THE ECONOMIC VALUE OF NATURAL AND ENVIRONMENTAL RESOURCES

Background document training

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1 INTRODUCTION

This document serves as background material to a training course on "the economic value of natural and environmental resources". This training course is developed under the project "Training of the Trainers", a project developed by MDF for CENN (Caucasus Environmental NGO Network).

This document contains background information on both theory and practice of nature valuation and the estimation of benefits[1].

- chapter 2 briefly introduces some theoretical considerations and gives a first overview of methods for nature valuation;
- chapter 3 deals with some of the most commonly used methods to value nature;
- chapter 4 is on Cost Benefits Analysis;
- in chapter 5 a case study is presented, revealing some of the ways a Cost-Benefit analysis can be applied.

This document serves as training and reference material to trainers, and can as such in no way be considered to be a comprehensive theory and empirical textbook. For further reading a "further reading list" is added and a CD-rom with some of the information available in the public domain.

1.1 Importance of valuation of natural and environmental resources

Why should we bother about the value of nature? Isn't the fact that nature is deteriorating, the climate is changing, resources are getting depleted, etc. enough reason to protect environment and nature to the limit?

Of course this is a legitimate argument, but in many cases this will not be sufficient to convince people with other ethical values (for example "making money"[2]).

Reasons to bother about monetary valuation of environmental and natural resources are:

- Environmental valuation techniques can provide useful evidence to support habitat conservation policies by quantifying the economic value associated with the protection of biological resources (Hanley and Shogren, 2001);
- Pearce (2001) argues that the measurement of the economic value of biodiversity is a fundamental step in conserving this resource, since "the pressures to reduce biodiversity are so large that the chances that we will introduce incentives [for the protection of biodiversity] without demonstrating the economic value of biodiversity are much less than if we do engage in valuation";
- By assigning monetary values to biodiversity, the benefits associated with biodiversity can directly be compared with the economic value of alternative resource use options (see also Nunes and van den Bergh, 2001). It thus can and should be applied in Cost Benefit Analyses of (larger) public and private projects.

The information in this report is intended to acquire basic knowledge on some of the most used and applications of valuation techniques.

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[1] Often studies use "benefits" to refer valuations of natural and environmental resources. Here, we use both terms interchangeable.

[2] "Making money" may have a negative sound, for many people in developing countries it is a first condition to survive.

2 THEORY OF AND METHODS TO DETERMINE THE ECONOMIC VALUE OF NATURAL RESOUCES

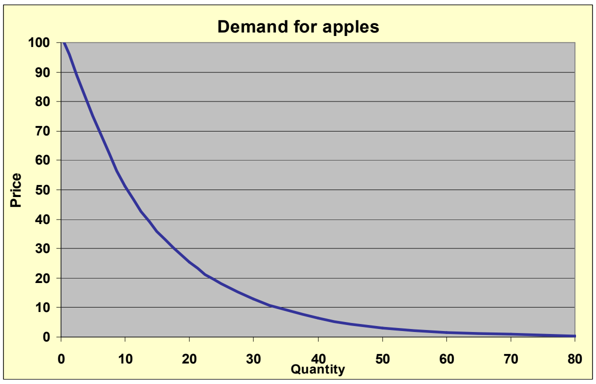
2.1 Introduction

This chapter deals with the theoretical framework for the valuation of natural and environmental resources and gives a first overview of the main available valuation techniques.

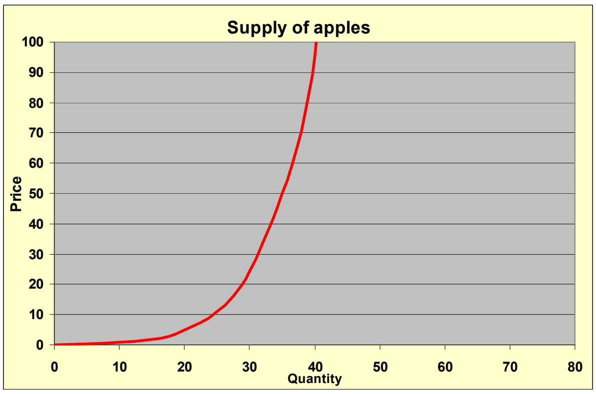
2.2 Market economy: demand, supply, price and quantity

To understand the role of economics in environmental nature protection, some background knowledge of market economy is needed.

In a market economy the so-called “invisible hand” of the market (Adam Smith, founder of classical economic theory) arranges the prices and quantities of products. This can be shown by the following graphs.



Assume the consumption of apples. If the price of apples is high, people – although they love apples – will consume only small quantities. On the other hand, if the price is low, demand of consumers for apples will be larger, and more apples will be sold. This is presented in the first graph. So a high price leads to low demand and the other way around.

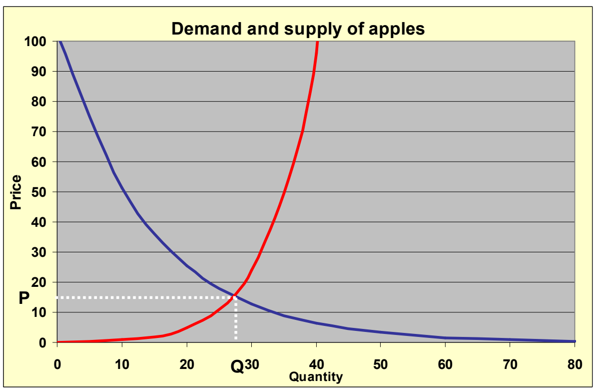


Now let’s look at the side of the producer who supplies apples. He will bring more apples to the market if the price is higher. This is shown in the second graph.

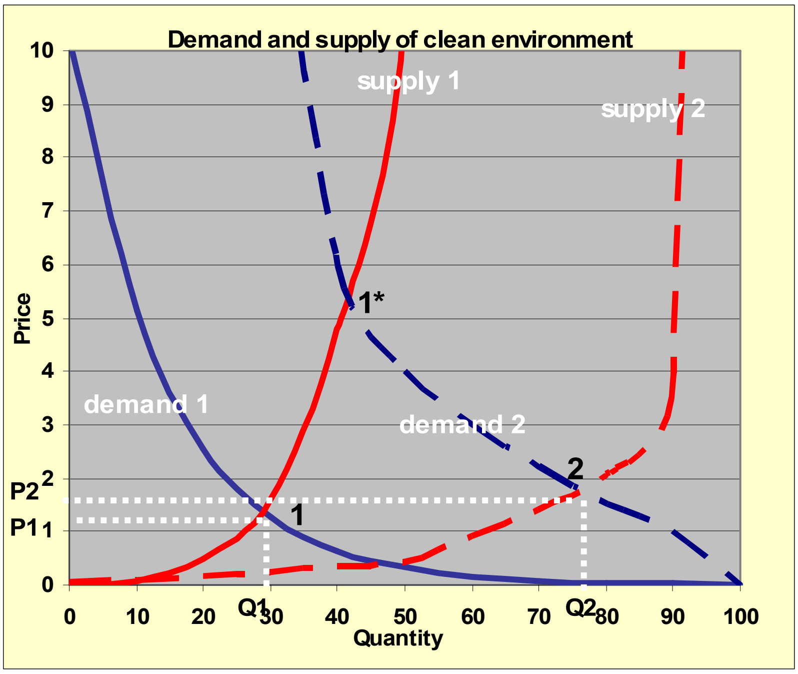
High prices lead to higher quantities supplied.

When consumers and producers “meet” each other at the market place, demand and supply are matched by the “invisible hand” of the market. This is shown in the third graph.

Here we have the demand and supply curve in one graph. Where demand is the same as supply – for as well the quantity as the price – the balance in the market is achieved. This is shown by the white dotted lines (one for price and one for quantity).



Although the example above relates to marketable products, the concept of markets can also be applied to environment. This is shown in the next graph.



In this graph the demand and supply for a "clean environment" are presented. On the x-axis the quantity of "clean environment" is shown (100 = 100% clean), so the options on the right hand of the x-axis are more preferred by consumers than on the left.
Two situations are sketched: an initial situation, with relative little demand for environment (low willingness to pay to achieve for example 50% or more reduction), and also little supply. In the second situation, the demand for environment has increased due to higher income levels. But also supply changes: it becomes cheaper, so more possibilities are available at lower costs. So if we know both demand and supply curves, we theoretically can estimate the optimal "quantity of clean environment" and the price we are willing to pay.

The graph shows that in the initial situation the demand would be about 30 and the price about 1.3. If only demand would increase (dotted blue curve), the price would rise to over 5, and supply would be increased to a little over 40. But due to the increased possibilities to supply clean environment, for a price of about 1.7, supply could be increased to over 75.

A practical example would be the reduction of sulphur from power plants. On the x-axis the %-reduction of SO2-emission is shown, on the y-axis costs per kg reduced. In the 70-ties (in EU) there was little abetment and it was quite costly, also incomes (and thus value of mortality, see par. 3.4) were much lower than currently and acidification was not yet know to the public. Since then, incomes have more than doubled and also environmental expenditures have more than tripled (> 3x), expressing the rising public concern for environmental protection. But on the other hand, due to large scale application and innovations, reduction costs also have declined, leading to lower abatement costs (the red dotted supply 2 curve). The result in this case is a moderate increase in the price paid per unit of pollution reduction, but a much higher level of environmental protection.

2.3 External effects

In "day-to-day" market economics, markets determine prices and quantities of products and services, as shown in the last paragraph. Theory says that due to demand and supply, an optimal mix of products and services is demanded and supplied, leading to the highest possible welfare (given the physical production and consumption limitations).

However, for products and services that are not sold on the market, no direct market price information is available, making it difficult to optimise the supply and demand of such services.

But although no prices exist for “a forest”, “biodiversity”, “pollution”, it is clear that many individuals attach a certain value to such non-priced goods and services.

Even before environmental problems became visible and well understood, economic theory had to deal with the problem of non-priced goods and services and the optimal supply and demand thereof. This leaded to the concept of “externalities” (or external effects). This also became a key concept in valuation of natural and environmental resources. Externalities can be described as follows (Wikipedia):

> In economics, an externality is a side effect from one activity which has consequences for another activity but is not reflected in market prices. Externalities can be either positive, when an external benefit is generated, or negative, when an external cost is generated from a market transaction.

An externality occurs when a decision causes costs or benefits to stakeholders other than the person making the decision, often, though not necessarily, from the use of common goods (for example, a decision which results in pollution of the atmosphere would involve an externality). In other words, the decision-maker does not bear all of the costs or reap all of the gains from his or her action. As a result, in a competitive market, too much or too little of the good will be consumed from the point of view of society. If the world around the person making the decision benefits more than he does, such as in areas of education, or safety, then the good will be underprovided; if the costs to the world exceed the costs to the individual making the choice in areas such as pollution or crime then the good will be overprovided from society's point of view.

So the valuation of natural and environmental resources should be seen as a part of the economic theory on externalities:
- positive externalities occur in case natural habitats create an economic benefit for certain consumers (that don’t pay directly for it): the vicinity of a forest, lake, etc. will create additional value to the ones that benefit from the vicinity of the natural habitat;
- negative externalities occur in case pollution or noise is emitted in the environment, changing the physical environment for consumers in a negative way.

As externalities, by definition, are not traded on markets, the value of the externality needs to be estimated making use of a variety of methods, that have been developed and applied the last 30 – 40 years (that will be explained in brief in the next chapters).

2.4 Classification of benefits

The following table classifies the kinds of benefits that (theoretically) can be distinguished, when valuating environmental resources.

The total economic value of environmental resources is built up of use and non use values. Use values are often easier to assess than non use values. In general it can be said, that the more to the right in the schedule for calculating the total economic value of environmental resources, the more difficult it will be to assess the value.

Table 2.1
Economic taxonomy for environmental resource valuation

Total Economic Value				
Use Values			Non-use Values	
Direct Use	Indirect Use	Option Value	Bequest Value	Existence Value
Outputs directly consumable	Functional benefits	Future direct and indirect values	use and non-use value of environmental legacy	value from knowledge of continued existence
• food • biomass • recreation • health • increased living comfort	• flood control • storm protection • nutrient cycles • carbon sequestration	• biodiversity • conserved habitats	• habitats • prevention of irreversible change	• habitats • species • genetic • ecosystem

source: based on EFTEC/RIVM, 2000,

Direct Use

Direct use ii is most obvious value category, as the economic benefits can be calculated by making use of market information. The outputs of the resource can be directly consumed:

- a forest may yield annually a certain amount of wood that can be sold or used for heating and construction;
- pastures provide space for some livestock
- a lake provides fish to fisherman;
- enjoying nature (recreation).

Many studies show that cleaner air (a natural resource) leads to less respiratory diseases and considerably less mortality. So health costs can be influenced positively by improving air quality. As the output (clean air) directly can be consumed, it is still classified as “direct use”, but assessing the money value will already be more difficult than

Indirect use

Indirect use of natural recourses relates to functional benefits, the outputs provide a social benefit from ecosystem functioning (e.g. water purification, erosion protection or carbon sequestration).

Option use value

Option value, where individuals are willing to pay for the future use of the resource (e.g. future visits to national parks, clean surface and ground water, avoiding of erosion to enable future use of pastures).

Two types of non-use value of environment can be distinguished:

Bequest values

This reflects the publics' willingness to pay to ensure future generations to enjoy the same environmental benefit in the years to come. This relates to the willingness to pay for preserving existing habitats, species and ecosystems. It also includes the willingness to pay to prevent for irreversible changes (for example: extinction of species).

Existence value

This non-use value reflects the "moral" or philosophical reasons for environmental protection, unrelated to any current or future use. It is related to the for example the scientific society and the value from knowledge of continued existence of species, habitats and ecosystems.

2.5 Methods

There is a wide range of methods to estimate the monetary value of natural and environmental resources. Here we give a brief overview of some important methods used. Basically the methods can be subdivided into two categories:

- methods that somehow link the change in an environmental or natural resource, to a market price that can be observed in reality (so called "revealed preferences");
- methods that determine preferences directly from consumers, by using various types of questionnaires ("Stated preference techniques")

2.5.1 Willingness to pay (WTP)

This is a so-called "stated preference technique". Basically this method aims at measuring the willingness of individuals to pay for environmental services, nature protection, etc. Most critical with this method is the way in which is explained what exactly has to be valued by the respondents and realistic monetary choices. A limitation is the "income restraint" (poor people will be less willing to pay, so average income levels influence outcomes of the studies). An advantage is that it can be used to valuate difficult to measure non-user values or the value of non traded goods and services.

2.5.2 Market prices

The most obvious way of measuring the value of nature is to see how much crop, fish, wood, livestock, etc. can be obtained by sustainable use of the natural habitat. By surveying crops, woodcutting, cattle breeding, etc, of the population, in combination with (local) market prices, the direct use value for the inhabitants can be measured.

2.5.3 Dose response function and valuation of morbidity, mortality, loss to crop and real estate

This method is often used in studies that aim to estimate the monetary damages of environmental degradation, for example through pollution of the air by fine particles, sulphur dioxide, nitrogen oxides and volatile organic compounds. It has been successfully applied in EU studies on air-pollution (ExternE). It requires large datasets, establishment of dose-response function (for mortality, health, loss of crop and real estate). Moreover, it requires valuation of mortality, putting a monetary value on life, which is not undisputed.

2.5.4 Hedonic pricing

Here prices of for example houses are observed. By statistical analyses the environmental or nature valuation attributes in the price of property can be separated (for example, price of property decreases by 0.5% by an increase of the noise level with 1 dB(A)). This method is mostly applied to noise, but it can also be applied to nature by looking at values of property near natural areas.

