreted as respectively tangible and intangible goods and services.

2.4. The functions of nature approach

The functions of nature approach, which distinguishes production, information, regulation and carrier functions, was originally developed by ecologists to identify the substance and energy flows between the ecosystem and the economic system (e.g. van der Maarel and Dauvellier, 1978). The approach was immediately applied by both ecologists and economist[3] to determine the economic value of ecosystems (van Holst et.al, 1978; Gren et.al, 1994, de Groot, 1992; Costanza et.al, 1997), even though it was not meant for this purpose. Figure 2 shows how the different types of functions form a link between the ecosystem and the economic system.

Figure 2. The functions that ecosystems fulfil for the economic system



Source: adapted from Ruijgrok (1999) and based on van der Maarel and Dauvellier (1978).

In figure 2 the different categories of functions are represented by arrows pointing in different directions. The production and information functions reflect a flow from the ecosystem to the economic system. They form the supply of goods (production) and services (information) from which humans directly derive welfare when using or not-using it. These are the welfare flows that we are searching for when trying to determine the economic value of ecosystems. Carrier function represent an opposite flow from the economic system to the ecosystems. Humans put houses, waste, roads etc. in the ecosystem. These functions should not be included in ecosystem valuation studies, because they lead to overestimates. In the end, the space that ecosystems provide carries all human activities, rendering the ecosystems´ value equal to the value of all human activities. In situations where we would like to compare the benefits of ecosystems with the benefits of economic activities to choose between the two, this is not very helpful[4].

Regulation functions are flows inside the ecosystem and are represented by an arrow inside the ecosystem. They are the processes and characteristics that make the carrying of activities and the production of goods and services possible. Originally, they were also called conditional functions (Harms, 1973). Including these conditional functions in addition to goods and services (i.e. production and information functions) is the major cause of overestimates in valuation studies.

Conditional functions such as pollination, nutrient recycling, nurseries, carbon sequestration etc. only indirectly generate welfare since they lead to respectively food production, clean water, fish production and protection against the effects of climate change. This means that if both the pollination and the food production, or both the nursery and the fish are being valued and added up to

[3] It may be noticed here that in studies done by economists the total economic value concept usually plays a central role , whereas in studies by ecologists the functions of nature approach is the central focus.

[4] E.g. suppose we need to decide on whether to build a road through a nature area. We would like to compare the benefits of the road with the costs of loosing the nature area. If the benefits of carrying a road are attributed to the nature area, than the costs of loosing nature will always be exactly equal to the benefits of the road, leaving the matter undecided.

determine the total economic value, one and the same welfare flow is valued double[5]. This is comparable with valuing both the ice cream machine and the ice creams and adding the two values up to determine the socio-economic value of ice cream production.

2.5. Prevention of omissions and overlap

For the sake of not omitting any important ecosystem values, it is useful to identify conditional functions. At the same they can be the cause of overestimates, when overlapping with other goods and services. By linking conditional functions to goods and services that directly generate welfare, it becomes easier to carry out a valuation study without omissions and without overlap. Textbox 1 presents a list of wetland ecosystems functions and links the goods and services to conditional functions.

Textbox 1. Linking conditional functions to goods and services

Condition	**Goods and Services**
Nursery; Migration routes; Aeration (oxygen)	Fish
Nutrient availability; Ground water fluctuation; Pollination; Soil formation; Erosion control; Biological control	Food and other harvestable products
Erosion control (waterways); Sedimentation control	Transportation possibilities
Nutrient recycling (e.g. denitrification); Carbon sinking (organic matter); Metal binding; Silicium production; Salinity control	Clean Water
Water absorption of soil (sponge function)	Protection against floods
Carbon sequestration	Protection against climate change
Fish nursery, natural succession, biological control etc.	Recreational opportunities
Several functions that lead to biodiversity, such as natural succession and biological control	Existence and bequest of biodiversity (non use)

Textbox shows that nurseries lead to fish production and nutrient recycling to clean water. Since each time there is only one welfare flow, this means that one should either value the nursery or the fish, and either the nutrient recycling or the clean water.[6] From literature on economic valuation methods, we know that conditional functions such as nutrient recycling cannot be valued in a reliable way with methods that measure benefits in terms of people's willingness to pay, such as CVM and TCM, whereas as commodity-like goods and services, such as ´clean water´ and ´recreational visits´, can (Freeman, 1986). These conditional functions can, however, be valued quite easily by means of cost-based methods such as abatement cost avoided. Such cost-based estimates are, however, proxy´s of the actual economic value, since it may cost much to abate e.g. nutrient emissions, although the welfare derived from less nutrients may be smaller than the abatement costs.

