Economic Evaluation, Land/Water Use, and Sustainable Nature Conservation of "De Vechtstreek" Wetlands

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Abstract

Elements of an integrated analysis of a land/water use and nature conservation in "De Vechtstreek" area are presented. This is a river plane composed of patches of lakes and polders, in the centre of The Netherlands. The attention is focused on the economic dimensions of the research. To this end, an overview is given of available information for a set of main wetland function and use categories. This includes estimates of costs and benefits associated with particular activities. These are used in an illustrative cost-benefit analysis of a change to more nature conservation in "De Vechtstreek". The method makes use of the assumption that there are fixed relationships between land/water use area size and values. It is concluded that the nature conservation is a rational economic strategy for discount rates below 13% for a time horizon of 10 years, up to 18% for an infinite time horizon. The approach is aimed to be applied to other scenarios than nature conservation as well, in which case integration with nature science information and models will be pursued, as well as estimation of benefits transfer functions.

1. Introduction

This paper presents information on the economists' contribution to a Dutch multidisciplinary study of the "Vechtstreek", a region that is dominated by the presence of wetland ecosystems. The Vechtstreek is the plain area of the Vecht river in the centre of the Netherlands. The northern half of the Vechtstreek is part of the province of Noord-Holland, while the southern half is part of the province of Utrecht. On the western side the area is bordered by the Amsterdam-Rhine canal and the Vecht river, and on the eastern site by an area called "het Gooi". The Vechtstreek covers about 8 by 20 km with wetlands, including small lakes, streams and fen-grassland patches, which have created characteristic flora and fauna, as well as a high biological diversity. The history of the earea in the last centuries has been a unique combination of natural and economic processes, dominated by peat extraction, erosion of small pools in larger lakes, and recovering of land via drainage and regulation of water tables. The appreciation of the natural features of the Vechtstreek is indicated by the fact that the area has the highest concentration of regional nature conservation organisations in the Netherlands (Pyttersen's Nederlandse Almanak 96-97, 1996). The high value of nature in this area is also reflected in it being part of the "Ecological Main Structure" of the Netherlands, and in the Vecht river belonging to the "Netherlands Blue Axis" ("Nederland Waterland").

The Vechtstreek is characterised by a particular hydrological pattern. Groundwater flows from the higher located "Utrechtse Heuvelrug" area through the "Gooi" area into the lower located valley of the Vechtstreek. A sustainable natural system of wetlands and typical vegetation is based on "high quality" groundwater flowing into the wetlands, i.e. water poor of nutrients. The functions and structure of the wetlands are threatened by keeping water levels in polders in the area low, as well as by subtracting groundwater for drinking water purposes. Moreover, to sustain the waterlevel in the wetlands, polluted water from the Vecht river is led into them, causing eutrophication. As a consequence, the area's biodiversity is at risk. To conserve the area nature characteristics and biodiversity, initiatives are taken by the provinces of Noord-Holland and Utrecht to protect the area from further deterioration. These initiatives are entailed in a nature conservation project that will be studied in this paper.

The broader study of which the present analysis is part, is aimed at an integrated study of scenarios for combined economic development and nature conservation of the Vechtstreek. The approach is aimed to be applied to a number of different scenarios, which means moving away from the present situation of land/water use. Therefore, integration with nature science information and models will be pursued, as well as estimation of benefits transfer functions. This part of the research is still under progress. It consists of five main inputs or modules. A hydrological GIS model based on a spatially disaggregated data base is used to statistically predict water quality and quantity patterns in the area, given spatial characteristics of water quality and quantity management and unintended influences. A non-spatial ecological model, applicable to every point in space, is used for statistical prediction of "equilibrium vegetation" given a number of abiotic parameters. An economic model consists of valuation functions, relating activities to land/water use patterns and hydrological and ecological parameters, notably in resource based activities like recreation and nature conservation. A selected number of scenarios will be examined based on these interlinked models. Although each scenario will focus on representing a particular land/water use pattern, it may also include specific environmental management decisions by water boards and municipalities in the area, or conditions external to the region. However, the future analysis is aimed to mainly consider land/water use alternatives. The approach will be completed by an evaluation of the selected scenarios, based on a set of criteria reflecting economic efficiency, ecological/biodiversity and spatial and economic equity. Both cost-benefit and multi-criteria analysis will be applied for this purpose. The present paper will mainly focus on cost-benefit analysis in relation to a land/water use pattern consistent with sustainable nature conservation. More details on the overall study can be found in Turner *et al.* (1997), and more information on the area in Barendregt *et al.* (1992).

The main goal of this paper is to perform an illustrative cost-benefit analysis of the nature conservation scenario/project. First, a framework is presented to link the functions, use categories, benfits and costs for the area under consideration. Next, an overview is given of available information for a set of main wetland function and use categories in the area. This includes estimates of costs and benefits associated with particular activities, based on a range of approaches, including actual values and opportunity costs. These are used in an illustrative cost-benefit analysis of a change to more nature conservation in “De Vechtstreek”. The method makes use of the assumption that there are fixed relationships between land/water use area size (including vegetation cover) and values. Costs of acquiring and restoring areas, and the costs of sanitation of the river Vecht and the Vecht lakes will be accounted for as investment costs. It is assumed that the nature conservation project reflects sustainable land use and cover in the area.

The organisation of the remainder of this paper is as follows. Section 2 presents a framework for analysis, based on wetland functions, and a categorisation of costs and benefits of (economic) activities associated with these functions. Next, the relation of this framework with the nature conservation project will be presented. . The scenario/project will be described in more detail in Sections 2 and 3.2. Section 3 discusses basic information, focused on economic values, related to particular activities and the scenario/project considered. Section 3.1 links activities (uses) to values, as well as to functions and costs. Section 3.2 to 3.4 offers a discussion of basic data on economic indicators for costs and benefits of various wetland functions under the nature conservation scenario/project, for three activities regarded to be most affected by this scenario/project: nature conservation, nature recreation and agriculture. Next, in Section 4, impact modelling of a change in land use and cover is examed. Section 5 offers an illustrative evaluation exercise based on a dynamic cost benefit analysis. Section 6 concludes with indicating fundamental problems, ways to proceed, and a wider discussion of valuation against the background of biodiversity.

2. Framework for economic analysis

The general framework is a slightly adapted and more detailed version of the ecosystem valuation/evaluation framework in which functions and values are combined. Figure 1 shows the framework upon which the economic analysis builds. As opposed to other environmental valuation and evaluation problems, such as related to air pollution in cities, here a system approach is required that pays due account to hydrological and ecological processes, spatial structure and nature functions. Barbier (1994), Gren *et al.* (1994) and Turner (1995) have discussed functions in relation to costs and benefits in the context of a total valuation of wetlands. The first step in evaluating the value of wetlands in the Vechtstreek is to identify those wetland functions which are relevant for present or future costs and benefits. We will estimate the economic value of a wetland by valuing these wetland functions. Extensive, general lists of functions of the natural environment are offered by De Groot (1992) and Turner (1988).