2.5.5 Travel cost method

Part of economic behaviour can be measured implicitly by looking at how individuals spent their money and time. The Travel Cost method aims at measuring travel costs (for example to visit a protected natural area) and time (and value this economically) and (sometimes) the economic spin off (consumptions in the region, costs of accommodation).

2.5.6 Prevention costs

Applying preventive measures can be a way to mitigate negative effects of economic developments for nature. The costs thereof can be regarded as the value of the protected area or species. Examples of such measures can be other, longer routes of road (to prevent cutting off part of a natural area), a tunnel, passages for animals.

2.5.7 Compensation costs

Theoretically spoken it is possible to create a new nature area that can be compared with the old area although 100% is not possible). The costs to compensate the loss of natural area can be assumed to be the value of the nature area in question.

2.5.8 Opportunity Costs method

The opportunity costs of a resource, is the value of the next-highest-valued alternative use of that resource. For a natural area this may be agricultural use, use as a road, and in some cases economic development (industry, housing). The opportunity costs of nature thus will depend largely on location and (for agriculture) fertility. In the Netherlands natural area is valuated at about € 20,000 per ha (CBS), agricultural land costs € 30,000 – 40,000, industrial € 100,000 - € 200,000 and housing € 2,000,000 - € 5,000,000 per ha.

2.6 Benefit transfer

Benefit transfer is not a method to assess benefits or damages in a specific case by carrying out statistical analyses or questionnaires. Benefit transfer aims at using results of earlier studies to put a value on nature. The studies to use for benefit transfer can be any type of the here above described methods.

To apply benefit transfer successfully the following three criteria apply (Boyle and Bergstrom (1992)):

1. Similarity of the environmental good or service to be valued;
2. Similar demographic, geographic, economic and social characteristics, or the ability to adjust for these kinds of parameters statistically (King & Mazzotta, 2004). EFTEC/RIVM mention the following potential adjustments (p. 127):
   - average income;
   - population size and characteristics;
   - background conditions;
   - level of impacts, and
   - other determinants;
3. Evidence of sound economic and statistical methodology applied in the preliminary study.

A fourth criterion can be added:

4. Use if possible more than one reference study to have an idea of credibility and reliability.

The advantage of benefit transfer compared to more fundamental research method is the saving of time (quick results) and costs. The disadvantage is of course the lack of credibility (especially when using results from EU or US and transfer them to Georgia) and the lack of “local evidence” (benefits assessments based on interviews in Georgia).

2.7 Linking theory with practice

In practise, the valuation techniques available to the researcher, will determine which type of benefits can be assessed and to some extend, the magnitude of the benefits. Often, the benefits measured by the researcher may be linked to more than one of the categories depending on what exactly is valued by the method or may be biased:

- when applying a willingness to pay study, the respondents will have at least some differences is understanding what they are asked to value (recreational use, existence value, option value). Also, it can be assumed that the understanding of the value of money for each individual differs;
- when applying a hedonic pricing study (mostly based on differences in prices of property), part of the additional value due to environmental benefits may relate to living comfort (including recreational opportunities and silence), partly to non-user values (when people with large gardens also promote nature protection);
- when applying a dose-response functions with "value of life" estimates, discussion on applying monetary valuation of mortality will affect the credibility of the result, also the uncertainty on dose-response relations.

So even when applying sophisticated methods to assess the value of natural and environmental resources, there always remains area for discussion on the results of valuation studies. Benefits are often less obvious than costs, and thus results of benefit studies are less precise than cost estimates (although also evidence exists that costs estimates are not very accurate and in certain cases overestimate costs of policies by factors (IVM, 2006).

3 METHODS TO VALUATE NATURAL AND ENVIRONMENTAL RESOURCES

3.1 Introduction

In this chapter some further explanations will be given on some of the most popular methods to valuate natural and environmental resources.

In each section a different method will be explained briefly, and at the end of the section one or more examples are given of how the method is used to assess certain environmental values.

The following methods will be discussed:
- contingent valuation and willingness to pay
- market
- dose-response and value of life
- hedonic pricing
- travel cost
- prevention costs
- compensation costs
- opportunity costs

The first five of the above mentioned methods require, when applied to a certain problem, large amounts of data to be collected (by surveys) and statistical data processing techniques. Moreover, in most cases it requires precise procedures for acquiring data (the questionnaires need to be fine tuned to the natural or environmental resource to be valuated). In this chapter some of the basics are explained for each of these methods, but for application in practise, further reading is necessary (see list of further reading).
The last three mentioned methods are less data requiring. Often, with the help of other estimates these methods arrive at a rough estimate at low costs.

In the last paragraph, special attention will be given to so-called "benefit transfers", as this method is widely used in various studies. It also can help to make a quick assessment of a certain value, and give a first rough estimate. But in many cases, firm data can be found and used for the assessment of damages, benefits and the value of environmental and natural resources,

Value estimates of natural and environmental resources can be used as "stand alone" result in defence of natural values, but it also can be applied in Cost Benefit Analysis (CBA) (see chapter 4).

3.1.1 Background materials

For the different issues discussed in this chapter, background material for further reading (in English) is available on a CD-ROM. This CD-rom contains the following documents:
- Bluffstone
- Ecotec
- EFTEC/RIVM
- IZCM
- Nature Article
- Neiland
- OECD
- RIVM
- Serbia
- TME Georgia
- Training document

- UNEP: economics of environment
- WB: Cost Benefit of Kolkheti wetlands
- WB: Dixon with formula for rapid assessment of mortality rates related to airpollution.

3.2 Willingness to pay (WTP) or Contingent Valuation Method (CVM)

3.2.1 Introduction

Basically CVM aims at measuring the willingness of individuals to pay for environmental services, nature protection, etc. CVM is a survey-based, stated preference, methodology that provides respondents the opportunity to make an economic decision concerning the relevant non-market good. Values for the good or service are then inferred from the induced economic decision. The CV method is in use for over 30 years.

CVM is one of the most advanced and the most used techniques for environmental valuation. In contingent valuation researches, precise questionnaires are developed, aiming to obtain a direct answer from the individuals questioned.
The essential part of the questionnaire is information about the willingness to pay for a certain environmental benefit, or willingness to accept compensation for a forgone benefit, or an incurred cost. The contingent valuation questionnaire should define:
- environmental good – that has to be valued by the respondent – itself;
- the institutional context of its consumption (how is the externality “consumed” by respondents);
- and the way of paying for it (privately, publicly).

Although the questions are related to a hypothetical situation, the respondents are expected to behave as if they were in a real marketplace. Respondents state the preferences in a form of a bidding game. Econometric techniques are used to analyse the obtained results. Accuracy of conclusions is closely related to the construction of the questionnaire. That is the reason why a precise procedure should be applied (Arrow et. al. 1993).

Most critical with this method is the way in which is explained what exactly has to be valued by the respondents and realistic monetary choices. A limitation is the “income restraint” (poor people will be less willing to pay, so average income levels influence outcomes of the studies). An advantage is that it can be used to valuate difficult to measure non-user values or the value of non traded goods and services.

A wide variety of CV studies have been carried out on a wide range of environmental and nature issues:
- preserving biodiversity;
- (water and nature) recreation;
- water supply and supply of sewerage;
- increased access to natural habitats;
- etc.

On the internet, various sites give summaries and overviews of the results of CV-studies.

3.2.2 Application

A Contingent Valuation study start with the design of a questionnaire. The questionnaire of course, should be tailored to the needs of the survey. This means that a precise description must be given of the kind of environmental goods or services that need to be valued by the respondents.

The design of the questionnaire would include the following issues (see for more details, paragraph 3.2.4):
- key descriptive statistics on the population interviewed:

- age
- sex
- level of education
- household income
- size of household
- ownership of dwelling
- a description needs to be prepared that details the benefits, that respondents are expected to enjoy if the measure to improve the environmental service or good is implemented.
- question(s) on whether the respondent would support the improved environmental service or good;
- a choice bid format has to be used, in which the payment for the environmental service may be for example:
  - an increase in the per-person monthly tariff from the level households are already paying;
  - an increased allocation of budget to a improve the level of environmental service;
  - an increase in compensation for an individual who will not have access to the improved environmental good or service.

  Respondents must be offered about ten possible bids (to be chosen in consultation with local experts).

By means of statistical analysis techniques (regression for example), the results of the questionnaire can then be interpreted.

When analysing the results of a CV study, It is important to assess what the expected hypothetical relationship will be between the willingness to pay for a service and certain parameters (like level of the bid; income, household size, gender, age, education, private interest). This can be used afterwards, when analysing results, to check whether the results are in line with the hypothetical expectations.

As this method is based on questionnaires, the method can be and has been applied to a variety of natural and environmental resources and environmental problems.

3.2.3 Practical examples

Willingness to Pay to be Connected to Sewerage as Required Under the Urban Wastewater Treatment Directive in Lithuania, the case of Ukmerge
In this study (Bluffstone and DeShazo, 2006 (?)) the willingness to pay for extended environmental services, as a result of the implementation of the EU environmental directives on waste and wastewater, were surveyed. Here a summary is given of the results for the WTP for sewerage services.

The provision of sewerage in EU countries is regulated in the Urban Wastewater Treatment Directive. It has two major parts:

- The first part requires that wastewater treatment plants meet effluent concentration standards;
- The second part of the directive requires that sewerage be extended to all residents in towns with more than 2000 inhabitants, as long as costs are not “excessive.”

Since independence in 1990, Lithuania has been engaged in a program of wastewater treatment plant construction and upgrading. Like several other Lithuanian towns, Ukmerge has a treatment facility that probably already meets the requirements of the directive.
Sewerage, however, has received little or no attention, largely because it is believed that the individual septic systems commonly used are effective for treating small amounts of household sewage. Only sewerage was therefore considered, and only respondents who indicated they did

not have sewerage services were surveyed. 42.6% of respondents said they did not have access to the sewage system.

A description of the services provided by the sewerage component of the Directive on Urban Wastewater Treatment was read to each respondent:

> "You have indicated that you are not connected to the municipal sewerage system. I would like to acquaint you with some of the potential benefits of connecting to the centralized sewer system. If you were connected, you would not need to service your private septic system or pit toilet. This would create a more sanitary environment in your yard. If you currently use a pit toilet, connection would allow you the opportunity to have indoor plumbing. Furthermore, there is little or no smell associated with centralized sewage systems."

Each respondent was then asked if they would support the program if they had to pay an additional monthly fee (on top of the tariff they already pay) ranging from 0.04 euros (0.20 litas) to 1.11 euros (4.90 litas) per person per month. The nationwide average per capita tariff is approximately 0.5 euros per month, but the cost is higher in Ukmerge because of debt service for the new treatment plant. Over half of those NOT connected indicated they would favour a program to extend sewerage at the bid they were offered.

The statistical analysis shows that the signs of all coefficients are as hypothesised and all estimates are also significantly different from zero, at least at the 10% level.

Respondents were asked for their maximum willingness to pay. Slightly over 35% said they were willing to pay zero for the program. Of particular interest is that 12% of all respondents in this group said they did not need sewerage. Another 38% said they were satisfied with the current situation. Most of the remainder focused on their inability to bear additional costs (34%).

Levels of Support for Extension of Sewerage at Various Tariff Levels

Proposed Additional Tariff per person per month	Estimated Percentage of Population that would Support the Sewerage Extension Program
0.18 euros (0.79 litas)	25%
0.04 euros (0.19 litas)	50%
0.01 euros (0.04 litas)	75%
0.002 euros (01 litas)	100%

The table suggests substantial household willingness to pay for sewerage services. Whether this figure is "enough," of course, depends on the costs. Half of respondents indicated a willingness to pay an additional 0.51 euros (2.24 litas) per person per year for sewerage services. If 20% of the Lithuanian people do not have sewerage services (a perhaps high figure), this means that the national willingness to pay for sewerage upgrading is approximately 0.40 million euros per year.

How does that figure compare with the costs? The answer is rather badly. Beginning in 2011, when costs are slated to start being paid in Lithuania, it is expected that annualised costs will be approximately 42.5 million euros (187 million litas). Even with substantial income growth between the year 2000 and 2011, it is unlikely that the annual willingness to pay for sewerage will cover even 10% of the estimated annual costs. This finding suggests that sewerage extension is an area where subsidies will be necessary if it is to be provided as the directive requires.

Benefits of water quality improvements from different valuation studies

A study on the UNEP website gives an overview of the benefits of water quality improvement. Here the main results of some 10 studies from different regions in the world are shown. The unit shown in the table is the measured willingness to pay of individuals for improved water quality (Many of these studies used CVM to arrive at a figure

Study and region	Economic method used to measure benefits of water quality improvement a)	Annual benefits per individual
Michael et al. 1996 Maine, USA	Hedonic Model Measures changes in property prices	$35 - 633
Needelman and Kealy, 1995. New Hampshire, USA	Discrete Choice Measures benefits for swimming	$1.46
Bockstael et al. 1988 Chesapeake Bay, USA	CVM d) Measures benefits for swimming	$48.35 - 198.86
Gren et al. 1997 Baltic Sea - Sweden	CVM - measures total benefits	$392 - 758
Gren et al. 1997 Baltic Sea - Poland	CVM - measures total benefits	$39 - 78
Sandstrom, 1996 Sweden	TCM e) - measures recreation benefits	$21 - 48
Goffe, 1995 France	CVM - measures recreation and other benefits	$31 - 42
Georgiou, 1998 UK	CVM- measures recreation benefits	$8 - 9
Choe et al. 1996 Philippines	CVM measures public health and recreation benefits	$0.40 - 1.63
Choe et al. 1996 Philippines	TCM - measures recreation benefits	$1.5 or 2.08
Smil, 1996 China	Total benefit estimate - for fisheries only	$0.13

Source: UNEP
Notes:
a) All values are annual except for the Needelman and Kealy, 1995 study which reports seasonal benefits, the Choe et al. 1996 study which reports monthly benefits and the Smil, 1996 study which is a one-time estimate.
c) Estimates were first converted to US Dollars, when in another currency. Then they were converted to 1997 US Dollars using the GDP Deflator. Data for exchange rates and GDP deflator are from Economic Report of the President 1998 US Government.
d) CVM is contingent valuation method.
e) TCM is travel cost method.

The results in the table show that there are considerable differences in outcomes. A not surprising difference is between righer and poorer countries. Whereas in rich countries benefits of improved water quality are at least valued at $ 8 per capita per year or (much) more, in developing countries (Philippines, China), the per capita benefits are much smaller (up to $2). This can be explained by the income restraint that plays a role in CVM studies (the “bidding” needs to be adapted to local circumstances), the lower the average income, the lower the ability and thus willingness to pay.

Value of increased biodiversity due to cleaner water soils

In 2003, a postal survey with a response of about 1000 inhabitants of the Netherlands was held to assess the Willingness to Pay of the Dutch population for increasing biodiversity due to cleaning up polluted water soils (RIZA, 2004). The experiment was designed in such a way that three different types of questions were asked on the willingness to pay (“Open question”, “Payment card” or “Dichotomus choice” format) to different groups of respondents.

The questionnaire was designed by experts and includes, background information and map on current water soils pollution problems and effects on biodiversity. Background questions on age, sex, income etc. were asked to see how good the sample matches with the Dutch population and corrections afterwards. Also questions on how much households think that they currently pay per year were asked to check the current cost-knowledge. It appeared that on average, respondents though that they paid about € 180 per household per year (whereas in reality a household pays about € 500 per year for water supply, sewerage and sanitation).