From the above one can conclude that linking conditions to goods and services, does not only help us to prevent omissions and overlap in valuation studies, but it also explicitates a choice in valuation methods.

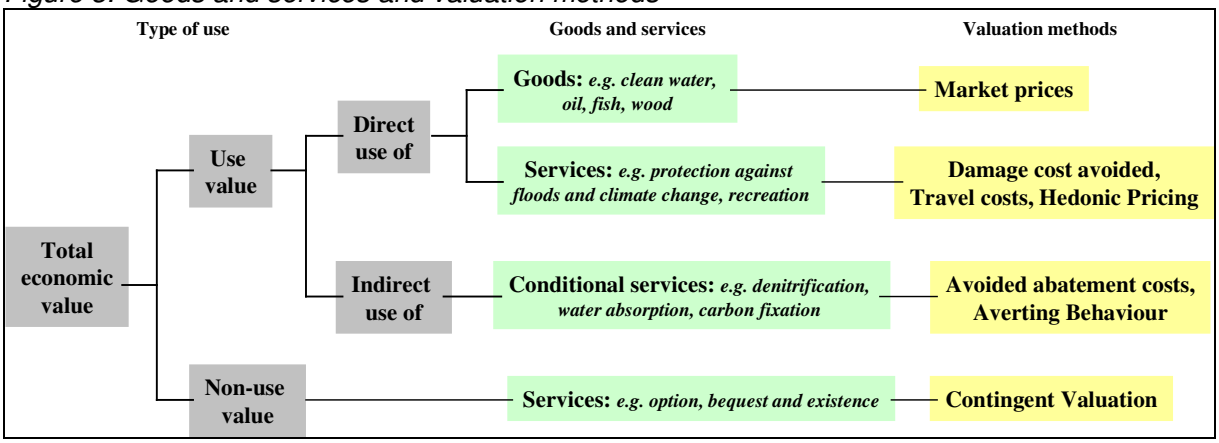
[5] An argument that is sometimes used in this case, is that we should value both the pollination and the food production, because the food is not valued adequately; the value of pollination is not included in the food value. This is of course another way of saying that the market value of the food does not reflect the true socio-economic value of the food. If that is the case one should determine the correct economic value of the food, and not try to value the pollination function. More over: the economic valuation of pollination depends of the welfare that we derive from it, and we derive welfare from it as it leads to food. So we need the correct value of food one way or the other.

[6] When there are two or more conditions to one good, one should choose between the good and the most limiting condition.

2.6. Different goods and services, different valuation methods

The various goods and services produced by our natural environment, can be monetarized by means of different valuation methods. Figure 3 indicates which valuation methods are appropriate for the economic valuation of certain goods and services.

Figure 3. Goods and services and valuation methods



Textbox 2 gives a brief description of the different economic valuation methods.

Textbox 2. Description of valuation methods

The Contingent Valuation Method (CVM)

CVM is a survey method in which respondents are asked how much they are willing to pay for the use or non-use of goods and services[7]. Their stated preferences are assumed to be contingent upon the alternative goods that are offered in a 'hypothetical market'. Essential elements of the survey are: description of the good or service that is to be valued, description of the payment vehicle and description of the hypothetical market. CVM is the only method that allows us to measure the non-use value.

The Travel Cost Method (TCM)

TCM relies on the assumption that the travel costs that people make to visit an area reflect the welfare they derive from it and thus its economic value. Travel costs are, however, related to distance. In order to determine the willingness to pay of visitors from various distances, distance circles are drawn in the service area of a site. The percentage of inhabitants of each circle that will visit the site at a fixed amount of travel cost per circle is determined by means of a survey. TCM can only be used to value the economic benefits from recreational services.