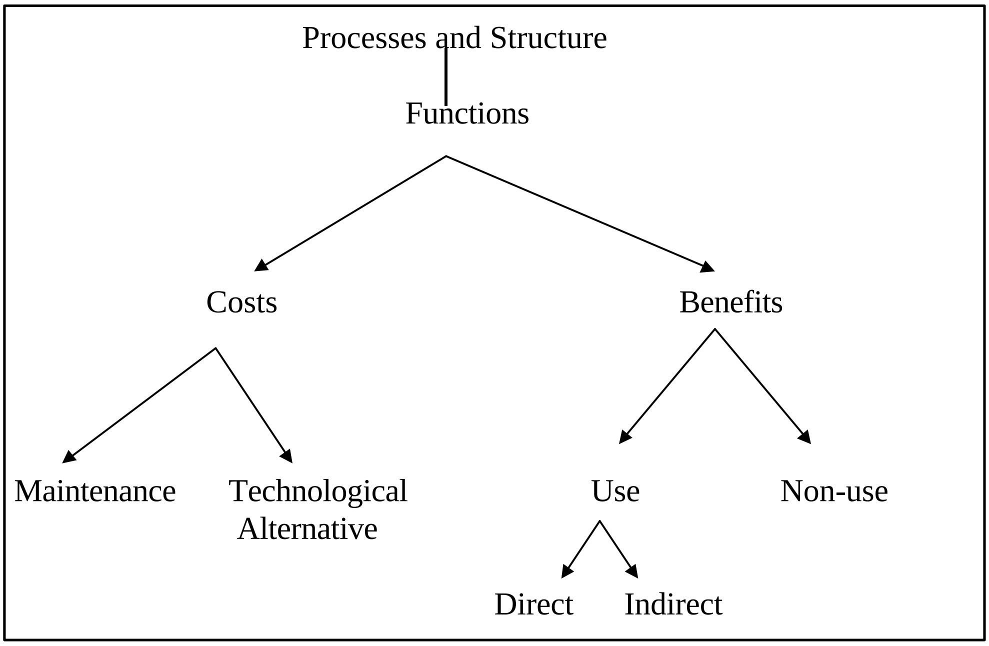

Figure 1. Framework for the economic analysis of wetland ecosystems

For the present study case area, wetland functions are categorised as follows:

1. Regulation functions.

a. Regulation of runoff and flood prevention
b. Watercatchment and groundwater recharge
c. Storage and recycling of organic matter
d. Storage and recycling of nutrients
e. Storage and recycling of human waste
f. Maintaining biodiversity

2. Carrier functions

a. Provision of space
b. Cultivation

3. Production functions

a. Provision of water
b. Provision of fuel and energy

4. Information functions

a. Provision of aesthetic information
b. Provision of historic information
c. Provision of cultural and artistic inspiration

Further on, as we identify economic activities that will change in scale because of the nature conservation project, we will relate these function to activities.

Subsequently, an assessment is made of the costs and benefits associated with each of these wetland functions. Thereto we distinguish between the following costs:

1. Continuous costs associated with maintaining one or more wetland functions
These costs concern regular conservation costs, aimed to ensure sustainable use of the wetland functions.

2. Investment costs:
(a). Investment costs associated with maintaining one or more wetland functions. These costs can be further categorised into the costs of acquiring areas and the costs of restoring them.
(b). Investment costs to ensure sustainable use of a wetland function. These costs have to be made because wetland functions like "storage and recycling of human waste" are subject to very intensive use (see De Groot, 1992). Examples are the costs of sanitation of the riverbed of the Vecht and the costs of reducing phosphate concentration of the water in the Vecht lakes.

3. The *opportunity costs* of forgone alternative land use and cover
This is the highest value of alternative use of a function. A special type of opportunity costs is addressed by Krutilla and Fisher (1975), who consider lost future values of nature (option and quasi-option value, bequest value and nonuse values) due to irreversibility of land use changes. Lost benefits of nature conservation are therefore included as opportunity costs of land development (for a clear account, see Porter, 1982). However, in our case study irreversibility is for the moment not emphasised, since we focus on a sustainable nature conservation project. Therefore an ordinary CBA evaluation will be performed.

We distinguish between the following benefits:

1. *Actual benefits*, generated by a wetland function

The benefits generated by wetland functions can be categorised in use benefits and nonuse benefits (see Turner, 1988). Use benefits can be further split up in direct use benefits, indirect use benefits and option benefits. Estimating benefits of uses is not so straightforward as estimating costs of maintenance of functions. Following Barbier (1994), direct use benefits have been derived from direct use or interaction with a wetlands' resources and services, and can be valued by market analysis based on the travel costs method, and non-market valuation based on the contingent valuation method (see Turner, 1995). Consumptive uses can often be valued via market based methods. Indirect use benefits reflect the indirect support and protection provided by wetlands' functions and can, among others, be valued by means of estimating the costs of replacing these functions by human made technology (see Gren *et al.*, 1994). Nonuse benefits can only be valued by means of non-market valuation methods.

2. Benefits which are associated with future values

Future values remain an unresolved issue. First consider the use benefits option value and quasi option value. Option value reflects the uncertainty of individuals about their future demand of goods and services depending on wetland functions, while quasi option value reflects the value of preserving options for future use given some expectation of the the change in information or knowledge. Second, consider (anthropocentric) nonuse benefits. These reflect individuals' knowledge and appreciation of the wetland being maintained, provided they do not have any intention of using the wetland in any way (existence value). Alternatively, if the appreciation extends to future generations mainly, then the term bequest value is used.

3. *Costs of replacing a wetland function*

Assessment of these costs can serve as an indicator of a lower bound on the economic value of the associated wetland function. It will be included *as benefits* in the cost-benefit analysis. An example of estimating the economic value of a wetland by the costs of replacing its functions by human technology can be found in Gren *et al.* (1994). One of the problems of this approach is that such replacement only represents a partial substitute for the wetland, since it can not replace general ecosystem functions like climate regulation and the maintenance of the stock of biological resources.

The actual functions, costs and benefits which are relevant for our study case area are summarised in Table 1.

Now that we have derived a framework for our economic analysis, its relation with the nature conservation scenario or project is explained. Note that the term “project” more clearly indicates the change that the valuation/evaluation aims at. Indeed, as the land/water use and land cover induces changes in the present situation, it can be interpreted as an investment project which is aimed to contribute to a situation of sustainable nature conservation. The changes concern land/water use and land cover, and imply an enlargement of the surface area of the wetland ecosystems in the area. The investment costs cover acquiring and restoration of areas, and the sanitation of the river Vecht and the Vecht lakes. The change in land/water use and land cover also induces changes in costs of maintaining wetland functions and changes in costs to ensure sustainable use of a wetland function. In addition, they induce changes in benefits derived from wetland functions.

In this initial stage we assume a linear relation between the surface area of a wetland ecosystem, and the (marginal) benefits derived from (changes in) wetland functions and uses. This means, for instance, that the net benefits of the activity “nature based recreation”, are assumed to increase in proportion with the enlargement of the wetland area. Furthermore, it means that the benefits of regulation functions, estimated by costs of replacing them by human made technology, are also supposed to increase in proportion with the enlargement of the wetland area. This relates in particular to protection against storm and flooding and wetlands acting as nutrient sinks.