The willingness to pay question is introduced by the following choice:
- Option 1 (no cost): no extra water soil sanitation, and possible further decrease of biodiversity (without quantifying this);
- Option 2: extra water soil sanitation, leading to an increased biodiversity n and around the water (without specifying this).

In most questionnaires, the increase of biodiversity was not specified, but in some of the “payment Card”-type questionnaires, it was stated that the increase would be 25%, in others that it would be 50%.

Average willingness to pay per household per year for an increase of biodiversity in and around surface water in the Netherlands as a result of the sanitation of polluted water soils

	Open Question	Payment Card	Payment Card	Payment Card	Dichotomous Choice
	ns	ns	25%	50%	ns
Average WTP per household per year (€)	69,9	48,9	52	50,8	56,8
Standard error	9,5	6,3	6,3	5,5	4,8
Median value	50	40	35	35	
Range (min-max)	0-600	0-500	0-600	0-300	1-250
Number of observations	92	104	115	113	388

Source: RIZA
Explanation: ns: no specification of increase in biodiversity; 25%: 25% increase in biodiversity; 50%: 50% increase in biodiversity

The results show that on average the willingness to pay of the Dutch population for biodiversity by sanitation of polluted water soils – a non-use value! – would be about € 50 to € 70 per household per year, or a total of € 345 million a year[3].
However, in a pessimistic way of interpreting the results, one might assume that the non respondents are legitimate “non-willing to payers”. In tat case the average willingness to pay decreases to € 10, or € 60 mln per year.

90% of the respondents (including some of those not willing to pay) state that they think that cleaning polluted water soils is important or very important, for the risks to humans and biodiversity. Most respondents (35%) that are willing to pay, state as reason to pay, that they have just enough money for it (and implicitly support biodiversity), also 35% mention reasons linked with nature protection or the health of current and future generations.

This research can be seen as a good example of asking the right questions, good information provision to respondents, right format of the questions, in order to achieve credible results.

[3] Annual costs are estimated at between € 25 and € 75 million per year for cleaning up water soils.

Willingness to pay for nature protection

In 1988 in the Netherlands a study was performed on the willingness to pay of the Dutch population for nature protection. The results showed that on average the WTP of the inhabitants in the Netherlands to protect nature in 1988 was about € 71[4] per in habitant (prices 2000). For the total population (15.5 mln at that time) WTP is estimated at € 1,110 mln per year.

The willingness to pay can also be expressed per hectare, by dividing total value through the area of nature:

- Total nature area in the Netherlands is 460,300 ha;
- This leads to an annual value of the WTP per hectare of € 2,413;
- The total value per hectare can then be estimated at (over eternity, 5% discount rate) € 48,270 per ha.

This number can for example be used when transferring the results from this study to for example a natural habitat in the Netherlands (to get a first indicative figure). For example, if applied to the Meinweg (see also paragraph on Compensation and preventive costs) the total value of this natural area is: 1,800 ha x € 48,270 per ha = € 86.884.501.

3.2.4 Example questions in a questionnaire for Contingent Valuation

In a Contingent Valuation survey, the key issue is to ask respondents to state their:

- knowledge of;
- experience with;
- perceptions of;
- preferences for

proposed changes in our natural environment. In addition, respondents are asked for the “Willingness to Pay for the proposed changes by means of market simulation to see if respondents are willing to support their stated revealed preferences financially.

Design of questionnaire

The design of the questionnaire is elementary in achieving reliable results. A good questionnaire at least would include:

- a description of the environmental problem to be valued and proposed changes
- general questions on respondents household;
- control questions;
- willingness to pay question.

In some cases one may choose for parallel application of different questionnaires or even different methods to survey a certain issue.

Before designing the survey, one should learn as much as possible about how people think about the good or service in question. Consider people’s familiarity with the good or service, as well as the importance of such factors as quality, quantity, accessibility, the availability of substitutes, and the reversibility of the change.

Description of the environmental good or service

A clear description must be given of the environmental good or service that is under study. For example, if only biodiversity aspects of improving water eco systems are under survey, this should be explained and respondents should be told that user values of cleaner water excluded

[4] Christie et al (2004) estimate in a recent study that in Great Britain the Willingness to Pay is on average £ 50 per inhabitant per year (which is about € 75). These results are quite comparable with the study for the Netherlands.

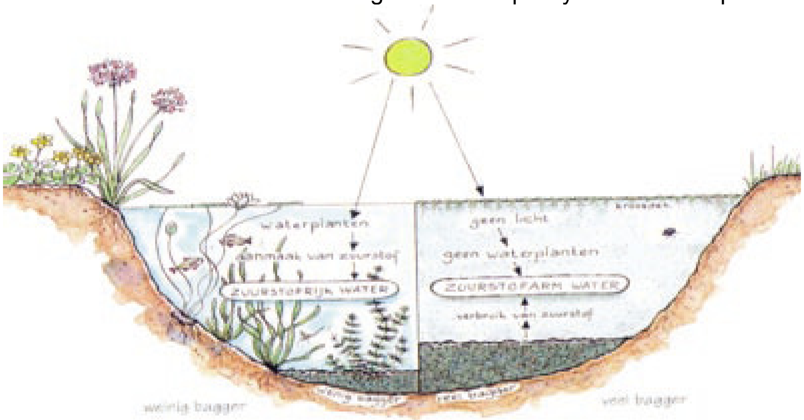
in the valuation. Both the ecosystem and the proposed changes need to be explained to the respondent.

In the next two textboxes, an example is given of the way biodiversity in relation to watersoil pollution was explained in a CV-study in the Netherlands, and the potential change:

YOU ARE NOW KINDLY REQUESTED TO FIRST READ THE FOLLOWING TEXT

Netherlands is situated in the delta area of the rivers Rhine, Maas and Schelde. A large part of the by these rivers transported suspended solids (named “dredging sludge”) settles in our delta. Also in polders and city cannels sludge accumulates. For good water management, inland shipping, recreation and nature it is therefore necessary that rivers, cannels, lakes, ditches, etc. are regularly dredged. During the 80-toes is became clear that a large part of the on water soils accumulated sludge is polluted with heavy metals and other toxic substances. Due to the ongoing aanvoer of sludge, the in the past accumulated polluted sludge under water has increased, as the necessity to dispose of this polluted sludge. The accumulation of polluted sludge in water-soils has negative consequences for nature. A clean water-soil is an important precondition for the existence of a variety of flora (plant-species) and fauna (animal-species), also referred to as biodiversity. Also the water-quality is influenced by polluted water-soils, as shown in the picture. One of the possible effects of polluted sludge is that it may cause water with little or no oxygen, with little or no life in it.

Figure
The effect of the accumulated sludge on water-quality and different plat- and animal species (biodiversity)



Another possible result is that the pollution will be absorbed by organisms, living in or on water-soils like worms, shell animals and plants. These organisms are eaten by fish and birds. In the end, the whole food-chain is at risk, including human beings, as presented below.

Polluted water-soils

Risk for:

Nature:	**Humans:**
Accumulation toxic substances in fish and mammals by: - direct contact with pollution - eating of soil animals - eating of plants - eating of fish	Accumulation toxic substances by: - direct contact with pollution by recreation activities in or near polluted water soils (pre higher risk for children) - eating fish

Source: Brouwer, 2004 (translation by TME)

Next an explanation is given on the possible changes that need to be compared and valuated:

YOU ARE NOW KINDLY REQUESTED TO FIRST READ THE FOLLOWING TEXT
In total, 85 million cubic meters (m3) of polluted sludge is accumulated in water-soils, where this is a risk for nature and environment. To compare: with this amount, 200 of the largest mammoth oil tankers on the world could be filled. If in the coming 10 years no additional dredging takes place, 90% of polluted sludge will stay in the water-soils, with as consequence that the numbers of plant- and animal-species (biodiversity) in and around water in the Netherlands remain small or even decrease further.

Two situations are considered:

Situation 1: In the coming 10 years no additional sludge will be dredged on places where this is a risk for nature and environment. As consequence that the numbers of plant- and animal-species (biodiversity) in and around water in the Netherlands remain small or even decrease further

Situation 2: The coming 10 years all 85 million cubic meters of polluted sludge will be dredged, on places where this constitutes a risk for nature and environment. As a consequence, the number of plant- and animal species (biodiversity) in and around surface water increases.

Key descriptive statistics on the population interviewed

In the questionnaire a few questions should be added on characteristics of the population that is interviewed:

- age
- sex
- level of education
- household income
- size of household
- ownership of dwelling

Such information can be used in the analytical stage of the investigation to see if the sample is representative. The information can also be used (if relevant) to correct the answers of the sample. For example, if 30% of the relevant population (normally adults) is under 30 years old, and 70% over 30 years, whereas in the sample 85% of the respondents is over 30 years, the relative weight of answers of younger respondents could be increased to adapt the sample results to the entire population.

Sample and population

First one needs to decide which part of the population is relevant (all or only part of the population, for example a region or an age group). Next one has to draw a sufficient large samples out of the population(groups).

There are four ways of performing a study:

- postal survey: sending a questionnaire with (prepaid) return envelope
- internet survey;
- telephonic interviews;
- face to face interviews.

First one needs to decide on the acceptable size of the sample. This should be related to the population to be surveyed (i.e. whole country or a region) and sufficient results to have reliable (significant) results. As a rule of thumb one would like to have between 500 and 2000 answers on a questionnaire (if dealing with a problem that affects large parts of population).

In order to have high response rate (the respondents in the sample that will return a useful answer), one needs to follow certain rules:

- don’t take too much time of people (10 minutes is better than 20);
- make people feel rewarded (by compensating them financially or otherwise)

- design an attractive but to the point questionnaire, with questions that leave little doubt for misunderstanding;
- make it easy to give answers and return the questionnaire (an envelope with stamp and return address)

However, getting a high response rate also may limit the possibility to get detailed answers. So always a balance needs to be sought between quality and quantity.

In case of a high non-response (to a postal survey) one might exercise a small control (telephone) interview (focussing on only a few questions) to know whether the non-repondents gradually would react the same as the respondents.

Control questions

It is always good to include control questions in the questionnaire to test the robustness of the results of a CV-survey.

Examples:

- if possible, ask people about current payments of related (environmental) services. For example, if water related issues are under investigation, one may ask respondents how much they think they are paying for water services (supply of drinking water, sewerage and wastewater treatment). Preferably, this should be an open question, but also a closed format may be used, if an open question would pose to much difficulties (for example, when not referring to private payments but to tax-increase or budget spending)
  The answers can be compared with actual recorded payments (statistical or through water companies)
- Ask if respondents their willingness to preserve nature, biodiversity, natural habitat (to check consistency with results on willingness to pay questions)
- Ask (in case of NONE willingness to pay) what reasons respondents have not to pay (for example include the following reasons):
  - Nature protection should be regulated by law
  - Polluters should pay
  - Water (Nature) already is in good shape
  - I already pay enough taxes
  - I do not earn enough
  - Should be paid from general budget (rearranging priorities)
  - Etc.
- Ask (at the end of the questionnaire) if people agree with the following two propositions:
  - proposition 1: Plant- and animal species should be protected by law, not by asking people to pay for it.
  - proposition 2: Plant- and animal species have the right to be protected however much this would cost our society.

Willingness to pay questions

These form the core of the questionnaire (for analytical purposes) and can be asked in several different formats. The main choice is between:

- an open question: How much would you be willing to pay to ……..? (referring to one of the alternatives given and explained in the questionnaire) and asking people to specify a certain amount of money.
- a closed question: asking people to fill in a closed question and mark the relevant / right answers:
  - pay-card format: about 10-30 different amounts can be mentioned and respondents should specify which amount he would be willing to pay (one answer only)

- digotomous choice format: for about 10 amounts respondents are asked if they are willing to pay or not for the mentioned amount (note that in each questionnaire only one amount is mentioned, on which respondents should answer yes or no on the willingness to pay question). This means that 10 different kind of questionnaires are diffused (with 10 different "yes or no" questions on a varying amount of money);
- in both cases the designer of the questionnaire should have some idea of the range of willingness to pay of the surveyed population. Such information can be obtained from earlier investigations, or from a quick rough sample with the open question (for example street interviews).

Also a combination of formats is possible. For example the following question could be asked, combing the "open" and "closed" format:

"How much would you be willing to pay for improved air quality to EU standards in the inner city of ...." (assuming that some background information is given on air quality, the causes and the morbidity and mortality due to air pollution)
- € 2 per year (for the household I am living in) YES NO, please specify amount which you would be willing to pay less than € 10
- € 5 per year, YES
- € 10 per year, YES
- € 20 per year, , YES, NO, if more specify what you would be willing to pay.

Things that should specified in relation to the willingness to pay question are (based on King and Mazzota):
- If the household is the unit of analysis, the reference income should be the household's, rather than the respondent's income;
- The mechanism by which the payment will be made, for example through increased taxes or private contribution;
- Respondents should be reminded to consider budget constraints;
- Respondents should understand the frequency of payments required, for example monthly or annually, and whether or not the payments will be required over a long period of time in order to maintain the quantity or quality change. They should also understand who would have access to the good and who else will pay for it, if it is provided;
- In the case of collectively held goods, respondents should understand that they are currently paying for a given level of supply. The scenario should clearly indicate whether the levels being valued are improvements over the status quo, or potential declines in the absence of sufficient payments.

Statistical analysis

Before making any claims on the "willingness to pay", the results of the investigation should be analysed making use of statistical techniques to test the statistical significance of the results.

3.3 Market prices

3.3.1 Introduction

The most obvious way of measuring the value of nature is to see how much crop, fish, wood, livestock, etc. can be obtained by sustainable use of the natural habitat. By surveying crops, woodcutting, cattle breeding, etc., in combination with (local) market prices, the direct use value can be measured.

This method can of course only be applied if direct use values are to be estimated, the production (and surpluses) and market prices are known.

In principle the application of the method is rather straight forward, measuring production (surplus), observing prices and multiplying the quantities with the prices.

The method of using “market prices” is often used to assess the (a part of the) value of natural habitats (wetlands, forests, pastures, etc.).

3.3.2 Application

To apply this method basically two types of information are needed:

- production quantities of marketable goods (on the precondition, that the level of production is “sustainable”, that is to say, does not exceed the carrying capacity of the natural habitat)
- local market prices.

Once these two issues are know, the total value of direct use for a certain category can be estimated. The method is very applicable in regions where not all products are sold for money (partly exchanged and partly consumed by the producer).

To apply the methodology, first an overview must be made of the potential direct use values. This may include:

- crop growing (at small and integrated scale), including non cultivated picking herbs, medical herbs, fruits, etc.;
- cattle breeding (also taking into account the carrying capacity);
- fish;
- hunting of mammals and birds;
- firewood;
- wood for construction;
- (clean) water extraction;
- recreation (or economic activities related to recreational activities)

The next step must be to assess quantities extracted or produced. This can be done by a survey under a representative sample of the population / beneficiaries of the natural habitat. Some knowledge in advance must be obtained to tailor the questions to the actual situation. This may be the way in which crop is produced, whether it is sold and at what price to whom (what market?), in case of own use, quantities must be estimated, the interviewer then needs to know what is the best way to communicate about such quantities (sacks, kg, other units) and if necessary establish rules of thumb (one sack means 20 kg, a bread is 600 gram, a cubic meter of wood equals 500 kg, etc.).
Also, as with CVM questionnaires, key household information needs to be collected, as to enable statistical sound processing afterwards.

The sample must be large enough to be more or less representative for the population. This may involve several 100 interviews, to meet statistical demands. By comparing characteristics of the sample with the total population under investigation, the results of the sample can be magnified to the whole population.