The Hedonic Pricing Method (HPM)

HPM is based on the idea that market goods are often traded at prices in which amenities of the natural environment are internalised. Therefore HPM derives the value of environmental services form market prices of e.g. houses or wages by means of a regression analysis. A regression equasion i.e. hedonic price function is formulated. For example: Value(house) = F(architecture, contents, environmental amenities, local taxes, noxious facilities, etc.). This function is used to calculate the willingness to pay for a marginal change in environmental amenities.

The Averting Behaviour Method (ABM)

ABM considers the expenditures made to avert or mitigate negative effects from a reduction of environmental qualities, as indication of how much welfare people derive from a healthy environment. The willingness to pay for a clean environment is deducted from people's purchases of products and services to avert the negative effects of pollution. For example, the value of no more ozone depletion is deducted from the purchase of products such as hats and suncream to prevent health damage.

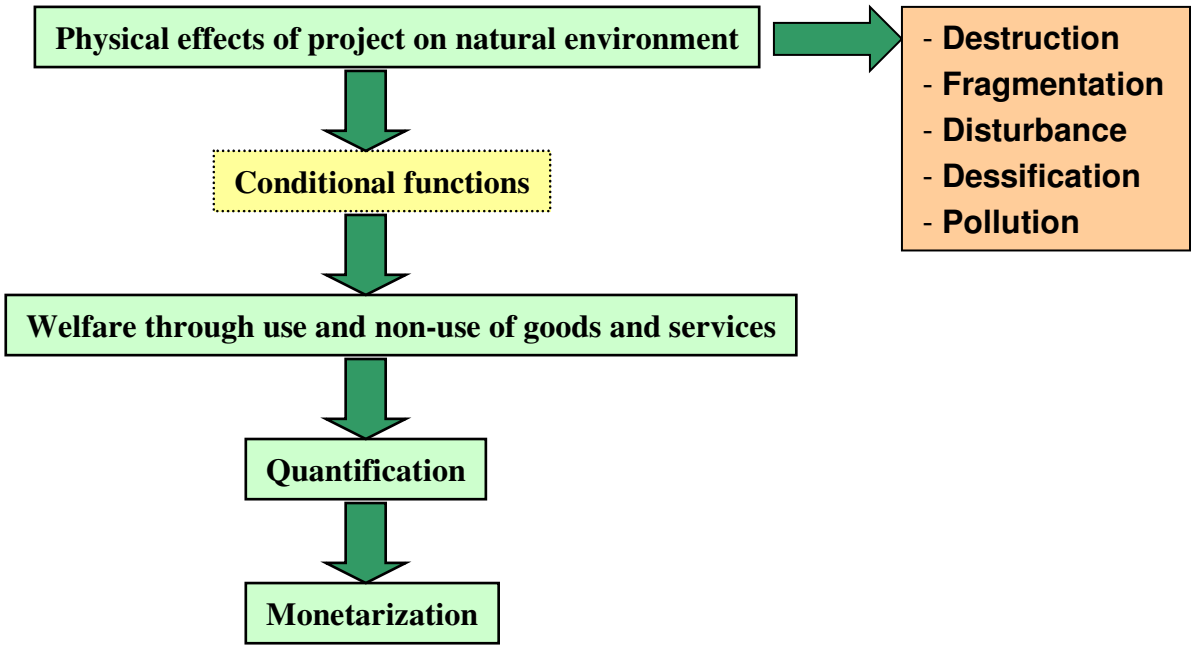
[7] Or what compensation they need to be given in order to accept not being able to use or losing a natural good (i.e. their willingness to accept).

Avoided costs methods (ACM)
ACM relies on the fact that many environmental services, such as nutrient purification (e.g. denitrification) and carbon fixation, avoid all kinds of costs in the future. Avoided costs may be damage costs of abatement costs. For example: nutrient purification of reed lands will avoid high water treatment costs and carbon fixation may prevent damage from climate change. ACM is mainly suited for the valuation of services and in particular of conditional functions.