The next step is to identify those activities that will change in scale because of the enlargement of the wetland surface area. Economic activities are included, which

- change in scale because of the impact that the nature conservation project has on these activities, i.e. nature conservation, nature based recreation and agriculture.
- can potentially replace regulation functions of the wetland-ecosystem. These activities concern the replacement by human made technology. While the project

induces changes in the scale of regulation functions, the costs of replacing these functions by human made technology also change.

The valuation her focuses on the sectors “Nature conservation”, “Nature based recreation” and “Agriculture”, and is therefore not entirely complete. However, these activities and related values are expected to be most strongly affected by the scenario/project considered. Moving from the present land use and cover to the nature conservation project means that the land use of certain areas will change from agriculture to nature conservation (see Section 3.2). These changes in land use induce changes in the activities nature conservation, nature based recreation and agriculture. The impact of the land use changes on costs and benefits of other activities or sectors and associated values is assumed negligible. This means that activities like drinking water abstraction, infrastructure, housing, local economic services and industry and public services will not be included in the CBA. It might be part of future research to develop an I-O model which includes all these activities, in order to verify whether our assumption is correct. The idea is that all the activities are interactively determined, and any change in one of them will affect the others, and therefor the total indirect value of the wetland. Thus, an assessment of the multiplier effects of differential scenarios relative to the present situation is feasible. A quantitative I-O table can be constructed in the following ways: (i) gathering data on I-O relations in the region; (ii) “transferring” information about I-O relations in other regions; (iii) breaking down I-O tables for The Netherlands or the two provinces of Noord-Holland and Utrecht. This is an item for future research.

3. Economic activities and values

3.1 Activities, benefits, functions and costs for De Vechtstreek

In this section functions are related to the activities, and available data and estimates for all relevant activities are presented. The activities examined are: nature conservation, nature based recreation and agriculture. Table 1 includes a preliminary classification of relevant value categories per activity (see Brouwer *et al*., 1997 and Gren *et al*. 1994), and an indication of the uncertainty involved in the quantitative assessment of each. "Indirect values" refers to off-site values or to values related to on-site activities that interact with resource-based on-site activities, where the latter generate direct use values.

The activity “nature conservation” is related to all included regulation functions (see De Groot, 1992). That is, the increment in scale of the activity “nature conservation” implies an increment in scale of these regulation functions. The costs associated with these functions are the continuous costs and investment costs associated with maintaining these functions. The benefits of nature conservation can be estimated via stated preference by means of non-market valuation methods (see Barbier, 1994). The associated benefit categories are non-use value and use value.

The activity “nature based recreation” uses the wetland information functions “provision of aesthetic information” and “provision of cultural and artistic information”, the wetland production function “provision of water”, the wetland regulation function “maintenance of biodiversity” and the wetland carrier function “provision of space” (see De Groot, 1992). The sum of net recreational benefits has been derived, as well as a preliminary assessment of consumer surplus. The associated benefit category is use value.

The activity “agriculture” uses the wetland carrier function “cultivation”, the production functions “water” and “fuel and energy” and the regulation function “recycling of organic matter” (see De Groot, 1992). The value added based on these functions is estimated via market-analysis of the agriculture in the area. The associated benefit category is use value.

Table 1. Categorization of activities, benefits, functions and costs for De Vechtstreek

Human Activity/ Service	*Benefits associated with the wetland function(s)*	*Based on wetland function*	*Costs associated with the wetland function(s)*	*General estimation method / uncertainty indication*	*Available information for this study*
1. Nature conservation	Non-use value and use value *Sub-categories*: Bequest value, existence value and (quasi) option value	Regulation functions (**a, b, c, d, e** , **f**)	Continuous costs and investment costs associated with maintaining these functions	Benefits estimated via stated preference by means of non-market valuation methods	Actual maintenance costs (continuous and investment)
2. *Nature based recreation*	Use value *Sub-categories*: Direct use value, indirect use value and option value	Information functions (**a, c**), Production function (**a**), Regulation function (**f**), Carrier function (**a**)		Sum of net recreational benefits (estimated by market analysis), and value added derived from consumer surplus (by non-market valuation)	Net benefits of recreation related activities, and a preliminary assessment of consumer surplus
3. Agriculture	Use value *Sub-categories*: Direct use value based on market analysis	Regulation function (**c**), Carrier function (**b**), Production functions (**a, b**)		Value added estimated via market-analysis by the value added of the agriculture in the area (reliable)	For all the polders the value added based on the surface of agricultural land has been estimated
4. *Replacing the wetland function by human made technology i to provide protection against storm and flooding*	Use value *Sub-categories*: Indirect use value and quasi option value	Regulation function (**a**)	Costs of replacing a wetland function by human made technology	Costs of replacement technology (uncertain)	
5. Replacing these wetland functions by human made technology to provide nutrient sink	Use value *Sub-categories*: Indirect use value and quasi option value	Regulation functions (**c, d**) Regulation function (**e**)	Costs of replacing function by human made technology Maintenance costs associated with compensating for unsustainable use of functions (sanitation of the bottom of the river Vecht, reducing the phosphate concentration in the Vecht lakes).	Costs of replacement technology serve to indicate value added of the associated wetland function (uncertain)	

Human made technologies which can potentially replace regulation functions of the wetland ecosystem under the nature conservation project are technologies that provide “protection against storm and flooding”, and technologies that provide “nutrient sink” services. The increment in costs of replacing a wetland function by human made technology is induced by the increased scale of the wetland function that results from the nature conservation scenario/project. This increment in costs serves to indicate the value added of the change in scale of the corresponding wetland function. As Gren *et al.* (1994) indicate, these replacement costs seems to underestimate the true value of the wetland function. The associated benefit category is use value.

Technologies that provide “protection against storm and flooding” are related to the wetland regulation function “runoff and flood prevention” (see De Groot, 1992). Technologies that provide “nutrient sink” are related to the wetland regulation function “storage and recycling of organic matter”, “storage and recycling of nutrients” and “storage and recycling of human waste” (see De Groot, 1992).

Finally, the sanitation of the bottom of the river Vecht and the of reducing the phosphate concentration in the Vecht lakes takes place in order to ensure a sustainable use of the regulation function “storage and recycling of human waste”. These activities have to be undertaken because of an overuse of this regulation function in the past. The associated costs of these will be interpreted as investment costs of the nature conservation project. The associated benefit categories are quasi option value and indirect use value.

Notice here the potential problem of double counting. Because separate economic activities may use, or be based on the same function(s) generated by the wetland ecosystems of the Vechtstreek, valuation of each separately may create double counting of benefits. For instance, the activity “agriculture” uses the regulation function “storage and recycling of organic matter”. The activity “replacing wetlands functions by human made technology to provide nutrient sink” is also based on the regulation function “storage and recycling of organic matter”. This means that the value added associated with this function is estimated both by the value added of agriculture and by the value added based on the costs of replacement technologies. How can we deal with the problem of double counting of benefits? An option would be to omit certain estimated benefits in order to make sure that the benefits associated with a particular wetland function are counted only once. A disadvantage of this option is that by omitting certain estimated benefits, the remaining sum of benefits may underestimate the total value associated with a particular wetland function.