3.3.3 Practise

Valuation of the Kolketi wetlands in Georgia

In the period 2001 – 2005 a variety of studies have been carried out to assess the economic importance of the Kolkheti wetlands in Georgia.

Two major studies were carried out to assess the economic importance:

- a Cost Benefit study on the establishment of the kolketi national park (Arin)
- a study on Valuating resources in Black sea coastal wetlands (Neiland)
- a study on Resource Use in the Kolkheti National Park: Grazing, Logging, Fishing, Hunting (ICZMC).

All of these studies have mainly focussed on collecting data on the direct use values for the population living in or near the wetlands (in the “support zone”).

All three studies have made use of questionnaires and interviews to assess economic use values for the population. By comparing the sample population with total population, estimates were made for the whole area (which was different in each of the three studies).

These data were then combined to assess “unit values” for wetland valuation. This was done by dividing the total use values per category for the study area by the area in hectares. Then the results of the three studies were combined, and the “best” estimates were selected of the three studies to arrive at a credible figure for the Kolketi wetlands (expressed in € per ha annual value). The results of this are shown in the next table.

Table
Estimated direct and indirect use values of the Kolkheti wetlands, in € (2005) per ha.

(in)direct use	value (€ per ha)
Crop	168
Livestock	169
Fishing	237
Wood & wetland products	13
Hunting	9
Recreation and Tourism	0,51
Carbon Sequestration	3,03
Existence Value	0,94
Total	601

Source: own estimate based on: Arin (2001), Neiland (2001) and ICZMC (2004)

The first 5 direct use categories were assessed by making use of market information. This information was gathered by field investigations, interviewing several 100’s individuals about their social-economic situation in relation to the wetlands (crop, firewood, cattle, hunting, fishing, etc.) and (semi) market prices for these products. As such the average income from wetland products could be estimated per household. Next, the total income was assessed for the population under investigation, and finally, this total was divided by the number of hectares.

Use value of recreation was estimated on basis of a few assumptions about increased recreational activities and value added per additional (eco)-tourist. For carbon sequestration it was calculated how much carbon can be sequestered per year and this was multiplied by a “Carbon price” of US$ 10 per tonne C. Finally, the existence value has been estimated by making use of a WTP study in Georgia for biodiversity preservation in “strict” natural parks (closed to the public, only open for research) and attaching this number (GEL 2 per capita per year) to the Kolketi wetlands.

3.4 Dose response function and valuation of morbidity, mortality, loss to crop and real estate

3.4.1 Introduction

This method is often used in studies that aim to estimate the monetary damages of environmental degradation, for example through pollution of the air by fine particles, sulphur dioxide, nitrogen oxides and volatile organic compounds. It has been successfully applied in EU studies on air-pollution (ExternE). It requires large datasets, establishment of dose-response function (for mortality, health, loss of crop and real estate). Moreover, it requires valuation of mortality, putting a monetary value on life, which is not undisputed.

3.4.2 Application

To apply this method a variety of information is needed (see for example (Dixons, 1997):

- Emissions of certain substances (fine particles, SO2, NOx, VOC) and the resulting ambient air concentrations;
- The exposed population (or crop, buildings) by the different ambient air concentrations;
- Dose response functions, describing the relationship between exposure to certain ambient air concentrations and morbidity (illness) and mortality (death), or reduced crops, additional maintenance costs of buildings;
- Examination of the costs of morbidity and mortality or costs of crops.

The first type of information can be obtained from actual measurements and emission cadastres (if existing). Also exposed population can be estimated by making use of statistical information.

To establish dose response functions, involves the analysis of large amounts of information about relevant parameters (concentration of pollutants, exposure (and who or what is exposed?), physical response in terms of number and type of morbidity and mortality cases).

Although there are some theoretical problems (for example, to attribute a specific pollutant in stead of a cocktail of pollutants to morbidity or mortality), in principle the methods to establish dose response functions are theoretically sound if used with caution.

A simple, “quick and dirty” formula to estimate mortality due to air pollution, is established by (Dixon, 2000):

Mortality = $6.72 * 10^{-6}$ * (concentration of PM10 in mg/nm3) * (population)

For example:

- a city has 20 000 inhabitants
- the concentration of PM10 in the air is on average 80 mg/nm3

mortality can be estimated as:

- $6.72 * 10^{-6}$ * (80 mg/nm3) * (20 000) = 10.8 inhabitants per year

The monetary valuation of environmental impact on human life and health is one of the more complex and controversial issue in environmental valuation theory and practice. In this kind of analysis, an individual estimation of personal value of life and health is basic. Valuation of the individual’s life made by the other members of society should be added in the next stage, and finally the aggregate social costs incurred by the environmentally caused health problems should be taken into consideration. According to that, life risk valuation include three kinds of estimates:

VOR_{ii} refers to the individual **i’s** valuation of risk to themselves, i.e. “own risk”

VOR_{ij} refers to the individual **j's** valuation of risks to individual **i**
SCI_i refers to the social cost of illness suffered by individuals and by the rest of society, i.e. social cost of morbidity, invalidity and mortality.

Statistical value of life is calculated by adding all individuals' WTP aimed for environmental improvements. For example, it is assumed the annual death risk caused by a certain environmental change is 0.005 and that the exposed population is 10,000. This means that in the analysed group there will be 50 death cases in the year to come. If specific measures and policies were implemented, the risk rate would be 0.003, and twenty lives would be saved. If all of the targeted group members are questioned to reveal personal WTP for risk minimisation, and the average WTP is 5000 US$[5] it means that 10,000 men together are willing to pay 50 million US$ for the environmental improvement. Assuming that the improvements will cause 20 saved lives annually, it can be stated that the average statistical value of life is 2,5 million US$.
It is clear that the mentioned technique only gives an indication of the "real value of life". It is just a way to obtain economic information how much the targeted population is willing to pay for the improvements.

Certain improvements in practice can be made with "value of a life year" (VOLY) calculations. Instead of mortality estimation, a valuation is made for an additional year of life saved by the environmental improvements. For example, if an implementation of the specific environmental improvement measure has effect in 0.4 years longer life, and the average WTP for cost coverage is 10.000 US$, it can be concluded that an additional year of life has value of 25.000 US$ for the targeted group of people.

Similar approach can be used in WTA ("Willingness to avoid") analysis. However, the results obtained using WTP and WTA may differ in a range 2-5 times (Gregory 1986). The reason for such drastic deviation can be found in a fact that there is no substitutes for the majority of environmental goods, and men are much more willing to claim for a compensation for the lost benefit, than to pay for environmental resource protection (Hanemann 1991).

In applying the mentioned techniques, another drawback may appear, related to the individual wealth of respondents. The fact is that WTP and WTA will largely depend on wealth of people analysed. So, the rich will always attach higher values to the environmental goods and services than the poor, irrespective of the real risks.

Although the method has the mentioned drawbacks, it is widely used. For example, the ExternE project of the EU makes (also) use of this method, and also in the Netherlands it has been used to assess damages of air pollution. Currently, the value of life in these kind of studies is about € 1 - € 3.5 mln per case of mortality (depending on income levels in the EU countries).

Less disputed is the use of this method to assess health related costs (medicine, loss of production through illness, social payments), losses of crops (for each important crop dose-response relations have been established) and additional maintenance costs of buildings.

[5] The willingness to pay can also be assessed by statistical techniques by observing health budgets, estimated loss of incomes, social subsistence costs, etc.

3.4.3 Practise

The benefits of compliance with the environmental acquis for the candidate countries

In this study (ECOTEC et al, 2000), the benefits of the reduction of air pollution in candidate countries[6] are estimated. For that purpose, use is made of the Ecosense model, which enables modelling of main emission sources all over Europe, exposed populations, and assessments of the damages to health and mortality by dose-response functions. In the final step, money values are attributed to the avoided number of mortalities and other benefits.

In the following table an overview is given of the benefits of avoided mortality in the "candidate countries". The first column gives an overview of the estimated (minimal) reduction in mortality in the candidate countries, due to the implementation of the EU environmental directives on air pollution. The second column gives the correction factor for Purchase Power Parity (see under benefit transfers for further explanations), which is an indicator of the value of life used in the study (in this case it also represents the value in € million per case of mortality). The last column shows the calculated annual benefits due to reduced mortality.

Estimated annual (minimal) reduction of premature mortality due to implementation of the EU air directives, and monetised benefits thereof

Country	reduction of premature mortality	correction for Purchase Power Parity	Benefits € mln per year
Bulgaria	357	0,30	107
Cyprus	64	0,75	48
Czech Republic	996	0,39	388
Estonia	136	0,43	58
Hungary	998	0,42	419
Latvia	171	0,43	74
Lithuania	101	0,43	43
Malta	11	0,75	8
Poland	7 115	0,48	3 415
Romania	2 423	0,25	606
Slovakia	714	0,39	278
Slovenia	93	0,75	70
Turkey	1 820	0,46	837
Total	14 999		6 353

Source: based on Ecotec, 2000.

By making use of standardised dose-response functions and models that can assess the relationship between reduced emissions and reduced concentrations, the results shown in the above table can be acquired in a relative cost-efficient way. However, the basic research to better understand the dose-response functions, and model these in a more detailed way is very costly and time consuming but may improve the results. For example, the results of a Dutch study show that the way the population is divided over age groups largely influences mortality rates and thus damages and benefits (RIVM/EFTEC).

[6] Actually, ten of the mentioned countries became member of the EU in 2004.

3.4.4 Value of life and purchase power parity

The following table gives an overview of the value of life in various countries (including Georgia and some neighbouring countries). The assessment is based on the Value of Life in the Netherlands and Purchase Power Parity comparisons between countries.

Table
Value of life and purchase power parity

country	Purchase Power Parity (estimate 2005)	Purchase Power Parity (estimate 2005)	Value of Life (estimate 2005)
Netherlands	$30.500	€ 24.400	€ 3.360.480
Georgia	$3.300	€ 2.640	€ 363.593
Armenia	$4.500	€ 3.600	€ 495.809
Azerbaijan	$4.800	€ 3.840	€ 528.862
Russia	$11.100	€ 8.880	€ 1.222.995
Ukraine	$7.200	€ 5.760	€ 793.294
Moldova	$1.800	€ 1.440	€ 198.323
Romania	$8.200	€ 6.560	€ 903.473
Bulgaria	$9.600	€ 7.680	€ 1.057.725
Turkey	$8.200	€ 6.560	€ 903.473
Greece	$22.200	€ 17.760	€ 2.445.989

Source: Value of life (Netherlands): EFTEC/RIVM; PPP: CIA The World Factbook (version October 2006), US$/€=1.25

The “value of life” for the Netherlands is calculated as follows:

Calculation average Value Of Life (VOL), the Netherlands

Mortality	VOL (2000)	VOL (2005)	Share (2005)	VOL (2005)
Under 65 years	€ 3.470.000	€ 3.512.507	86,0%	€ 3.019.486
65 years and over	€ 2.400.000	€ 2.429.400	14,0%	€ 340.994
Average value of life			100,0%	**€ 3.360.480**

Source: VOL 2000: EFTEC/RIVM (2000, p. 83) and own assessment.

It starts with the VOL values for 2000, these are adapted for economic growth (per capita: 1,2% in total over 5 years), next the shares of “under 65 years” and “65 years and over” for 2005 are added to assess the average value of life in 2005.

3.5 Hedonic pricing

3.5.1 Introduction

Hedonic pricing is a valuation method making use of revealed preferences. For example, the prices of property is compared with certain environmental characteristics like noise, vicinity of nature, valuable ecosystems, natural habitats, biodiversity, clean water, etc.
By statistical analyses the environmental or nature valuation attributes in the price of property can be separated (for example, price of property decreases by 0.5% by an increase of the noise level with 1 dB(A)). This method is mostly applied to noise, but it can also be applied to nature by looking at values of property near natural areas.

3.5.2 Application

Applying hedonic pricing requires access to and capacity to process large amounts of real estate market information, environmental characteristics of property, etc. So normally, such projects can only be undertaken by statistically well educated researchers.

Often, researchers make use of earlier estimates. For example, if the relationship between the value of property and a change in noise level of 1 dB(A) is established in general terms (for all property applicable), this relationship can be applied in other situations as well, if certain demands are met (see paragraph on benefit transfer for further reading).

Hedonic pricing is applied in only a few cases in nature protection (see (OECD)).

3.5.3 Practise

Assessing benefits of noise policy in the Netherlands

In 2000 a study on the benefits of environmental policy in the Netherlands was performed. Noise benefits were estimated in 2 ways: by assessing willingness to pay, and by means of hedonic pricing. In latter case, use was made of earlier estimates and combined with Dutch noise data.

The following table gives an overview of results from various hedonic pricing studies for traffic noise.

Road traffic noise valuation studies in Europe

Study	Country	% change of house price per dB(A)
Vainio (1995)	Finland	0.36
Haolomo (1992)		0.98
Weinberger et al (1991)	Germany	0.5 - 1.3
Collins and Evans (1994)	UK	0.65-1.28
Bateman et al (1999)	UK	0.20
Soguel (1994)	Switzerland	0.91
Pommerehne (1988)		1.26
Iten and Maggi (1990)		0.9
Saelensminde and Hammer (1994)	Norway	0.24-0.54
Grue et al (1997)		
Obos		0.24
Flats		0.21
Houses		0.54
Lambert (1992)	France	1.0

Although an average of between 0.6 – 0.8% can be determined from the above results, in the Dutch study an average value of 0.4 % change per dB(A) has been applied to assess the total damage of noise. The main reason is that most recent studies point at somewhat lower values.

This leads to following estimate of noise damage in the Netherlands.

Total noise damage for the Netherlands in 2010

Noise band	Average exceedance (in dB(A)	No of households (x 1000)	NDSI	Average house price	Damage Present value € million
51-55	3	2089	0.004	€ 124 921	€ 3 131.4
56-60	8	2197	0.004	€ 124 921	€ 8 782.9
61-65	13	1054	0.004	€ 124 921	€ 6 844.9
66-70	18	285	0.004	€ 124 921	€ 2 559.3
71-75	23	55	0.004	€ 124 921	€ 630.2
76-80	28	11	0.004	€ 124 921	€ 155.5
>80	32.5	1	0.004	€ 124 921	€ 24.1
TOTAL					€ 22 128.2

Source: EFTEC/RIVM

3.6 Travel cost method

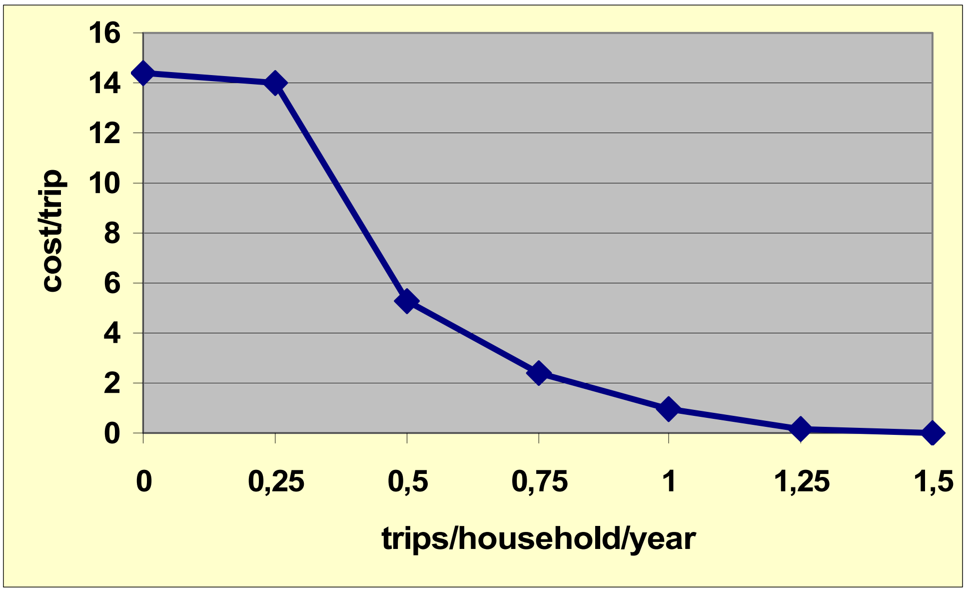
3.6.1 Introduction

Part of economic behaviour can be measured by looking at how individuals spend their money and time. The Travel Cost method aims at measuring travel costs in relation to visits to for example natural habits. As it measures the actual travel expenditures of individuals (as a function of distance) in relation to for example the visit to a natural habitat, the recreational value of the natural habitat can be measured.