2.7. Translating physical effects into welfare effects

In order to include the effects of projects on nature, water and soil in CBA, the Guideline presents an action plan to translate the physical impacts of a project into welfare effects. Figure 4 illustrates this action plan.

Figure 4. From physical impacts of EIA to welfare effects in CBA



In EIA at least five types of physical impacts are distinguished: (1) destruction/habitat loss, (2) fragmentation, (3) disturbance, (4) dessification, (5) pollution. Since CBA is a welfare analysis these physical impacts need to be translated into welfare effects. This is done by identifying the conditional ecosystems' functions that are affected by the physical change. After identifying the affected conditional functions, the goods and services that depend on those functions are looked up. For example, the EIA may report the fragmentation of nature due to a road cutting through the area. In order to determine the welfare effect of this impact, we need to determine which goods and services are affected by this. This is not easy to say. It becomes easier when we first determine which ecological conditions to the goods and services produced by the area are affected. E.g. if a conditional fish migration route is cut, most like the good ´fish production´ will be affected. Or, if e.g. the conditional sponge function of the soil is disturbed, most likely the service ´protection against flooding´ is affected.

The Guideline for Valuation of Nature Water and Soil provides tables with goods and services and their conditional functions as well as indications of whether destruction, fragmentation, disturbance, dessification or pollution is most likely to affect the condition. These tables are meant to help translate the impacts reported in the EIA into the welfare effects that we are looking for in CBA.

3. USE POSSIBILITIES OF THE GUIDELINE FOR THE VALUATION OF NATURE, WATER AND SOIL

In this section the requirements for a successful application of ecosystem valuation the political decision making arena as well as the use possibilities for decision makers.

3.1. Quicker and cheaper assessments by means of authorised values

The fact that ecosystem valuation studies hardly ever leave the university campus to enter the political arena may a.o. be attributed to two things: 1) a lack of methodology, and 2) a lack of authorised values for environmental goods and services.

With the launching of the Guideline for the ´Valuation of nature, water and soil´ the lack of methodology is no longer an issue. The Guideline provides an action plan on how to determine the welfare effects of the deterioration or amelioration of the natural environment, and how to value those so they can be incorporated into cost benefit analyses of various types of projects. Although the guideline provides some calculation examples, it does not provide values for the various goods and services that nature, water and soil generate for society.

In the political decision making process there is often little time and little budget. There is a need for quick and cheap assessments, compatible with the speed of the political decision making process. This means that there is neither time nor budget for lengthy studies. And unfortunately ecosystem valuation studies, especially when they entail empirical monetarisation research with methods like Contingent Valuation, Travel Cost or Hedonic Pricing, are known for their time and budget consumption.

A way to overcome the time and budget constraints of the political arena is to work with sets of authorised values for both the quantification and monetarisation of environmental goods and services. For some services such as carbon fixation and human health, internationally authorised values already exist. But for most goods and services there are no authorised values. In 2006 the Dutch Guideline will be accompanied by a handbook with authorised values for the various goods and service that nature, water and soil produce. In this handbook nature, water and soil will be classified in categories. E.g. nature is classified in the categories forest, grassland, reed land, heath, mudflats etc. Authorised values will be provided for both quantification (e.g. kg N purification per ha) and monetarisation (e.g. Euro per kg N purification).

Although authorised value may not always be applicable to local circumstances (empirical research may be required), the availability of values is important to ensure the inclusion of environmental values in CBA´s. It is the key to environmental values playing a role in actual political decision.

3.2. Application possibilities

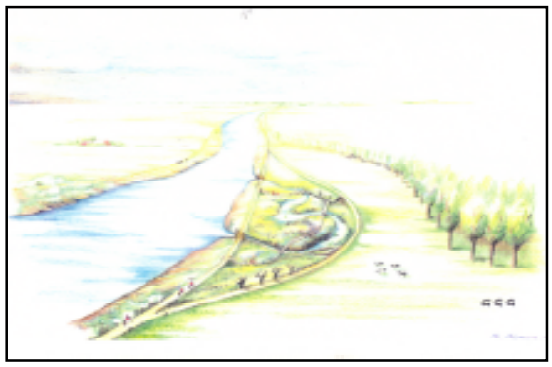
The Guideline for the ´Valuation of nature, water and soil´ is meant for physical projects in the fields of infrastructure (roads, railroads, harbour expansions), water quantity (flooding), water quality (European Water Framework Directive), drinking water, soil cleaning and housing (urban renewal). The guideline is meant to assess projects that cause damage to the environment as well as to assess investments in the natural environment.