3.2 Nature conservation

3.2.1 Introduction

Nature conservation applies to almost half of the study area, and is aimed at preservation of habitats of species, and maintenance of biodiversity and landscape values. The study case area comprises nature reserves and pasture land. This alternation of nature and agriculture creates an attractive landscape, appreciated by many people that live or recreate in the area. As a result, a great number of functions and uses are combined in this area: pasture lands with breeding and wading birds; recreation in nature reserves; water based recreation on lakes and rivers. In other words, the area is characterised by multiple functions, multiple use of ecosystems, sometimes at the same spot, and - inevitably related to this - conflicts between uses. In particular, many uses have led to fragmentation of the nature areas. In order to minimize this type of problem nature conservation organisations buy and restore additional areas and connected with existing ones. These activities induce changes in the present situation, and will be interpreted as part of an investment project which is aimed to contribute to a situation of sustainable nature conservation. The associated investment costs are the costs of acquiring and restoring areas, and the costs of sanitation of the Vecht river and the Vecht lakes. The changes concern land use and cover, and enlarge the surface area of the wetland ecosystem. The change in land use and cover induces changes in benefits associated with wetland functions. The benefits of nature conservation can be estimated via stated preference by means of non-market valuation methods using value transfer. This will be part of future research. The change in land use and cover also induces changes in costs of maintaining wetland functions. In this subsection, various costs of conserving nature areas, restoring nature areas, and santitation of the Vecht river and the Vecht lakes, which are all associated with the nature conservation project, will be presented.

In order to estimate conservation costs, the Vechtstreek area has been disaggregated into 48 areas. This spatial disaggregation is based on current or future (planned) ownership of areas by the two main nature conservation organisations in the region, "Natuurmonumenten" and "Staatsbosbeheer". Conservation costs are estimated for areas which are already in ownership of one of the two nature conserving organisations. In addition, costs of future conservation and costs of acquiring these areas have been estimated for areas which are nominated for ownership of these organisations. The three categories of areas are listed in Table 2; the areas which are located in the province of Utrecht form the National Ecological Structure (Ecological Main Structure) of the province.

Currently, these areas are either privately owned, in ownership of a municipality, or owned by a nature conservation organisation - e.g., "Het Utrechts Landschap" or some other foundation. Because the nominated areas in the province of Utrecht are already under conservation, there is no reason for restoration once they are acquired ("Plan Veiligstelling Gebieden", 1996).

In the province of Noord-Holland, various agriculture areas will be acquired and developed as nature areas. When acquiring and nature development is completed (probably in 2010), these areas will be handed over to the nature conservation organisations. Estimating the costs of conservation will not be undertaken, because regular conservation of nature in these areas will not be in place in the near future. For both provinces, costs of acquiring is financed by national and regional authorities (each 50%).

There are also plans to restore the Vecht river and costs of these plans have been estimated ("Restauratieplan Vecht 1996-2015", 1996). The restoration plan covers the provinces of Noord-Holland and Utrecht and includes improvement of water quality, ecology and banks; sanitation of the bottom of the river; and improvement of water quantity management. Municipalities, district water boards and other organisations of both provinces are involved in this plan. Its realisation will many take years, and is estimated to be finalised in 2015. During this period, regular management of the Vecht river will not be in place. Therefore, costs of regular conservation of the river will not be included.

Finally, the Vechtstreek includes several lakes which need restoration and regular conservation. The lakes are located in the provinces of Noord-Holland and Utrecht. The main activities concerning restoration and conservation are dredging, draining and reducing the concentration of phosphate. The costs associated with these activities have been estimated by the district water board "Amstel, Gooi en Vecht".

3.2.2 Costs of conserving nature areas

To estimate the costs of nature conservation, information has been gathered about the costs of conserving measures for a variety of vegetation types. This information is combined with the information on the actual vegetation at the respective nature areas to arrive at an estimation of the costs of conserving the respective nature areas. The conservation costs per nature area are estimated for 48 nature areas in total. In Table 2 these are categorised according to area ownership.

Table 2. Estimated costs of conservation of nature areas in the Vechtstreek

Ownership nature conservation organisation	Number of areas	Total surface (in hectares)	Conservation costs (in Dutch guilders)
"Natuurmonumenten"	24	3884	Dfl 4,834,639.-
"Staatsbosbeheer"	5	499	Dfl 658,856.-
Nominated	19	2974	Dfl 2,131,784.-
TOTAL	48	7357	Dfl 7,625,279.-

Source: Own estimates

An important problem is that the conservation costs for the areas owned by each of the two nature conservation organisations are not available. Natuurmonumenten has presented some information on areas which are included in the Vechtstreek.[1] Their conservation costs per hectare are in a range of 30% to 64.3 % of the estimates in Table 2.

The conservation costs for the respective areas are estimated by using information concerning:

1. the vegetation descriptions of the respective areas (cf. "Handboek Natuurmunumenten", 1996);
2. the advised conservation of particular vegetation types (cf. "Normenboek Staatsbosbeheer", 1996; "Landschapsbeheer Noord-Holland", 1997; "Plan Veiligstelling Gebieden", 1996);
3. the costs associated with the respective types of conservation ("Landschapsbeheer Noord-Holland", 1997; "Plan Veiligstelling Gebieden", 1996).

Using these sources, the costs of conservation of particular vegetation types are known. Combining this knowledge with the vegetation descriptions of the respective areas, we arrive at the yearly conservation costs per area. The costs of conservation of the nominated areas (i.e. Dfl 2,131,784.-) will be included in the CBA, because it reflects the change in conservation costs due to the nature conservation project.

The total costs of acquiring the 19 nominated areas are Dfl 111.850.000,-. These costs will be included in the CBA as part of the investment costs of the nature conservation project. These costs are calculated as follows. Of the nominated areas 1681 hectares are presently agriculture land. The costs of acquiring these are Dfl 55.000,- per hectare. The remaining 1.293 hectares are covered by forests. The costs of acquiring these areas is Dfl 15.000,- per hectare (source: Province of Utrecht).

3.2.3 Costs of restoring nature areas

The costs of acquiring areas and of stimulating particular vegetation for the province of Noord-Holland are listed in Table 3. They concern the following areas:

- “Horstermeerpolder” (250 hectares). Nature-development is planned for this area.
- “Spiegelpolder” (20 hectares), and “Nieuwe Keverdijkse Polder” and “Zuiderpolder” (130 hectares). These areas are also planned to become nature-development areas.
- “Gemeenschapspolder-Oost” (140 hectares) and “Aetseveldsche Polder” (100 hectares). These are planned as forest and recreational areas.