The basic assumption behind this valuation method is that someone who has low expenditures to make a visit to the natural habitat, has a higher "consumer surplus" than the visitor of the habitat that pays a lot to get there (due to longer distance).

3.6.2 Application and practice

To measure travel costs, first a "demand curve" for visiting natural habitats must be estimated. This is done by collecting a lot of information of visitors of the site (number of trips per year, travel costs, distance to the site). As illustration a demand curve is shown in the figure. It basically shows the relationship between number of trips per household per year (x-axis) and the travel cost per trip (y-axis). It can be seen easily that increasing travel costs lead to less annual trips.



The next step is to calculated consumer surplus. It is clear that the consumers who make 1.25 visits per year, have much lower costs than the visitors who just make 0.25 visits or less per year. By integrating the demand curve between the actual costs of visits and that price at which the visitor rate would fall to zero (the y-axis), the consumer surplus is estimated. This leads to the following summary of results in the next table:

Calculation of consumer surplus for a natural site

zones	zonal population	household trips	number of trips per household	average travel cost per household	average travel cost per trip	Consumer surplus per hh	consumer surplus per trip/hh	Total consumer surplus per year
1	10000	12500	1,25	0,16	0,128	2,6	2,08	26000
2	30000	30000	1	1	1	1,67	1,67	50100
3	10000	7500	0,75	1,83	2,44	0,94	1,25	9400
4	5000	2500	0,5	2,66	5,32	0,42	0,84	2100
5	10000	2500	0,25	3,5	14	0,1	0,4	1000
	65000	55000	0,85					88600

Source: OECD, Handbook of biodiversity valuation

The table shows that first zones have to be defined, next the population per zone needs to be assessed. Then per zone the number of household trips needs to be counted. This enables calculation of number of trips per household per year. Next, the average travel costs per household need to be assessed per zone (by taking into account distance, fuel costs, depreciation costs, bus ticket costs, “time” costs). This enables to estimate a “demand curve” (as shown above) and estimation of consumer surplus. By multiplying consumer surplus by the number of trips per year, total consumer surplus can be calculated. This total represents an estimate of the Willingness to Pay of visitors of the natural site for the “use-value” of the site.

3.7 Prevention costs

3.7.1 Introduction

Applying preventive measures is a way to mitigate negative effects of economic developments for nature. The costs thereof can be regarded as the value of the protected area or species, assuming that the democratic process that leads to such measures and thus expenditures represents a “societal demand curve” for a clean environment.
Examples of such measures can be other, longer routes of road (to prevent cutting off part of a natural area), a tunnel, passages for animals.

A major drawback of this method, is that it gives an estimate of mitigation costs. Even assuming that the level of costs is in accordance with the societal preferences, it may underestimate the actual values of nature (as theory says that we should spend money on problems as long as the additional benefits are larger than the additional costs). But, in case an irrational decision has been taken (without democratic consultation) spending much money on small additional benefits, it also may be that the value is overestimated.

Therefore, it is recommended to use this method primary to make a first rough estimate.

3.7.2 Application and practise

Applying the method is relatively simple. One needs to identify the problem to be valued, and one needs to know (or estimate) expenditures to mitigate the problem.

An example of using prevention costs to value nature is the following:
The Dutch and Belgian governments almost agreed on re-activation of an old railway (“Iron Rhine”, from Antwerp to the Ruhr area). TME (2002) carried out a study on the potential economic damage due to this. Part of the Railway goes through a natural reserve the “Meinweg” of 1,800 hectares.

The value of this area was assessed in various ways, one of the methods was to estimate the damage (due to the railway) based on prevention costs. The preventive measure is the construction of a 5 km tunnel under the Meinweg area (which would solve the problem largely) would cost about € 115 mln. Divided by the area protected (1,800 hectares) the value of the Meinweg can be estimated at € 63,000 per hectare.

3.8 Compensation costs

3.8.1 Introduction

In some cases, a natural habitat is destructed due to the construction of a road, a harbour, industry, etc. Clearly, economical interests prevail in such cases. Theoretically spoken it is possible to create a new nature area that can be compared with the old area (although copying a natural habitat is not for 100% possible), as to compensate the loss of natural habitat.
The costs to compensate the loss of natural area can be assumed to be the value of the nature area in question (as a lower limit value).

As with prevention costs method, this method explains the value of a natural habitat by looking at the costs of replacing an existing value, rather than estimating the user and non-user values. Therefore, this method should only be used for a first rough estimate, if no other materials are available.

3.8.2 Application and practise

If we take the example of the Meinweg (see paragraph on preventive costs) again, the following can be argued.
In this case we assessed the value of nature (per hectare) by estimating how much it would cost to create elsewhere the same kind of natural habitat. A study of ANWB (1992) estimates that to create one hectare of nature incurs costs to society of € 45,000/ha. Applying this to the 1,800 ha of the Meinweg, sets the value to € 81 mln.

3.9 Opportunity Costs method

3.9.1 Introduction

The opportunity costs of a resource, is the value of the next-highest-valued alternative use of that resource. For a natural area this may be agricultural use, use as a road, and in some cases economic development (industry, housing). The opportunity costs of nature thus will depend largely on location and (for agriculture) fertility. In the Netherlands natural area is valuated at about € 20,000 per ha (CBS), agricultural land costs € 30,000 – 40,000, industrial € 100,000 - € 200,000 and housing € 2,000,000 - € 5,000,000 per ha.

In this situation, the value of the habitat will be determined by the surrounding economic factors. So in different economic and spatial situations, the same ecological values can be valued differently in money terms.

3.9.2 Application and practise

Application of this method is not widespread, as one may have “moral” problems with applying the method. For example, to assess the value of a natural habitat, one might argue that there would be people willing to pay a high price for the land, if they were allowed to build a house there (which is exactly what the nature protector doesn’t want). Taking this price would give an upper estimate of the natural habitat.

The main problem with this method is that it probably overestimates the value of nature, as the price is based on the next best economical use of land (which in this case would be construction of houses). It can be argued that the economic use of the land in stead of nature, adds value to the land, so the value of nature would be lower. But the opportunity cost method does not give an indication of how much lower, so results of this method will be difficult to interpret.

3.10 Benefit transfer

3.10.1 Introduction

Benefits transfer is a frequently applied method aimed for economic valuation of environmental changes. The essence of benefits transfer is that use is made of previous valuation studies of similar environmental performances in other countries or regions, and then, with necessary adjustments, is applied in a present study. It relies on methodology and data from previous studies, and it transfers it to the current case, producing estimates for a specific environmental damage.

Relying on the results from previous studies may create a set of problems. It is not always methodologically correct to transfer and to apply data on physical impacts, geographical aspects and local population preferences form a previous study to the current one. The mentioned procedure is more accurate if the local influences are less. For global impacts, such as climate change, or ozone layer depletion, the methodology is fully justified. However, when local characteristics are present, previous results should be adjusted and applied with care. Necessary adjustments should be made for: income, population size and characteristics, background conditions and other determinants for which current data are accessible.

Boyle and Bergstrom (1992) proposed the following three criteria for a successful benefits transfer application:

- Similarity of the environmental good or service to be valued;
- Similar demographic, geographic, economic and social characteristics, or the ability to adjust for these kinds of parameters statistically (King & Mazzotta, 2004). EFTEC/RIVM mention the following potential adjustments (p. 127):
    - average income;
    - population size and characteristics;
    - background conditions;
    - level of impacts, and
    - other determinants;
- Evidence of sound economic and statistical methodology applied in the preliminary study.

A fourth, practical criterion is:

- Use if possible more than one reference study to have an idea of credibility and reliability.

The advantage of benefit transfer compared to more fundamental research method is the saving of time (quick results) and costs. The disadvantage is of course the lack of credibility (especially when using results from EU or US and transfer them to for example Georgia) and the lack of “local evidence” (benefits assessments based on local interviews).

3.10.2 Application

The benefit transfer methodology is especially useful in cases where an assessment of a wide range of environmental damages needs to be made at country or regional level. In such case the assessment of different damages require various different approaches/methodologies. It then will be very costly and time consuming to perform various original valuation techniques like Contingent Valuation (“Willingness to Pay”), Hedonic pricing, Time costs, etc.

Applying Benefit transfer, requires adjustments of some of the parameters used in the original study. For example, when using damage estimates of air pollution of a reference case and applying it to a new case, one needs to consider:

- concentrations of the pollutants in question

- exposure (how many people are exposed to certain concentrations);
- the dose-response function: if it is a general one (like presented in the paragraph on dose-response functions), one needs to consider whether the exposed population has the same characteristics as in the reference case. This of course does not have to be the case: a relative young population will be less sensitive that a population with much aged people;
- the value of life (this may differ largely between countries depending on purchase power parity comparisons: see box). In general the value of life nees to be adapted to the local circumstances. For example, if the value of life in the original study was € 1 mln (let's assume the Netherlands) and the correction factor for the casestudy area (assume Serbia) is 8%, the value of life to be used in the benefit transfer is € 80,000 per capita.

Purchase Power Parity

A common way to make international economic comparisons between countries is to use so called purchase power parity (PPP) figures instead of using the official exchange rate. By using PPP attention is given to lower prices in some countries than others. PPP-indicators are frequently published by the OECD (and can also be found in the CIA factbook, which gives standardised profiles of nations around the world)).

The following table gives a few comparisons of GDP and GDP per capita expressed in PPP (2005)

GDP and GDP per capita in selected countries. purchase power parity in US$ 2005

	GDP mln US$ (ppp'05)	GDP/cap US$ (ppp'05)	GDP/cap as % of GDP/cap Netherlands
Netherlands	$499,80	$30.500	100%
Georgia	$15,56	$3.300	11%
Armenia	$13,46	$4.500	15%
Azerbaijan	$37,92	$4.800	16%
Russia	$1.589,00	$11.100	36%
Ukraine	$340,40	$7.200	24%
Moldova	$8,18	$1.800	6%
Romania	$83,60	$8.200	27%
Bulgaria	$71,50	$9.600	31%
Turkey	$572,00	$8.200	27%
Greece	$236,80	$22.200	73%

CIA, 2006

Compared to surrounding countries, GDP per capita in Georgia in 2005 is about 30 – 70% lower. Compared to the Netherlands, Georgian GDP per capita is 11% in 2005.

3.10.3 Practise

Examples of studies in which the benefit transfer methodology has been used successfully are:

European Environmental Priorities: an Environmental and Economic Assessment

The European Commission DG Environment study “European Environmental Priorities: an Environmental and Economic Assessment” (RIVM et al 2001a). This study estimates at EU level the economic costs to prevent and benefits to environment for various scenarios and over ten policy priorities. The methodology is based on a logical stepwise progression through emission, change in exposure, quantification of impacts using exposure-response functions, to valuation based on willingness-to-pay. For acidification and ozone the benefits are calculated by using monetary unit damage estimates for four pollutants (expressed as € per tonne SO_x, NO_x NH_3 and VOC), which were derived from a AEA-Technology study (RIVM, 2001b, p. 63, 73). Benefits of reducing particle matter (PM10) in air are based on mortality and morbidity costs and dose (emissions and concentrations) – response functions (RIVM et al, 2000a, p. 68-71). For climate change unit damage values (in € per tonne CO_2, CH_4 and N_2O) are used to asses benefits (RIVM, 2000b, p. 62). For water quality unit benefits were estimated based on Willingness to Pay studies for improved water quality and unit damage costs (expressed in € per tonne N and P) were derived from various Baltic Sea studies on nutrient reduction (RIVM et al., 2000c, p.34). Waste related benefits were also estimated using unit damage values for various disposal routes (expressed as € per tonne waste incinerated, landfilled, recycled and composted) (RIVM, 2000d).

The Benefits of Compliance with the Environmental Acquis for the Candidate Countries

The European Commission DG Environment study “The Benefits of Compliance with the Environmental Acquis for the Candidate Countries” (Ecotec et al. 2001). In this study, air quality benefits are estimated making use of the Ecosense model which was developed for the EU ExternE project. In Ecosense emissions and concentrations, dose-response functions for health damages, crops and monuments are modelled and linked by monetary unit values (for human life, etc.) to assess damages. For water damages were assessed by using Willingness to Pay studies from UK and USA for improved water quality (using € per inhabitant per year estimates). Waste damages are mostly assessed indirectly through impact-pathway analyses combined with Life Cycle Analyses of waste, estimating emissions of air pollutants (CO_2, CH_4, NO_x, etc.) and applying unit values (expressed as € per tonne CO_2, CH_4, NO_x, etc.).

Valuing the Benefits of Environmental Policy: The Netherlands

The study for the Netherlands Ministry of Economic Affairs “Valuing the Benefits of Environmental Policy: The Netherlands” (EFTEC/RIVM 2000), London, 30 June 2000. This study largely follows the European Commission DG Environment study “European Environmental Priorities: an Environmental and Economic Assessment” (RIVM et al 2001a). Additionally damages for noise and soil have been estimated. For noise benefit transfer (% decrease in value of property related to increase in noise levels, based on “hedonic pricing” studies) has been applied to assess benefits of the policy.

Valuing the Meinweg (1 800 ha natural habitat)

Another example of benefit transfer, related to nature is the study on the value of the Meinweg (in the Netherlands).
For the Meinweg different approaches were applied to asses the value of this natural habitat of 1,800 ha (see also paragraphs on willingness to pay, compensation costs and prevention costs). This leads to the following estimates making use of benefit transfer:

Original method	Value per hectare (€)	Total value Meinweg
Willingness to pay	€ 48,270	€ 86.8 mln
Compensation costs	€ 45,000	€ 81 mln
Prevention Costs	€ 63,000	€ 115 mln

Source: TME, 1999.

Valuing the Kolketi wetlands

For the Kolketi wetlands, an overview was made of the standardised results of various studies on wetland valuation. This results in the following overview of values (per hectare)

Derived annual unit values for wetlands (in € of 2005 per ha) from various studies, Georgian price level and purchase power parity

Study	Unit value € per hectare	Comments
"Nature study" (Constanza, 1997)	1,554	Specific for wetlands, PPP correction Results of study later heavily criticised (overestimation)
"Baseline Resource valuation study" (Neiland et al, 2002)	1,110	Specific for Georgia, direct use value (total value divided by area)
"Meta study on wetlands valuation"(Brouwer et al, 1997)	401	Specific for wetlands, based on WTP per household, PPP, Georgian population
Worldbank Cost Benefit study (Arin, 2001)	315 - 325	Specific for Georgia, mainly direct use value (total value divided by area)
TME (2002)	304	For nature conservation in general, PPP correction
"Meta study on wetlands valuation"(Brander et al, 2004)	40 (large range)	Specific for wetlands in the CCRU database on global wetlands, based on value per ha

Source: TME, based on various studies reviewed

The table shows that before applying benefit transfer, one must make difficult choices: which studies are most representative for the "transfer" case. This often means that the original studies must be carefully examined, as to assess what comes closest to the "transfer" case.