The environmental goods and service that are included pertain to nature, water quantity, water quality, cultural heritage (archaeology, geography/landscape, built heritage), social and cultural qualities (e.g. social cohesion, creative classes).

3.3. Experience

The Guideline for the ´Valuation of nature, water and soil´ has been applied to various cases. The first application was a rail road. This exercise showed that the damage to nature due to the construction of a rail road amounted to approximately 5 % of the total investment costs.

Another application pertained to the national flood protection plan in Belgium. The government had to make a decision on whether to increase the height of the river dykes or to create large inundation areas in the river basin. Although the creation of higher dykes was much less expensive the ecosystems´ benefits of the creation of inundation areas turned out to surpass the additional costs. An recent application is the calculation of optimal water quality standards, on the basis of costs and benefits, in relation with the European Water Framework Directive. In this CBA the benefits of increased water quality are determined on the basis of a water system analysis.



Inundation: a reduced tidal area

Besides these several other applications, such as the CBA on the calcium levels in drinking water, the benefits of acidification abatement, the construction of nature friendly river banks, the ecological benefits of flexible groundwater levels and many more. All these experiences show that environmental benefits are large enough to influence the results of cost benefit analyses and thus political decisions.

3.4. Contact

For further inquiries on the Guideline for the Valuation of Nature, Water and Soil and or for ordering free copies the guideline itself or of publications on case study applications, you can contact the author:

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REFERENCES

Costanza, R. d'Arge, R., Groot, R., de, Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neil, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and M. van den Belt (1997). "The value of the worlds ecosystem services and natural captial", in: *Nature*, Vol. 387, 1997, pp. 253-260.

Freeman, A.M. (1986). ´On assessing the state of the art of the contingent valuation method for valuing environmental changes´, Chapter 10. In: Cummings, R.G., D.S. Brookshire and W.D.

Gren, I.M., C. Folke, K. Turner and I. Bateman (1994). ´Primary and secondary values of wetland ecosystems´, in: *Environmental and Resource Economics*, Vol. 4, pp. 55-74.

Groot, R.S. de (1992). *Functions of nature, Evaluation of nature in environmental planning, management and decision making*, Wolters Noordhoff, Groningen.

Hanley, N. and C.L. Spash (1997). *Cost benefit analysis and the environment*, Edward Elgar Publishing Limited, Hants.

Harms, W.B. (1973). *Oecologische natuurwaardering in het kader van de evaluatie van natuurfuncties,* Instituut voor Milieuvraagstukken, Amsterdam.

Holst, van, B., W.T.M. Molle, T.H. Botterweg, P.M. Blok, M. Koss, J.W. Meijer, G.R. Otten, R. Kattenwinkel and W.M. van Liefland (1978). *Een haven op het Balgzand? Een economische en ecologische afweging van de voor- en nadelen van een beperkte zeehavenontwikkeling ten behoeve van Den Helder*, Stichting het Nederlands Economisch Instituut/Rijksinstituut voor Natuurbeheer, Rotterdam/Arnhem.

Maarel, E, van der en P.L. Dauvellier (1978). *Naar een globaal ecologisch model voor de ruimtelijke ontwikkeling van Nederland*, Staatsuitgeverij, Den Haag.

Pearce, D.W. and D. Moran (1994). *The economic value of biodiversity.* Earthscan Publications, London.

Ruijgrok, E.C.M. (1999), *Valuation of nature in coastal zones*, Phd-thesis, Elinkwijk bv., Utrecht, pp. 235.

Ruijgrok, E.C.M., R. Brouwer, H. Verbruggen, R. de Groot and E.J. Bos (2004). *Waardering van natuur, water en bodem in Maatschappelijke Kosten Baten Analyses; een handreiking ter aanvulling op de OEI-leidraad,* Witteveen+Bos, Rotterdam.