Although the costs of acquiring these areas and of stimulating particular vegetation are available (see Provincie Noord-Holland, 1995), some adjustments were made to arrive at figures for the Vechtstreek. Table 3 summarizes costs of acquiring areas and of stimulating particular vegetation.

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[1] These areas cover 7% of the total surface of nature areas in the Vechtstreek.

Table 3. Costs of restoring nature areas

Restoring activity	Costs (in Dutch guilders)
Acquiring areas	Dfl 29.429.299,20
Vegetation creation	Dfl 32.979.958,09
TOTAL	Dfl 62.409.257,29

Source: Province of Noord-Holland

These costs will be included in the CBA as part of the investment costs of the nature conservation project.

3.2.4 Costs of restoring the river Vecht

Restoring the river Vecht will involve the following three phases (cf. "Restauratieplan Vecht", 1996):

1. 1996-2000 applies mainly to banks, ecology and water quantity;
2. 2001-2010 applies mainly to water quality;
3. 2011-2015 applies mainly to the sanitation of the bottom of the river Vecht.

The first two phases apply to the improvement of the ecological function of water and banks, and the improvement of the infrastructure of the river Vecht. The respective costs for each phase of restoration are summarised in Table 4.

Table 4. Costs of restoring the river Vecht for each phase

Restoration activity	Time schedule	Investment costs × 1000 (in Dutch guilders)
Regulation	1996-2000	Dfl 233.59
Banks and ecology	1996-2000	Dfl 15,926.63
Water quantity	1996-2000	Dfl 1,592.66
Water quality	2001-2010	Dfl 30,271.14
Bottom of the river	2010-2015	Dfl 166,167.41
TOTAL		Dfl 214,191.43

Source: Restauratieplan Vecht (1996)

These costs will be included in the CBA as part of the investment costs of the nature conservation project.

3.2.5 Costs of restoring and conserving lakes

The costs associated with restoration and conservation are available for the lakes: Naardermeer (the lake of Naarden), Ankeveense plassen (the lakes of Ankeveen), Kortenhoefse plassen (the lakes of Kortenhoef) and Loosdrechtse plassen (the lakes of Loosdrecht): see Table 5. The costs of restoration and conservation have been

Table 5. Costs of restoring and conserving the lakes Naardermeer, Ankeveense plassen, Kortenhoefse plassen and Loosdrechtse plassen

Lake	Set up costs (in Dutch guilders)	Continuous costs (in Dutch guilders)
Naarderneer:		
reducing phosphate concentration		Dfl 200,000.-
dredging	Dfl 4,000,000.-	Dfl 12,500.-
draining		Dfl 25.000,-
monitoring water quality		Dfl 15,000.-
conservation of water ways		Dfl 12,500.-
Ankeveense plassen:		
dredging	Dfl 1,550,000.-	Dfl 5,000.-
draining		Dfl 35,000.-
conservation of water ways		Dfl 8,000.-
research	Dfl 175,000.-	
active biological conservation	Dfl 190,000.-	
monitoring water quality		Dfl 75,000.-
Kortenhoefse plassen:		
draining	Dfl 7,000,000.-	Dfl 45,000.-
conservation of water ways		Dfl 28,000.-
research	Dfl 175,000.-	
Loosdrechtse plassen:		
draining and reducing phosphate concentration		Dfl 200,000.-
TOTAL	Dfl 13,090,000.-	Dfl 661,000.-

Source: District Water Board “Amstel, Gooi en Vecht”.

classified in set up costs and continuous costs. The set up costs will be included in the CBA as part of the investment costs of the nature conservation project. Note that dredging and draining concern regular conservation and restoration. That is, if the bottom of a lake is severely polluted it has to be rigorously dredged before regular dredging can be started. In addition, restoration or acquisition of draining machines might be needed to improve regular draining.[2]

3.3 Nature based recreation

3.3.1 Introduction

A preliminary valuation of the recreational function of the Vechtstreek has been derived by estimating total revenues in the recreational sector and total spendings on recreation. In addition, value transfer has been used to come with alternative estimates of values, which are also very preliminary (Walsh *et al.*, 1992).

Estimation of total spendings on recreation allows to check the reliability of the total revenues estimate. Furthermore, an assessment of net recreational benefits will be derived from total revenues.

An entirely different approach for valuing recreation is value or benefit transfer. By applying value transfer, a preliminary estimate of consumer surplus from recreation has been derived.

3.3.2 Total spending on recreation

In estimating the total recreational spending a distinction has been made between daytrips, short vacations and long vacations. A daytrip concerns activities like biking or fishing during at least two hours, and is mainly undertaken by the people living in the area. A list of all activities that are accounted for as daytrips in the Vechtstreek is the following (CBS, 1997): Camping, picnicking, swimming, sightseeing and off-road driving, motorized and nonmotorized boating, hiking, winter sports, fishing, and other recreational activities.

The mean yearly spending during daytrips per individual was estimated by taking the mean number of daytrips which a person undertakes in a year together with the mean spending during a daytrip. Multiplying this by the average number of daytrips undertaken in the area over a year gives as an estimate of total yearly spending on daytrips: Dfl 479.956.688,-.

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[2] The set up costs are associated with activities which are undertaken recently, or which will be undertaken in the near future.

Following the CBS-definitions, a short vacation has a mean duration of 3.1 days and a long vacation 10.4 days (CBS, 1996a). For both types of vacation the mean spending per individual is known. The total number of both forms of vacation during a year is not available for the Vechtstreek per se, and has been calculated using statistics of the areas: "Hollands-Utrechts merengebied" and "Utrechtse Heuvelrug en 't Gooi".[3] Doing so, the following value for yearly spendings on short vacations in the Vechtstreek was derived: Dfl 20,392,695.-. In a similar way, the spending on long vacations in the Vechtstreek during a year was estimated as Dfl 38,868,838.-.

These data are both lower limits, because in the calculations only 16 of the 20 relevant municipalities could be included. The reason for this is that the remaining four municipalities where not included in the areas "Hollands-Utrechts merengebied" and "Utrechtse Heuvelrug en 't Gooi". We can conclude that spending on recreation in the Vechtstreek depends on a large extend on daytrips, most of which is undertaken by people living in the area. Because spending on daytrips, spending on short vacations and spending on long vacations are strictly separated in both our estimations and in the sources used, the spendings on each type of recreation can be added to arrive at a total spendings figure for recreation in the Vechtstreek, namely Dfl 539,218,421.-.

3.3.3 Total revenues of recreation related activities

Estimated revenues of activities related to recreation (such as hotels and restaurants) are presented here. Estimations on the number firms in the area are available. This information has been used to calculate the gross revenue for 1996 as Dfl 677,812,000.-. According CBS (1995) revenues of activities related to recreation in the Netherlands yields mean net benefits of 12.7%. Applying this to the gross revenue yields a net benefit of Dfl 86,082,124.-. Because multiplier effects are not included, this should be interpretated as a lower estimate. When performing scenario analysis, multiplier effects of differential scenarios relative to the present situation will be estimated.