Damages due to environmental pollution in Serbia

In case the damages of environmental pollution have to be evaluated (and thus the potential benefits of environmental policy), a relative simple benefit transfer methodology can be applied. In this benefit transfer unit values for a variety of pollutants have been established, reviewing recent relevant available literature (of which many sponsored by the EU).

Conclusions

The conclusion of this overview may be that in case benefits or damages have to be assessed at country level (or at EU level) the benefit transfer methodology is used successfully. The examples show that the type of benefit transfer applied differs from case to case:

- for acidification the Ecotec study uses the Ecosense model which follows the logical stepwise progression through emission, change in exposure, quantification of impacts using exposure-response functions, to valuation based on willingness-to-pay. In the study for the EU Pearce applies unit damage values per kg Pollutant emitted, thus implicitly covering the steps “change in exposure” and “impacts due to exposure-response function” in these numbers;
- Whereas Ecotec analyses waste disposal chains by means of LCA, indicating changes in emissions and using unit values for emissions to assess the damages of each waste disposal route, in the in EU study Pearce makes use of earlier conducted studies to directly arrive at monetary unit costs per tonne of waste.

3.11 Comparing the different methods: application

The following table gives a brief over view of the different valuation methods discussed in this document and the field in which they can be applied.

Method	Application	Comments
Contingent Valuation, Willingness to pay	Use and non-use values of natural habitats and environmental pollution	Sometimes difficult to know which values are measured, Most adequate when other methods fail
Market prices	Direct use values of natural habitats (crop, cattle, fishing, materials like wood, clean water)	Should be used if possible
Dose Response function	Health effects of pollution (fine particles, other smog, heavy metals), effects on habitats, crops and buildings (acidification, water pollution)	Needs to be linked with values of life, crops, habitats. Applied in many studies
Travel costs	Direct use value (recreational)	Requires large amounts of data. Values sometimes difficult to separate from other purposes of trips
Hedonic pricing	Additional direct use value of property (living noise free near biodiversity)	Requires large amounts of data and specialist statistical analysis
Prevention costs	Nature valuation Pollution (reduction)	Gives rough first estimate, should be accompanied by other “evidence”
Compensation costs	Nature valuation	Gives rough first estimate
Opportunity costs	Nature valuation	Gives rough first estimate

Benefit transfer	Can be used for any assessment of the value of nature or benefits of environmental protection	Leads at relative low costs to in many cases credible results. The transfer must be based on thorough comparison and correction between the original and the “transfer” country

4 COSTS AND BENEFITS

4.1 Introduction

Comparing costs and benefits of (proposed) environmental and nature policy is a method to assess whether a proposal can also stand the economic test. In a market, costs are normally lower than benefits (sales revenues), leading to profits that can be invested or consumed. But as pointed out in the previous chapters, such benefits are often difficult to estimate, making it at least more difficult to perform a societal cost-benefit analysis, than to assess costs and benefits of a business.

Cost benefit analysis in environmental and nature protection is especially important if there is a limited amount of money available for many environmental and nature development objectives. In such a case, cost-benefit analysis may guide how to spend money in the most effective way (optimise benefits).

But cost benefit analysis can also be applied to non-environmental projects, to include monetary information on environmental goods and services. This may for example be a cost-benefit analysis of different options to construct a road (and reduce traffic jams in city centres). Besides concrete monetary streams (investment in road and maintenance, fuel costs), also the environmental damages of the various alternatives can be assessed (natural habitat value, health value). (see the Case study).

Another application of cost-benefit analysis is the integrated assessment of priority European environmental problems (RIVM et al). In this study, the costs and benefits have been quantified for different policy areas.

4.2 Application

Cost benefit analysis the following basic steps:

- different options (alternatives, scenarios, variations) have to be defined;
- For each of the defined options, the costs and benefits categories need to be identified;
- Next, these need to be quantified. For costs investments and annual (operation and maintenance) costs need to be distinguished. For the assessment of the benefits, one of the methods introduced in chapter 3 can be applied, depending of the type of benefits to be valued;
- Finally, costs and benefits can be compared (at an annual basis or on a total basis).

Defining different options involves an inventory of different alternatives. For example, if the CBA is about the possible construction of a harbour, this might involve the following alternatives:

- 0-option: no change. Evaluate economics and environmental situation and valuate. This may be some natural and agricultural values;
- A-option: construction in (mainly) natural habitat (close to city). Here the natural value is lost, but of course the operation of the harbour will generate revenues (but maybe not enough to compensate for the loss of natural habitat);
- B-option: construction in agricultural area (more distant to city and connecting infrastructure). Here, no natural habitat is lost, but additional investments (and maybe operational costs) due to longer distance (or time costs) are needed.

But when evaluating the value of creation of a natural habitat by shifting agricultural land in nature, the options may be:

- 0-option: no change. Evaluate economics and environmental situation and valuate. Mainly agricultural value, maybe landscape value;

- A-option: creation of (large) natural habitat, closed to the public. Agricultural value lost, but non use value (“pristine nature”) created;
- B-option: creation of (large) natural habitat, partly open and partly closed to the public. Not only non-use value, but also use value (recreation).

To obtain information on costs and investments, engineering studies need to be carried out, or “standard” estimates are needed (by means of cost assessment methods).

To obtain information on benefits, all potential benefits do have to be taken into account, not only the value of the natural habitats need to be evaluated, of course the revenues need to be investigated but also the damage due to possible additional pollution, etc.
For each type of benefit, the most appropriate method to assess them must be selected and research needs to be carried out.

Once all cost and benefit information is available, an assessment can be made on the relation between costs and benefits, by calculating the Benefit-Costs ratio. If this is larger than 1, the project or proposal is economical viable (from a societal point of view), if the ratio is smaller than 1, the economic viability is questionable, although it may be that certain benefits cannot be valuated, which need to be added in the next step of decision making. The results of a CBA alone, can never mandate a decision on a societal project or proposal. In the final decision not only economical issues should be considered but also differences which cannot be evaluated economically. The advantage of a good CBA in this situation, that at least that information should also be part of the inventory made.

4.3 Assessing (future) costs and benefits, discounting and Net Present Value

In a CBA it is necessary to calculate not only the annual costs and benefits. A full CBA includes a detailed estimate of investment costs (at the beginning of the project), operation and maintenance costs during the lifetime of the project.

Assume a transition of 100 ha of agricultural land to natural habitat. The first step would be to assess benefits and costs thereof. Simplified it may look like this:

	Total	(year >) 1	2	3	4	5	6	7	8	9	10	11
Benefits (x € 1000)	280		7	14	21	28	35	35	35	35	35	35
Costs (x € 1000)	200	100	10	10	10	10	10	10	10	10	10	10

The investment is € 1000 per ha, in total €100 000.

The annual costs of maintenance is estimated at € 10 000.
The annual benefits (pristine nature with high level of biodiversity) are € 350,- per hectare per year when achieved, so in total € 35 000 per year. It is assumed that the full biodiversity potential will be achieved in some 5 years.
Over a 11 year period, the total Benefits are € 280 000, total costs € 200 000.

Without considering discounting, the above example shows that after eleven years the total benefits exceed the costs:
- the benefit-cost factor is 1.4 (280 000/200 000).

However, in CBA a discount factor needs to be applied, in order to express the time preference of humans for money: € 100 today has for most a higher value than € 100 next year. By discounting with a certain percentage the future value of money can be assessed. For example, with a discount rate of 4% after 1 year € 100 will be € 96, after two years (96% * € 96 =) € 92,16, etc. If the discount rate is 10% this would be respectively € 90 after 1 year, and € 81 after 2 years. So, the higher the discount rate the less costs and benefits in the future are valued compared with today.

The choice of discount rate is therefore crucial in CBA. Normally, nowadays (real) discount rates are applied of about 4%. Based on the above example, this would lead to the following

	Total (NPV)	(year >) 1	2	3	4	5	6	7	8	9	10	11
Benefits (x € 1000)	217		6,7	12,9	18,6	23,8	28,5	27,4	26,3	25,2	24,2	23,3
Costs (x € 1000)	180	100	9,6	9,2	8,8	8,5	8,2	7,8	7,5	7,2	6,9	6,6

Now the total is equal to the net present value (NPV) of the project over an 11 years period. The NPV of the benefits is with € 217 000 about 20% lower than undiscounted total. The NPV of the costs is also lower with € 180 000 (10% lower).

The Cost benefit factor diminishes as a result of discounting to 1.2. The highest costs of the project are made in year 1, whereas maximal benefits only occur after 5 years!

If a discount factor of 10% would be applied the following results would be obtained:

	Total (NPV)	(year >) 1	2	3	4	5	6	7	8	9	10	11
Benefits (x € 1000)	148		6,3	11,3	15,3	18,4	20,7	18,6	16,7	15,1	13,6	12,2
Costs (x € 1000)	158	100	9,0	8,1	7,3	6,6	5,9	5,3	4,8	4,3	3,9	3,5

Now, the NPV of the benefits is lower than the NPV of costs: € 148 000, compared to € 158 000. The benefit cost ratio is now smaller than 1, meaning that over 11 years, the project would not be “profitable”.

Above from the discount rate, also the evaluation period affects the outcomes. It can be easily seen that in the above example a shorter period of 6 years would more than half benefits, but only diminish costs by 25%.
But also the opposite is true: the longer the evaluation period, the higher the benefit cost ratio may be (assuming that annual benefits are always higher than costs, except for year 1).

For both estimates of (future) costs and benefits, some guidelines can be given on how to obtain them.
Costs are split up in investments and operational and maintenance costs. Investments are made one time, whereas operational and maintenance costs occur each year. To estimate investment costs one may rely on earlier estimates applied in other studies (if available, a sort of “cost transfer”) or carry out a cost-engineering study (for example based on a technical design).
Running costs can be estimated by looking into the operation: how many workers are needed to run the facility, what kind of other inputs are needed (energy, chemicals, water, etc.), what kind of maintenance can be expected.
To assess future benefits, one needs to analyse the physical changes that may influence the future benefits (or damage) compared to the base year. For example, if health costs are involved and the incomes increase, future benefits are larger (due to the increase of real income, which is part of the “formula” to calculate benefits). But also, if the composition of population changes

(more aged, more vulnerable to pollution) this also may affect the results (higher damages that can be avoided by good air quality policy).

4.4 Practise

Costs and benefits of accession

This example serves to give some quantitative background information on studies performed in Accession countries on both economic costs and benefits of EU environmental policy.
In the period 1994 -2000 many studies have been performed to assess the costs of accession. The study “Compliance Costing for Approximation of EU Environmental Legislation in the CEEC “ (EDC et al, 1997) gave a first comprehensive estimate of the investments that are needed in the 10 central eastern European countries. Later many specific country studies have been performed to assess investments to comply with EU environmental legislation.
To complete the picture, a study was commissioned by EU to calculate the financial benefits of EU accession (Ecotec) related to environmental improvements.

Here a brief overview will be given of the results of these studies, thus making a rough comparison between costs and benefits of EU environmental policy in new member states possible:

- first the costs of accession will be discussed;
- afterwards the estimated benefits;
- finally costs and benefits will be compared.

Costs of Accession

Table 1 gives an overview of the needed investments for accession.

Table 1
Investments needed for approximation to EU environmental legislation in Accession countries (excl. drinking water) (in € million), TME-estimate 1999

Country	Air	Water	Waste	IPPC	Total
Bulgaria	3607	2056	2477	3261	11401
Czech Republic	3393	1164	1152	3725	9434
Estonia	640	168	698	489	1995
Hungary	2479	1678	454	1761	6371
Latvia	511	776	343	90	1720
Lithuania	967	435	364	44	1810
Poland	7772	6524	3695	6927	24918
Romania	2031	1385	2568	806	6789
Slovakia	1735	499	892	1596	4722
Slovenia	540	1149	1073	50	2812
TOTAL	23674	15833	13716	18748	71972

source: compilation of estimates by TME based on POL-101, EST-101, BUL-111, ROM-101, SLO-, SR-, CR-, Worldbank, TME estimates.

The following table gives an estimate of the annual per capita expenditure on environment in accession countries. Total annual expenditures are estimated at 15% of total investment outlays (based on Jantzen, 1989). Per capita expenditures are then calculated by dividing total annual expenditures by population.

Table 2
Estimated per capita annual expenditures in accession countries to comply with EU environmental legislation

Country	Air	Water	Waste	IPPC	Total
Bulgaria	€ 65	€ 37	€ 45	€ 59	€ 206
Czech Republic	€ 49	€ 17	€ 17	€ 54	€ 137
Estonia	€ 64	€ 17	€ 70	€ 49	€ 199
Hungary	€ 37	€ 25	€ 7	€ 26	€ 95
Latvia	€ 31	€ 47	€ 21	€ 5	€ 103
Lithuania	€ 39	€ 18	€ 15	€ 2	€ 73
Poland	€ 30	€ 25	€ 14	€ 27	€ 97
Romania	€ 14	€ 9	€ 17	€ 5	€ 45
Slovakia	€ 48	€ 14	€ 25	€ 44	€ 131
Slovenia	€ 40	€ 86	€ 80	€ 4	€ 211
TOTAL	€ 34	€ 23	€ 20	€ 27	€ 103

Source: compilation of estimates by TME based on POL-101, EST-101, BUL-111, ROM-101, SLO-, SR-, CR-, Worldbank, TME estimates.

Estimated *additional costs* to comply with EU environmental legislation will incur a cost for the inhabitants of the accession countries (and now mostly new member states of the EU) of between € 45 and € 211, with an average of € 103 per capita per year.

Benefits of Accession

Cleaning up the environment will not only cost a lot of euros, it also will bring benefits to accession countries and new member states. The results of the study carried out for the EU (Ecotec) can serve for this purpose as a rough estimate. These are shown in table 3a and 3b, representing the low and the high estimate.

Table 3a
Estimated annual monetary benefits for accession countries due to implementation of EU environmental legislation, low estimate, € mln

Country	Air	Water	Waste	Total
Bulgaria	110	160	20	290
Czech Republic	730	1 560	95	2 390
Estonia	40	27	10	75
Hungary	590	280	115	985
Latvia	50	40	5	95
Lithuania	160	125	6	290
Poland	2 650	1 400	165	4 210
Romania	780	405	85	1 270
Slovakia	350	305	30	690
Slovenia	70	150	25	240
All Countries	5 530	4 452	556	10 535
	52%	42%	5%	100%

Table 3b
Estimated annual monetary benefits for accession countries due to implementation of EU environmental legislation, high estimate, € mln

Country	Air	Water	Waste	Total
Bulgaria	1 130	435	680	2 240
Czech Republic	3 600	2 475	1 150	7 220
Estonia	210	100	180	490
Hungary	4 100	1 080	1 900	7 080
Latvia	320	140	110	570
Lithuania	820	280	205	1 300
Poland	15 400	3 280	2 750	21 400
Romania	5 850	1 250	2 650	9 800
Slovakia	2 250	680	440	3 370
Slovenia	475	350	290	1 120
All Countries	34 155	10 070	10 355	54 590
	63%	18%	19%	100%

Source: Ecotec, 2000

There is a considerable difference between the low and high estimate (on average about a factor 5, but for some countries almost 10). As in the “high estimate” the assumed reductions for air are more in line with actual EU policy, and these estimates dominate the results, the high estimate is taken as a base for comparison with the cost results.