As mentioned in Section 2, we assume a linear relation between the surface area of a wetland ecosystem, and the benefits derived from wetland functions. So, the net benefits of recreation are assumed to increase in proportion with the enlargement

[3] Both of these areas are partly included in the "Vechtstreek". The statistics for these areas have been

of the wetland area. This means that the enlargement of the wetland area implies an increase in net recreational benefits of Dfl 34,797,912.-. This has been derived by multiplying the net recreational benefits (Dfl 86,082,124.-) with the proportional increment of the wetland area (2974 \ 7357; see Table 2). This will be included in the CBA as part of the increment of benefits due to the nature conservation project.

3.3.4 Valuing recreational daytrips by means of value-transfer

To assess the consumer surplus for recreation in the Vechtstreek, we follow an entirely different approach. That is, we estimate the value of daytrips by means of benefit or value-transfer. This involves transfer of a value estimated for one site to another. This approach is used to assess the consumer surplus for recreation in the Vechtstreek. Values for a range of recreational activities have been obtained from Walsh *et al*. (1992), who presents consumer surplus values reported by 120 outdoor recreation demand studies. These values represent consumer surpluses calculated in each individual study. In this way the consumer surplus per individual was derived for 19 recreational activities. The classification of recreational activities has been modified to match that for the Vechtstreek. Next, the consumer surplus per individual for recreation in the Vechtstreek has been derived by calculating the mean consumer surplus for this modified classification of recreational activities as $ 26.54. This amounts to Dfl 58.98 in Dutch guilders. Finally, this consumer surplus per individual for recreation in the Vechtstreek was multiplied by the total number of daytrips in the Vechtstreek during the year to arrive at the total yearly consumer surplus for recreation in the Vechtstreek: Dfl 2,010,177,887.-. This result has to be interpreted with some caution. The original values were surveyed at recreational sites which may differ significantly from those of the Vechtstreek in terms of size and other characteristics. Parsons and Kealy (1994), and Smith and Osborne (1996), indicate that the size of a recreational site correlates with its estimated value. Because the site characteristics of the original sites and the Vechtstreek can not be compared, no adjustments have been made for differences between them. Even if we could compare the site characteristics, we would not be able to correct for these differences because the parameter estimates on the relation between value and size of an area are not

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modified and combined to fit the Vechtstreek. The source of these statistics is CBS (1996b).

available. It follows that at the current stage of research the estimate on consumer surplus is very preliminary, and need to be further refined.

3.4 Agriculture

Agriculture is one of the main economic activities of the Vechtstreek. Agriculture includes arable and pasture lands and livestock. Agriculture land covers roughly 50% of the surface of the Vechtstreek.

The ground water levels in polders are relevant for agricultural production as it will affect feasibility and profitability of agriculture. The area has been subdivided into 16 polders with a uniform water level, ranging from 2.5 m below sea level to sea level. The area of the polders varies between 50 and 2763 hectares. For each polder data concerning land use and vegetation are available. Data for the water tables are available as well, for both summer and winter periods.

The value added of agriculture has been estimated in two ways for a nature conservation scenario of land use and land cover as discussed in section 3.2. For both the province of North-Holland and the province of Utrecht, estimates of value added of agriculture are based on the value added per hectare of agricultural land and the value added per agricultural firm respectively. If we consider the first case, value added per polder has been derived for both the province of North-Holland and the province of Utrecht by multiplying the area of agricultural land of the polder with value added per hectare (see Table 6).

Table 6. Value added for agriculture per province in 1993.[4]

Province	Value added per hectare (Dfl / ha)	Value added per firm (Dfl)
Noord-Holland	12,517	201,681
Utrecht	8,281	126,671

Source: “Kerncijfers land- en tuinbouw Noord-Holland 1997”

Aggregating over all the polders gives the total value added based on surface of agriculture land for each province (see Table 7). If we consider the second case, value added per polder has been derived for both the province of North-Holland and the

[4] These values are corrected for 1997 prices.

province of Utrecht by multiplying the number of firms of the polder with the value added per firm (see Table 6). Aggregating over all the polders gives the total value added based on the number of firms for each province (see Table 7). No distinction has been made between types of agricultural firms. So value added is a mean value over all types of firms. A majority in each provinces consists of crop- and grazing firms (source: "Kerncijfers land- en tuinbouw Noord-Holland 1997"). This might indicate that taking the mean value over all types of firms will probably not lead to highly unbiased estimates of the value added.

The nature conservation scenario implies an enlargement of the nature areas at the expense of the agricultural sector. The consequences of this nature conservation scenario for the agricultural surface area are determined. In contrast, the consequences of this scenario for the number of agricultural firms are uncertain. This induced us to take the value added based on the surface of agricultural land as the value added which will be included in the impact modelling and the present value calculation.

Table 7. Estimates for total value added of agriculture for the province of Noord-Holland and the province of Utrecht under the nature conservation scenario.

Province	Total surface of agricultural land (in hectares)	Number of agricultural firms	Value added based on surface of agricultural land (in Dutch guilders)	Value added based on number of firms (in Dutch guilders)
Noord-Holland	3741	145	Dfl 46,826,097.-	Dfl 29,294,166.-
Utrecht	3897	243	Dfl 32,271,057.-	Dfl 30,781,053.-
TOTAL	7638	388	Dfl 79,097,154.-	Dfl 60,075,219.-

Sources: De agrarische gebiedsvisie voor de Vechtstreek (1997), Kerncijfers land- en tuinbouw Noord-Holland 1997 (1997), Gebiedsperspectief voor de Vechtstreek (1994), Herinrichting Noorderpark (1995), Beheersplan Loosdrecht (1989)

The enlargement of the wetland area implies a decrement of the agriculture area by 2974 hectare (see Table 2). The associated reduction in value added based on surface of agricultural land is Dfl 30,797,975.-. This has been derived by multiplying the value added of agricultural land (Dfl 79,097,154.-) with the proportional decrement of the surface of agricultural land (2974 \7638; see also Table 7). This will be included in the CBA as part of the decrement of benefits due to the nature conservation project.

4. Impact modelling of land use changes

We are interested here in estimating the economic impacts for the Vechtstreek of a change in land use and cover. Two cases are distinguished:

1. Transforming agricultural areas into nature conservation areas open to recreation, like is the case for the Gemeenschapspolder and the Aetseveldsche Polder.
2. Transforming agricultural areas as a nature reserve that is not accessible for recreational visitors, like is the case for the Spiegelpolder, the Zuiderpolder and the Nieuwe Keverdijkse Polder.

Changes in net benefits are estimated of the transition from one to another land use and cover. Thereby, the impact of the transition on economic activities other than recreation are not considered. In addition, all initial costs like those related to restoration and acquiring of areas are omitted.

Consider the first case where one hectare of agriculture land is transformed into one hectare of nature conservation area open to recreation. A rough estimate for the value added of agriculture has been derived by dividing the total yearly value added by the total surface: Dlf 79,097,154.- / 7638 hectares (see Table 7). It follows that Dfl 10,356.- is a rough estimate for the value added per hectare of agriculture. By using the average costs of conservation of nature in the Vechtstreek, we adopt an average mix of vegetation. The associated costs has been derived by dividing the total yearly conservation costs by the total surface area: Dlf 7,625,279.- / 7357 hectares (see Table 2). This amounts Dfl 1,036.- per hectare. A transition of one hectare of agriculture land into one hectare of nature implies a change in net benefit changes from Dfl 10,356.- to - Dfl 1,036.- (i.e. a net cost!).