The per capita benefits of EU environmental policy can then be calculated as follows.

Table 4
Per capita estimated annual monetary benefits for accession countries due to implementation of EU environmental legislation, high estimate, €

Country	Air	Water	Waste	Total
Bulgaria	€ 136	€ 52	€ 82	€ 270
Czech Republic	€ 350	€ 240	€ 112	€ 701
Estonia	€ 140	€ 67	€ 120	€ 327
Hungary	€ 406	€ 107	€ 188	€ 701
Latvia	€ 128	€ 56	€ 44	€ 228
Lithuania	€ 222	€ 76	€ 55	€ 351
Poland	€ 398	€ 85	€ 71	€ 553
Romania	€ 260	€ 56	€ 118	€ 436
Slovakia	€ 417	€ 126	€ 81	€ 624
Slovenia	€ 238	€ 175	€ 145	€ 560
All Countries	€ 325	€ 96	€ 99	€ 520

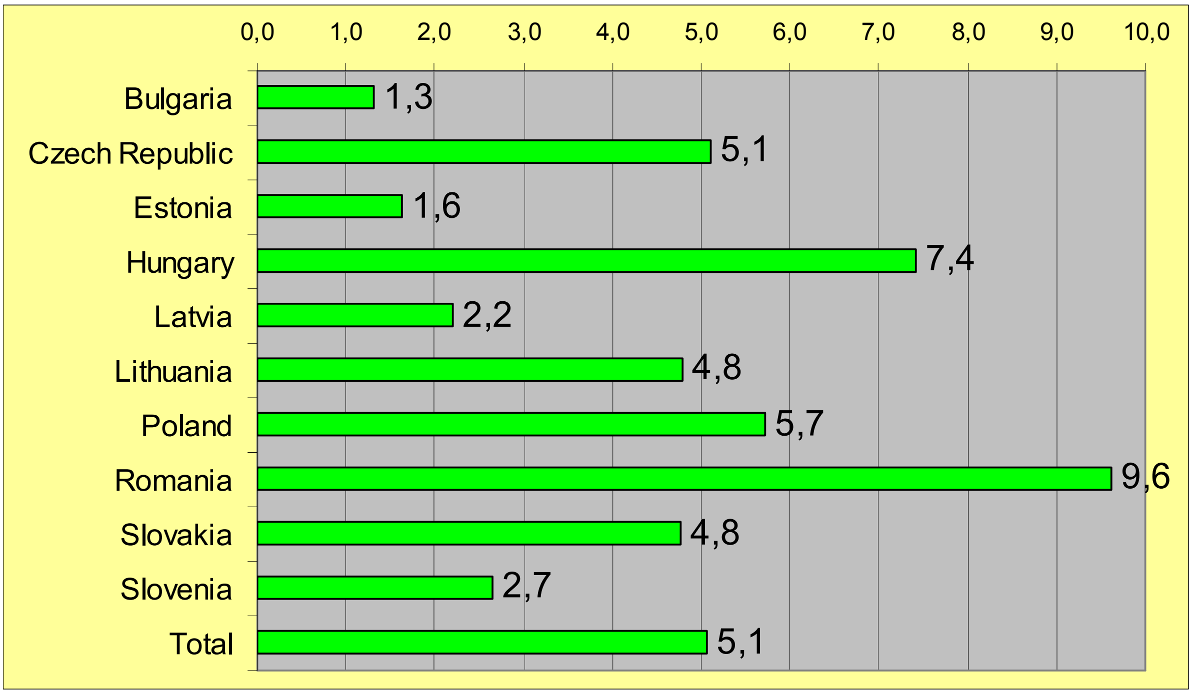
Source: Ecotec, 2000

Annual per capita benefits of EU environmental policy are estimated at on average € 520 (which is about 5x higher than the costs), they range from € 270 in Bulgaria to €701 in both Czech Republic and Hungary.

Cost/Benefits ratio of Accession

Having both estimates of costs and benefits of accession in the environmental domain, it now is possible to calculate the benefit-cost ratio for (former) accession countries. The results of these calculations are shown in the following graph.

Figure 1



source: TME estimations

The results show that on average benefits are 5x higher than costs. For some countries the benefit cost ratio is low, for example Bulgaria with 1.3. Several explanations can be given for such deviations from the average: high costs per capita (for example many old power station needing refurbishment, lack and bad maintenance of waste water and waste management infrastructure), low benefits due to low PPP income relative to other accession countries.

5 CASE STUDY

5.1 Introduction

The objective of the case study is to illustrate the use of cost benefit analysis and the role of valuation of nature in such analyses.

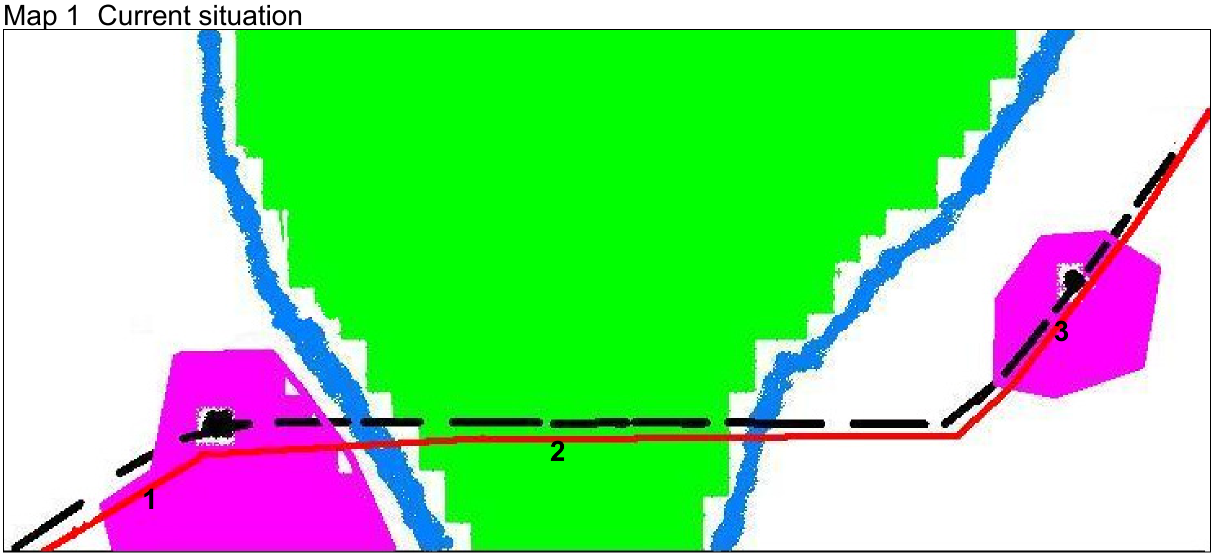
The case study is about a region of about 17.5 x 40 km flat land. There are two cities in the region:

- Branje (50,000)
- Oblanc (25,000)

Both cities are situated near rivers, with a forest in between (with high ecological quality and little to no human activities and settlements).

These two cities are connected by road (2-lane) and rail as shown in map 1.

Map 1 Current situation



(each centimetre on the map is 2.5 kilometer)

There is a plan ("Plan A") to build a highway which also connects Branje and Oblanc. As to safe time and costs the proposed trajectory of the highway will cut off a considerable part of the forest area. Alternatively the highway could follow the trajectory of the railway ("Plan B").

The objective of the case study is to identify (and if necessary estimate) the necessary economic information to find economic arguments pro and contra the construction of plan A or plan B.

This includes amongst others:

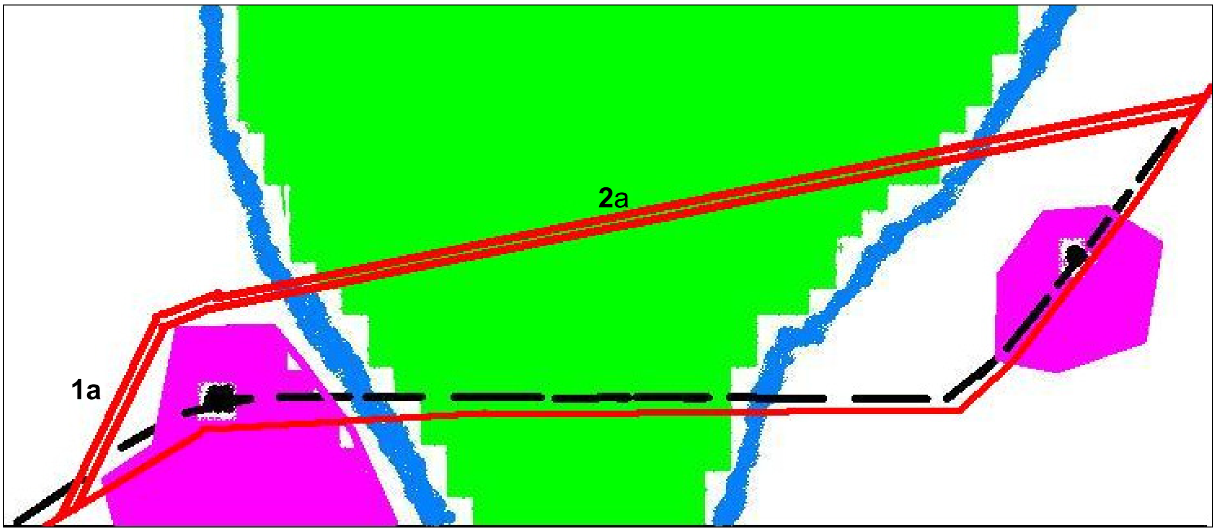
- construction costs of highway
- time / fuel savings for travellers;
- identification of preventive measures in plan A (tunnelling or wild passes) and effect thereof;
- value of natural habitat to be protected by plan B.

5.2 Case study alternatives

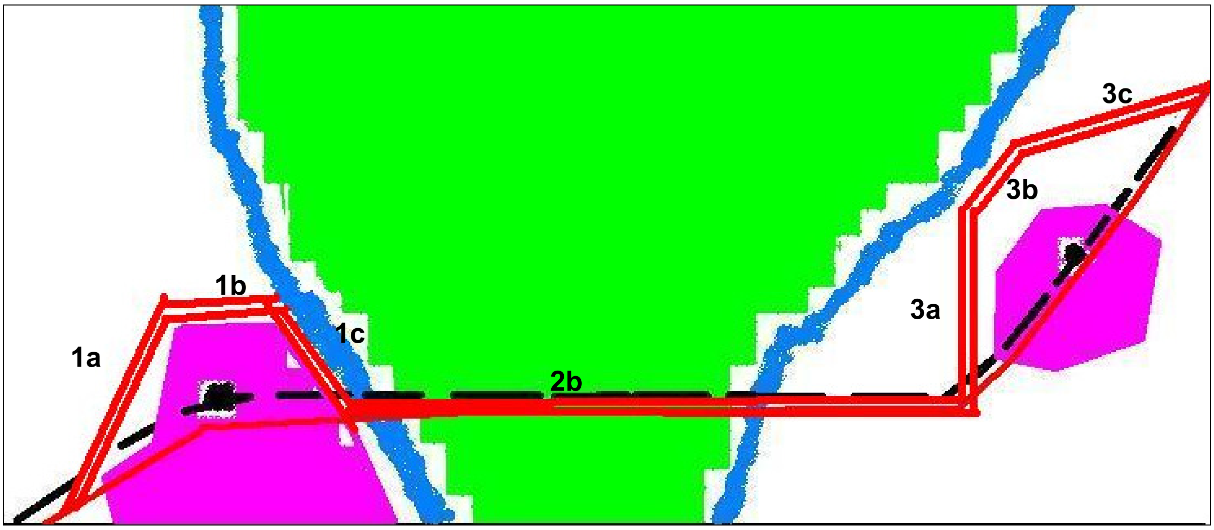
Map 2 and 3 give the basic information on the alternatives:

- plan A gives priority to savings in travel time (currently 25,000 movements in each direction each day, expected to grow to 50,000 in 10 years time)
- plan B gives priority to saving a considerable part of the natural forest by following the old (longer) trajectory and building of ring roads

Map 2 Plan A: Proposed construction of highway



Map 3 Plan B: Alternative to proposed highway



5.3 Quantitative results cost benefit analyses

5.3.1 Introduction

When carrying out cost-benefit analysis (CBA), the first step is to identify categories of costs and benefits. In this case these are:

- **investments in road renovation or road construction**. To assess these investments one needs to know length of road trajectories (in kilometres) and costs of construction or renovation (per km road);
- **the travel time and costs thereof for user of the road**. To assess this, one needs to quantify the length of the trajectories, the average speed on these trajectories and the (average) number of cars using the road daily. Additionally the value of travel time needs to be assessed (in € per hour);
- **the fuel use and costs thereof**. For this the length of the trajectories should be quantified, the average fuel use (in litres per kilometre) on these trajectories, the number of cars using the road daily, and the price of fuel (in € per litre);
- **the health damage due to particles in the air (PM or PM10)**. This can be assessed if the exposure is known (% of population exposed to various levels of air quality (expressed in microgram per cubic metre), making it possible to estimate annual mortality due to (bad) air-quality by means of a formula. Also the value of life (per person) needs to be assessed
- **damage to the natural habitat**. For this, one should at least know the area (in ha) and "unit value" of natural habitat (per ha). Additional information could be the ecological value (if this can be quantified).

In the following sections examples of how to quantify these different categories are presented. Although it has been tried to use realistic figures, it should be noted that the "unit costs" (for example investments per km road) are indicative.

5.3.2 Investments in road construction or renovation

Plan B is the most expensive, as more road needs to be constructed.

	LENGTH			UNIT INVESTMENTS	TOTAL INVESTMENTS ROADS		
	current	plan A	plan B		current	plan A	plan B
	km	km	km	Euro	Euro	Euro	Euro
section1	6,25			€ 800.000	€ 5.000.000		
section1a		7,5	7,5	€ 2.000.000		€ 15.000.000	€ 15.000.000
section1b			3,75	€ 2.000.000			€ 7.500.000
section1c			3,75	€ 2.000.000			€ 7.500.000
section2	25			€ 800.000	€ 20.000.000		
section2a		36,25		€ 1.500.000		€ 54.375.000	
section2b			21	€ 1.500.000			€ 31.500.000
section3	13,75			€ 800.000	€ 11.000.000		
section3a			7	€ 1.500.000			€ 10.500.000
section3b			2,5	€ 2.000.000			€ 5.000.000
section3c			7	€ 2.000.000			€ 14.000.000
TOTAL	45	43,75	52,5				
TOTAL INVESTMENTS					**€ 36.000.000**	**€ 69.375.000**	**€ 91.000.000**

5.3.3 Damage to natural habitats

In plan B the damage remains the same as current, in plan A the damage is much higher.

	AREA OF NATURAL HABITAT SPLIT OFF		
	current ha	plan A ha	plan B ha
part 1	4781	4781	4781
part 1*		10284	
TOTAL	4781	15066	4781
	DAMAGE TO NATURE PER HA: EURO 6,750		
TOTAL DAMAGE NATURE	€ 32.273.438	€ 101.692.969	€ 32.273.438

5.3.4 Travel Time and costs

Assuming 25,000 vehicles per day that use the road, the following estimates can be made:

	LENGTH			AVERAGE SPEED			TIME		
	current km	plan A km	plan B km	current km/h	plan A km/h	plan B km/h	current h	plan A h	plan B h
section1	6,25			20			7812,5		
section1a		7,5	7,5		100	100		1875	1875
section1b			3,75			100			937,5
section1c			3,75			100			937,5
section2	25			60			10416,7		
section2a		36,25			120			7552,1	
section2b			21			120			4375
section3	13,75			30			11458,3		
section3a			7			100			1750
section3b			2,5			100			625
section3c			7			100			1750
TOTAL	45	43,75	52,5				29687,5	9427,1	12250,0
							TIME COSTS (1 HOUR = 3 EURO)		
TOTAL TIME COSTS							€ 32.507.813	€ 10.322.656	€ 13.413.750

Continuation of the existing situation would lead to congestion and high time costs.