What does this transformation mean for recreation. We assume that the area of “recreational nature” and the yearly net benefit of recreation are linearly related to the number of recreational visitors. The yearly net benefit of recreation has been derived by dividing the total yearly net benefit of recreation by the total surface:

Dlf 86,082,124.- / 7357 hectares (see Section 3.2.3 and Table 2), which equals Dfl 11,701.- per hectare.

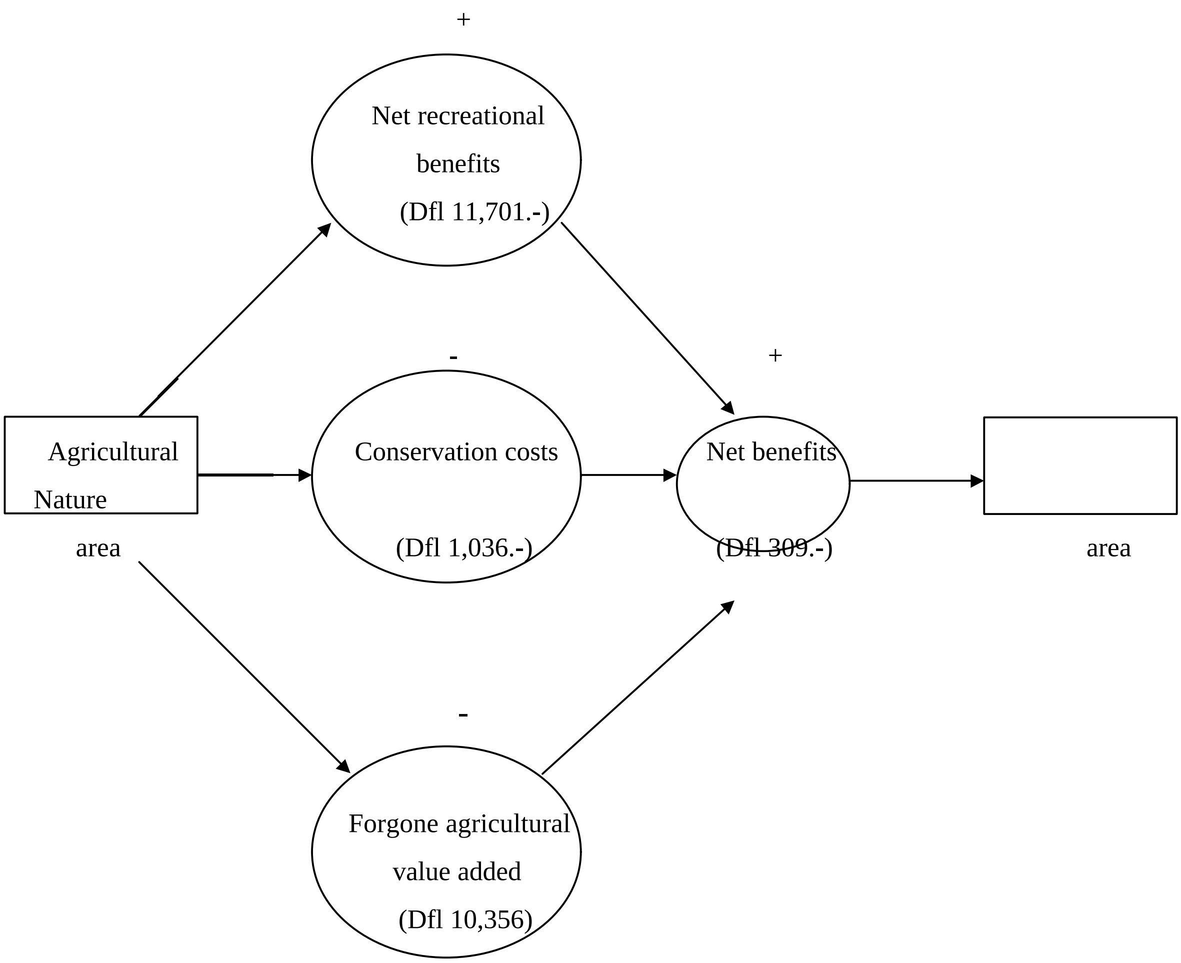

Figure 2. Changes in yearly flow of net benefits per hectare from transferring an agricultural area into a nature conservation area open to recreational visitors.

By taking the yearly net benefit from recreation per hectare (Dfl 11,701.-) minus the yearly average conservation costs per hectare (Dfl 1,036.-) minus the forgone yearly value added of agriculture (Dfl 10,356.-), we arrive at an increment of net benefits of Dfl 309.- per hectare. It can be concluded that by transferring an agricultural area into a nature conservation area open to recreational visitors, the yearly flow of net benefits from the area increases by Dfl 309.- per hectare (see Figure 2).

Consider next case 2, where more “nature conservation area” does not lead to an enlargement of the recreational area, so that additional recreational benefits are absent. By taking the yearly average conservation costs per hectare (Dfl 1,036.-) plus the forgone yearly value of agriculture (Dfl 10,356.-), we arrive at a decrement of net benefits of Dfl 11,392.-. It can be concluded that by transferring an agricultural area into a nature conservation area that is not accessible for recreational visitors, the yearly flow of net benefits from the area decreases by Dfl 11,392.- per hectare.

Table 8 summarises the costs and benefits associated with the alternative land uses, while Table 9 summarises the change in net benefits from changes in land use.

Table 8. Net benefits and costs associated with several activities on an acre of land (in Dutch guilders)

	Agriculture	Nature conservation	Recreation
Benefits	Dfl 10,356.-		Dfl 11,701.-
Costs		Dfl 1,036.-	

Source: Own estimates based on data of Table 2, Table 6 and Section 3.2.3.

Table 9. Net benefits per hectare of transforming one activity into another

TO FROM	Agriculture	Nature Conservation (open to recreation)	Nature Conservation (closed to recreation)
Agriculture		+ 309	- 11392
Nature Conservation (open to recreation)	- 309		-11701
Nature Conservation (closed to recreation)	+ 11392	+ 11701	

Source: own calculations based on Table 8.

5. An illustrative economic evaluation of the nature conservation scenario / project

5.1 Costs-Benefit analysis

Calculation of an appropriate net present value of the nature conservation project can contribute to an evaluation of conservation of wetlands in the Vechtstreek, and in particular help answering the question of economical rationality of the nature conservation project. This present value reflects a sustainable situation of land use and cover that exist under the respective project. A net present value formulation can be based on the approach proposed by Krutilla and Fisher (1975), where explicit attention is given to irreversibility of land use changes, while lost benefits of nature conservation are incorporated as opportunity costs of land development (for a clear account, see Porter, 1982). However, in our case study irreversibility is for the moment not emphasised, so that an ordinary CBA evaluation will be performed and the opportunity costs of the nature conservation scenario will not be included. In order to perform a CBA, cost and benefit estimates presented in Section 3 are used. The valuation is a partial analysis and covers only the sectors “Nature conservation”, “Nature based recreation” and “Agriculture”. The impact of the land use changes considered on other activities or sectors and associated values is assumed to be negligible in relative terms. Furthermore, at this stage of research, only for these sectors reliable estimates are available of direct costs and benefits. These are costs and benefits which change due to the nature conservation scenario. The costs and benefits included in the CBA are listed in Table 10. Following Barbier *et al.* (1997), retaining the Vechtstreek as a protected nature area is acceptable if the present value of total net benefits is positive. To calculate the present value, the change in total yearly (continuous) flows of costs and benefits are discounted. It is implicitly assumed that these flows remain constant over time.

Table 10. Costs and Benefits included in the calculation of the present value of the nature conservation project (in Dutch guilders).

Continuous costs and benefits:	*Notation*	*Estimated costs / benefits*	*Derived in Section*
Change in total yearly net benefit from recreation.	NBR	+ Dfl 34,797,912.- / year	3.3.3
Change in total yearly value added from agriculture	VAA	+ Dfl 30,797,975.- / year	3.4
Change in total yearly conservation cost for nature areas.	CCN	- Dfl 2,131,784.- / year	3.2.2
Set up costs:			
Costs of acquiring areas in the province of Noord-Holland	CBN	- Dfl 29,429,299.-	3.2.3
Costs of restoring acquired areas in Noord-Holland	CRA	- Dfl 32,979,958.-	3.2.3
Costs of acquiring areas in the province of Utrecht.	CBU	- Dfl 111,850,000.-	3.2.2
Costs of restoring the Vecht river.	CRV	- Dfl 214,191,430.-	3.2.4
Costs of restoring lakes	CRL	- Dfl 13,090,000.-	3.2.5

Note: "-" ("+") indicates costs (benefits).

A finite time horizon is adopted to take account of reinvestment in all sectors after T years. The present value of the nature conservation scenario discussed in Section 3.2:

$$PV = \sum_{t=0}^{T} \frac{NBR + VAA - CCN}{(1 + i)^{t}} - CBN - CRA - CBU - CRV - CRL$$

which implies

$$PV = (NBR + VAA - CCN) \times \frac{1 - (1/(1+i))^{T+1}}{1 - (1/(1+i))}$$

$$- CBN - CRA - CBU - CRV - CRL$$

Next, the internal rate of return is calculated by setting PV = 0. Because the time horizon T is uncertain, alternative values are examined, as summarised in Table 11.

Table 11. Internal rates of return for alternative time horizons.

Time horizon T	Internal rate of return
T = 10	i = 0.13
T = 15	i = 0.16
T = 20	i = 0.18
T = 25	i = 0.18
T = ∞	i = 0.18

Based on these results only, it follows that conservation and further development of the wetlands of the “Vechtstreek” as a nature area, as reflected in the studied scenario/project, is economically rational for an internal discount rate that does not exceed 18 %. A finite time horizon of say 10 years, consistent with re-investments in all activities (like agriculture), would lead to a 13% discount rate boundary. These results are very preliminary, and should be interpretated with much caution, because consumer surplus values associated with recreation, use value and nature conservation and nonuse values, have been incompletely included. Furthermore, the above present value calculation focuses on three activities, and excludes other activities listed in Table 1. However, as argued, given the scenario this is not too problematic, since most of the other activities are not expected to change much in terms of costs and benefits relative to the present situation. Lastly, much of the value estimates is surrounded by considerable uncertainty.

6 Problems and further research

Further research will be needed on several items. The assessment of costs and benefits of the included activities has to be performed in the context of specific scenarios. Under each of these scenarios, it has to be assessed which changes relative to the nature conservation scenario are relevant. Clearly, more extreme scenarios require assessment of costs and benefits (change) of more activities than was pursued in the preceding analysis since values relative to the present situation will very likely change considerably. The interaction of hydrological, ecological and economic value models under different scenarios will be included, as explained in Section 1. In addition, such more extreme scenarios may imply significant indirect economic effects (multiplier effects) which have to be examined, for instance, using a I-O type of approach as discussed in Section 2. Moreover, a more detailed assessment has to be made of the possible overlaps between value categories in Table 1. A combination of an analysis of functions and meta-analysis may be useful in this respect (see Brouwer, 1997).

As a result of these imperfections and incompleteness, the preceding preliminary analysis is not meant to imply that economic CBA can provide sufficient information to evaluate the nature conservation project. The data are incomplete, research is ongoing, and there are a number of fundamental problems associated with economic valuation and CBA evaluation (see Hanley and Spash, 1993; and Norton, 1994). Other categories of values as listed in Table 1 may be incorporated in the analysis. Further research is undertaken to obtain more information on the activities which were not included in the present analysis.

The approach is aimed to be applied to other scenarios than nature conservation as well, in which case integration with nature science information and models will be pursued. This was explained in Section 1. An important problem to be solved in that case is how values can be assessed for drastic land/water use changes compared to the present situation in the area. This is a neglected issue in environmental and ecological economics, where rigid valuation has been mostly oriented to marginal changes. Indeed, the theory of valuation is based entirely on marginal changes. In other words, we stumble here upon a basic problem for which no evident solutions exists. Our approach, assuming a fixed relationship between land use area and values, though very crude at this moment, seems to offer some options to go ahead. Benefits transfer studies may be useful in this respect, as they can empirically supported non-linear relationships (transfer functions) between site characteristics, including area size, and value estimates. This means that adjustments have to be made for differences in site and other relevant characteristics between the original sites, upon which the benefit transfer function is based, and the Vechtstreek, in order to make value transfer more reliable.

Another fundamental problem in performing economic evaluating is the absence or incompleteness of “future values”, include option values, bequest values, and intergenerational values. This is partly due to myopic preferences of people and the absence of future generations in present markets and public decision making. Furthermore, uncertainty about the future is significant, especially in the present case where a complex natural system is influenced by a number of exogenous (global or external) economic and natural processes. The present value will depend on the future scenario by which the stream of benefits will be influenced and the complexity of cause-impact relations to which the system is subjected.

Finally, in the recent literature a significant number of authors have criticised the valuation of biodiversity. Some biologists like Ehrenfield (1988) and Wilson (1992) doubt the concept of valuing biodiversity by means of market prices. The argument is that biodiversity is essential for every life and its value is infinite. Also, some economists (e.g., Gowdy, 1997) argue that the value of biodiversity transcends the market value:

- the value of biodiversity is at least as high as the value of the entire economy (life-support function);
- there is no substitute for biodiversity;
- biodiversity is essential for evolutionary potential, which can not be valued due to uncertainty;
- bequest, option and existence values cannot be cast in a market or stated preference framework as it has to do with citizen (collective choice) rather than market values.

Most of these considerations lead to the conclusion that the value of biodiversity is likely to be underestimated with any CBA.

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