5.3.5 Fuel use and costs

Due to the longer distance in plan B, fuel costs are slightly higher than in plan A, but still lower than in the current situation.

	LENGTH			SPECIFIC FUEL CONSUMPTION			FUEL CONSUMPTION		
	current	plan A	plan B	current	plan A	plan B	current	plan A	plan B
	km	km	km	l/km	l/km	l/km	l	l	l
section1	6,25			0,3			46875		
section1a		7,5	7,5		0,16	0,16		30000	30000
section1b			3,75			0,16			15000
section1c			3,75			0,16			15000
section2	25			0,2			125000		
section2a		36,25			0,18			163125	
section2b			21			0,18			94500
section3	13,75			0,2			68750		
section3a			7			0,16			28000
section3b			2,5			0,16			10000
section3c			7			0,16			28000
TOTAL	45	43,75	52,5				240625	193125	220500
							FUEL COSTS (PRICE = 0.80 EURO/LITRE)		
TOTAL FUEL COSTS							€ 70.262.500	€ 56.392.500	€ 64.386.000

5.3.6 Damage to health due to air pollution (particles)

The formula to estimate mortality due to air pollution is as follows (Dixon, 2000).

Mortality = 6.72 * 10 $^{-6}$ * (change in concentration of PM10) * (population)

	CONCENTRATIONS PM IN AIR				MORTALITY		
		current	plan A	plan B	current	plan A	plan B
	microg/ m3	%	%	%	# of dead/y	# of dead/y	# of dead/y
Branje	100	40%	25%	30%	13,44	8,4	10,08
50000	80	30%	15%	15%	8,064	4,032	4,032
Inhab	60	10%	10%	15%	2,016	2,016	3,024
	40	10%	25%	20%	1,344	3,36	2,688
	20	10%	25%	20%	0,672	1,68	1,344
TOTAL Branje					25,536	19,488	21,168
Oblanc	100	60%	0%	0%	10,08	0	0
25000	80	30%	0%	0%	4,032	0	0
Inhab	60	10%	0%	0%	1,008	0	0
	40	5%	20%	40%	0,336	1,344	2,688
	20	0%	80%	60%	0	2,688	2,016
TOTAL Oblanc					15,456	4,032	4,704

TOTAL MORTALITY	40,992	23,52	25,872

VALUE OF LIFE (= 375,000 EURO)

TOTAL HEALTH DAMAGE	**€ 15.372.000**	**€ 8.820.000**	**€ 9.702.000**

Here it follows that plan A reduces health damages the most, and plan B is second best.

5.3.7 Cost and Benefits total

Two kinds of assessments can be made:

- one, in which nature is not taken into account (health damage is included);
- one in which environmental concerns also play a role.

Traditional CBA

First the results of a traditional CBA are shown.

	current	plan A	plan B
TOTAL INVESTMENTS	€ 36.000.000	€ 69.375.000	€ 91.000.000
ADDITIONAL INVESTMENTS TO CURRENT		**€ 33.375.000**	**€ 55.000.000**
OPERATIONAL			
FUEL COSTS	€ 70.262.500	€ 56.392.500	€ 64.386.000
TIME COSTS	€ 32.507.813	€ 10.322.656	€ 13.413.750
HEALTH COSTS	€ 15.372.000	€ 8.820.000	€ 9.702.000
TOTAL OPERATIONAL	**€ 118.142.313**	**€ 75.535.156**	**€ 87.501.750**
FUEL SAVINGS		-€ 13.870.000	-€ 5.876.500
TIME SAVINGS		-€ 22.185.156	-€ 19.094.063
HEALTH SAVINGS		-€ 6.552.000	-€ 5.670.000
TOTAL SAVINGS COMPARED TO CURRENT		**-€ 42.607.156**	**-€ 30.640.563**
PAY BACK PERIOD (YEARS)		**0,78**	**1,80**

In this type of analysis, the economic choice would be plan A, as it has a very quick payback period (in less than 1 year the additional investments compared to continuation of the current situation would be earned back by savings in fuel, time and health).

Including valuation of natural habitats.
Now, also nature is taken into account, leading to the following CBA. Damage to nature of each of the alternatives is taken into consideration as if it was an investment. Now plan A has the highest additional investment.

	current	plan A	plan B
TOTAL INVESTMENTS	€ 36.000.000	€ 69.375.000	€ 91.000.000
DAMAGE TO NATURE	€ 32.273.438	€ 101.692.969	€ 32.273.438
TOTAL INVESTMENTS	**€ 68.273.438**	**€ 171.067.969**	**€ 123.273.438**
ADDITIONAL INVESTMENTS TO CURRENT		**€ 102.794.531**	**€ 55.000.000**
OPERATIONAL			
FUEL COSTS	€ 70.262.500	€ 56.392.500	€ 64.386.000
TIME COSTS	€ 32.507.813	€ 10.322.656	€ 13.413.750
HEALTH COSTS	€ 15.372.000	€ 8.820.000	€ 9.702.000
TOTAL OPERATIONAL	**€ 118.142.313**	**€ 75.535.156**	**€ 87.501.750**
FUEL SAVINGS		-€ 13.870.000	-€ 5.876.500
TIME SAVINGS		-€ 22.185.156	-€ 19.094.063
HEALTH SAVINGS		-€ 6.552.000	-€ 5.670.000
TOTAL SAVINGS COMPARED TO CURRENT		**-€ 42.607.156**	**-€ 30.640.563**
PAY BACK PERIOD (YEARS)		**2,41**	**1,80**

Taking into account the higher investment (due to damage to nature) of plan A in comparison with plan B, the lower annual savings of plan B are more than enough to compensate for this. This results in a pay-back period of 1.8 years for plan B and a pay-back period of 2.4 years for plan A. In this case plan B is the most economical viable.

LITERATURE

Arin, Tijen, “Benefits and Costs of Establishing the Kolkheti National Park”, Januari 18, 2001.

Bluffstone, 2006 (?), “Upgrading Municipal Environmental Services to European Union Levels: A Case Study of Household Willingness to Pay in Lithuania”, by Randall Bluffstone (Department of Economics, University of Redlands, Redlands, California) and J.R. DeShazo School of Public Policy and Social Research, University of California at Los Angeles, Los Angeles, California), forthcoming in Environment and Development Economics.

Boyl, K.J. and Bergstrom, J.C. (1992), “Benefit Transfer Studies: Myths, Pragmatism and Idealism”, *Water Resources Research,* 28 (3): p. 657-663

Christie et al, 2004, “A valuation of biodiversity in the UK using choice experiments and contingent valuation”, Mike Christie (a), Nick Hanley (b), John Warren (a), Tony Hyde (a), Kevin Murphy(b) and Robert Wright (c) ((a) University of Wales Aberystwyth ; (b) University of Glasgow (c) University of Stirling

Christie et al, 2004b, “Developing measures for valuing changes in biodiversity on farmland using choice experiments and contingent valuation”, Mike Christie (a), Nick Hanley (b), John Warren (a), Tony Hyde (a), Kevin Murphy(b) and Robert Wright (c) ((a) University of Wales Aberystwyth ; (b) University of Glasgow ; (c) University of Stirling

Dixon, 1996 (?), “The Economic Value of Health Impacts”, Worldbank, Washington.

Dixon, 2000:

Ecotec et al. 2001, “The Benefits of Compliance with the Environmental Acquis for the Candidate Countries”, in co-operation with EFTEC, IEEP, TME and Metroeconomica, London, 2001.

EFTEC/RIVM 2000, “Valuing the Benefits of Environmental Policy: The Netherlands”, London, 30 June 2000.

EFTEC, 2002, “Populating the Environmental Valuation Reference. Inventory: 40 European valuation studies.” Final report submitted to European Commission, DG Environment by Economics for the Environment Consultancy Ltd, London, 28 June 2002.

Hanley, N. , Shogren, J.A. and White, B. (2002), “Environmental Economics in Theory and Practice”, Palgrave - Macmillan, Houndmills Hampshire UK and New York.

Integrated Coastal Zone Management Centre, Georgia, 2004, ”Kolkheti National Park Resource Use Study: Grazing, Logging, Fishing, Hunting”, Final Report (draft), prepared by the Black Sea Eco-Academy, Batumi, May 2004.

IVM, 2006, “Ex-post estimates of costs to business of EU environmental legislation, Final report”, Edited by Frans Oosterhuis (IVM), Contributions by: Véronique Monier and Cécile des Abbayes (BIO); Benjamin Görlach (Ecologic); Andrew Jarvis and James Medhurst (GHK); Onno Kuik (IVM) Robin Vanner and Paul Ekins (PSI); Jochem Jantzen and Henk van der Woerd (TME); Peter Vercaemst, D. Huybrechts and E. Meynaerts (VITO), for DG-Environment, Amsterdam, April 2006. http://ec.europa.eu/environment/enveco/ex_post/costs.pdf

Dennis M. King, Ph.D, Univ. of Maryland, and Marisa Mazzotta, Ph.D, Univ. of Rhode Island "Ecosystem valuation", website http://www.ecosystemvaluation.org/

Neiland et al, 2002, "Management of the coastal wetlands of the Black Sea: A baseline study of resource valuation, stakeholder lively hoods and key issues in Georgia", Arthur Neiland (Centre for the Economics & Management of Aquatic Resources (CEMARE), Portsmouth; Sofico Akhobadze and Irakli Goradze, Black sea Regional Activity Centre for Biodiversity Conservation, Batumi, Georgia, June 2002.

Nunes, P.A.L.D. and van den Bergh, J.C.J.M. (2001). Economic valuation of biodiversity: sense or nonsense? *Ecological Economics 39, 203-222*, cited in Cristie et al (2004), "Developing measures for valuing changes in biodiversity on farmland using choice experiments and contingent valuation"

OECD, 1997, "Valuation of biodiversity benefits: Selected studies", OECD, Paris.

Pearce, D.W. and Turner K., 1990, "Economics of Natural Resources and the Environment", Harvester Wheatsheaf , New York and London.

Pearce, D., 2001, "Valuing biological diversity: issues and overview". In (Eds) OECD. Valuation of biodiversity benefits: Selected studies. OECD: Paris.

Pearce, D. (ed.) Pearce, C. and Palmer C., 2002, "Valuing the Environment in Developing Countries", Edward Elgar, Cheltenham UK.

RIZA, 2004, "De publieke beleving en waardering van schone waterbodems en biodiversiteit in Nederland" (Public valuation of clean watersoils and biodiversity in Netherlands), RIZA report 2004.022, ISBN 903695679X Author: Roy Brouwer, RIZA, Lelystad, August 2004.

IVAM & TME, 2002, De effecten van reactiveren van de IJzeren Rijn (Effects of re-activating of the Iron Rhine), Amsterdam/The Hague.

UNEP, "Planning and Management of Lakes and Reservoirs: An Integrated Approach to Eutrophication".

A website on which a lot of information and summaries of studies on costs and benefits of environmental and nature policy can be found is

http://envirovaluation.org/

http://www.externe.info/

http://www.ecosystemvaluation.org/contingent_valuation.htm

a Russian website with information on nature valuation:

http://www.kad.yaroslavl.ru/bibl/bibl_den_oz_knigi.htm#g

ANNEX: PROCESS OF PROVIDING TRAINING FOR TRAINERS

Introduction

The process of providing a “training the trainers” course started with discussions in August 2005 at the CENN premises. Specific interest was shown in economic valuation techniques for natural and environmental resources.

From June 2006 onwards, content of the training course has been developed, in close cooperation with and under coordination of Irma Alpenidze of MDF and with support from CENN-staff.

At the start of the training, a document named “THE ECONOMIC VALUE OF NATURAL AND ENVIRONMENTAL RESOURCES, Background document training”, was available to the attendants of the course. This document was supported by selected reports and documentation on natural and environmental resource valuation.

During the week 9-13 October 2009, the course took place.

After the course main focus has been on

(1) Supplying additional information on resource valuation and environmental economic theory in the Russian (and English) language.
(2) Adding some information to the earlier version of the training document.
(3) Describing the process.

Expectations

According to the “needs assessment”, CENN has selected two priority areas for training: Environmental Impact Assessment (and SEA) and economic valuation of natural resources. It was agreed that the TME-input to the course would focus on the second priority, whereas active oral input would be given on how to develop a course on EIA as CENN is also supported by the International Commission for Environmental Impact Assessment.

The course and documentation on economic valuation of natural and environmental resources should at least cover:

- some basic theoretical background on environmental economics and valuation of natural and environmental resources;
- introductions in most used valuation techniques;
- introductions and examples on valuation of different aspects of nature and environment.

The outcome should be a training programme on nature valuation and a trained group that at least has basic understanding and fundamental ability to transfer the knowledge discussed and apply it to a wider audience.

My expectations were that with the documentation and discussions with a group of interested environmental and nature specialists, it would be possible in a relative short period transferring the essential knowledge on nature and environmental valuation.

The training

The document prepared by TME has been presented, where necessary further explained, discussed and suggestions were made by the attendants how to improve the documentation.

Given the lively discussions on each of the subjects discussed during the first two days, the suggestions made, in the course of the week, a basic level of knowledge and understanding was acquired by most of the attendants.
After discussing and prioritising the possible contents of the training course, the last day, a proposal was made by the group on how to develop a training course on the topic of natural and environmental resource valuation. A training programme, prioritising certain elements of the wide range of methods and applications of nature valuation, has been develop at the end of the training.

The group was in general reasonably satisfied, although some found it to much theory and "college", whereas others stressed the importance of a firm theoretical explanation, as to enable mastering the contents.

A few requests were formulated by the group:

- some more suggestions on reading on environmental economy (preferably in Russian too). Most trainees feel the need for further studying environmental economic theory and the application thereof;
- some additions to the document:
    - example of Purchase Power Parity figures for various (neighbouring) countries;
    - examples of how value of life is calculated and actual values;
    - more guidance on developing a Willingness to Pay questionnaire
    - guidance on the selection of methods for valuation of certain aspects of nature and environment.

Follow up of the training of 9-13 October 2006

After the training the additional information was collected and partly incorporated in the documentation.
Moreover, contacts with Russian environmental economists were used to get access to environmental economic literature. So far, as a result of the border blockade between Russia and Georgia, literature has not yet been acquired. Some documents in Russian on nature valuation have been acquired electronically and have been sent to CENN.

An outcome of the training is that the CENN staff – after the training – in general would like to have more grip and theoretical basis on questions like:

- how does economics work?
- where is the environmental dimension in economics?
- how it could be incorporated?
- how future benefits and costs can be estimated;
- some background on Net Present Value and discount rate?
- environmental taxation and calculating of these.

It appears, that although most of these issues have been discussed during the training, either explanations were not sufficient, or the attendants should do some additional study (textbook on (environmental) economics).

A lesson from this experience may be that attendants have to do some reading on environmental economics before they are further trained in valuations techniques and application for nature and environmental protection.
Alternatively, some more time should be addressed to the basics of economic theory and the connections with environment and nature. But this would automatically result in less training in the various methods.