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External Economic Benefits and Costs in Water and Solid Waste Investments

Methodology, Guidelines and Case Studies

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Foreword

All projects funded by the EIB need to be justified in economic, financial, technical and environmental terms. The Bank's Projects Directorate uses appraisal methods that reflect these various concerns. At the same time, we are aware of the rapid strides being taken in the development of environmental appraisal, and in particular the economic valuation of environmental impacts. The general principles and methods of environmental valuation are now widely known and a large body of empirical evidence is being assembled. The current report is intended to make this academic and research literature more accessible for operational appraisal purposes.

The report focuses on the water, wastewater and solid waste sectors, and forms part of a larger programme of work being done in sectors of interest to the Bank, also including energy and transport. The whole programme aims to give project staff the analytical tools and data necessary to reflect as fully and accurately as possible the environmental impact of projects funded by the Bank.

The work was carried out by the Institute for Environmental Studies at the Free University, Amsterdam, in association with Economics For The Environment Consultancy Ltd, London. The Bank has sponsored this work, but the authors and their institutions remain ultimately responsible for all matters of fact, analysis and judgement presented in the report.

Herbert Christie
Director-General
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Contents

Foreword	i
Acknowledgements	iii
1. Objectives	1
1.1 Introduction	1
1.2 Tasks	1
1.3 Environmental appraisal at the European Investment Bank	2
1.4 Appraisal practices at other multilateral financial institutions	2
1.5 Structure of the report	3
2. Methods	5
2.1 General Approach	5
2.1.1 Impact Pathway Approach	5
2.1.2 Externalities	7
2.1.3 Economic value	9
2.1.4 Sources of value	10
2.2 Valuation methods	11
2.2.1 Demand curves	12
2.2.2 Market prices	12
2.2.3 Hedonic prices	13
2.2.4 Travel cost method	14
2.2.5 Averting behaviour	16
2.2.6 Productivity analysis and exposure-response techniques	16
2.2.7 Contingent valuation method	16
2.3 Some further issues in valuation	18
2.3.1 Economic valuation versus other weighing methods	19
2.3.2 Discounting	19
2.3.3 Generalisability and transferability	21
2.3.4 Benefit transfer	21
2.3.5 Valuation of mortality and morbidity	22
2.3.6 Marginal versus average costs	24
2.3.7 Doublecounting	24
2.3.8 Indirect impacts and other omitted parameters	25
2.3.9 Uncertainties	25
2.3.10 With and without principle	26
3. Guidance	27
3.1 Overall approach	28
3.2 The guidelines	33

3.3 Demonstration case studies	45
3.3.1 A wastewater project	45
3.3.2 A freshwater project	48
3.3.3 A waste project	52
4. Conclusions	57
References	59
1. Objectives	1
1.1 Introduction	1
1.2 Tasks	1
1.3 Environmental appraisal at the European Investment Bank	2
1.4 Appraisal practices at other multilateral financial institutions	2
1.5 Structure of the report	3
2. Methods	5
2.1 General Approach	5
2.1.1 Impact Pathway Approach	5
2.1.2 Externalities	7
2.1.3 Economic value	9
2.1.4 Sources of value	10
2.2 Valuation methods	11
2.2.1 Demand curves	12
2.2.2 Market prices	12
2.2.3 Hedonic prices	13
2.2.4 Travel cost method	14
2.2.5 Averting behaviour	16
2.2.6 Productivity analysis and exposure-response techniques	16
2.2.7 Contingent valuation method	16
2.3 Some further issues in valuation	18
2.3.1 Economic valuation versus other weighing methods	19
2.3.2 Discounting	19
2.3.3 Generalisability and transferability	21
2.3.4 Benefit transfer	21
2.3.5 Valuation of mortality and morbidity	22
2.3.6 Marginal versus average costs	24
2.3.7 Doublecounting	24
2.3.8 Indirect impacts and other omitted parameters	25
2.3.9 Uncertainties	25
2.3.10 With and without principle	26
3. Guidance	27
3.1 Overall approach	28
3.2 The guidelines	33

3.3	Demonstration case studies	45
3.3.1	A wastewater project	45
3.3.2	A freshwater project	48
3.3.3	A waste project	52
4.	Conclusions	57

1. Objectives

1.1 Introduction

Most projects in the water and solid waste sector result in environmental and social effects which are external to the financial costs and benefits of such projects. Therefore, the economic implications of these external effects are seldom reflected in the prices used to assess the costs and benefits of these projects. However, in projects funded by international organisations, such as the European Investment Bank (EIB), externalities are receiving increasing attention. As a result, a need arises for a standard, transparent and easy to apply methodology for monetary valuation of externalities and their inclusion in the conventional project appraisal.

The scope of the applied methodologies to assess external effects includes the full life-cycle of materials, projects and processes under investigation. This so-called *impact pathway approach* combines aspects of economic valuation (EVA) and life cycle assessment (LCA). Since the methodology of socio-economic cost benefit analysis (CBA) generates both financial details and estimates of environmental externalities in monetary terms, internal and external costs can be combined so that ultimately the socially optimal investment can be determined. This approach is especially applicable in environmentally sensitive sectors such as wastewater and solid waste.

1.2 Tasks

The main objective of this study is to provide the staff of EIB's department of Infrastructure II, which is responsible for the appraisal of projects in the water, wastewater and solid waste sector, with practical tools and information to permit the systematic identification, quantification and valuation - as far as present knowledge and techniques allow - of external environmental benefits and costs in a form suitable for use in its routine economic appraisal analysis and decision rules at the EIB. This involves the following tasks:

- to describe and classify the principal external environmental benefits and costs associated with freshwater, wastewater and solid waste investment projects;
- to describe the principal techniques used in practice to quantify such effects both in physical and monetary units;
- to summarise the work done so far in this field and its principal findings, including typical values for such effects in the most commonly found circumstances, and to identify any major gaps;
- to develop practical valuation methods and approaches, including short-cut techniques and rules-of-the-thumb, appropriate to the EIB - bearing in mind the nature of its projects, the circumstances of its borrowers, its operating environment, including typically short appraisal periods, and professional resources available - and to illustrate their use in particular cases;

- to propose standard parameter values for use in the project work of Infrastructure II - allowing for variations in the type of externality and other relevant features of the project and borrower - and to illustrate their application in particular cases.

1.3 Environmental appraisal at the European Investment Bank

Projects financed by the Bank are designed and planned in such a way as to have the necessary technical, financial and human resource capability at least to comply with the relevant prevailing laws and regulations. Within the EU, the relevant environmental standards are those laid down in Community directives, or national standards, whichever are stricter. Alternative technical solutions are compared especially, but not exclusively, in terms of cost effectiveness (EIB 1997). Outside the EU, the EIB faces a range of situations. In countries aiming for EU membership, EC legislation is an obvious guideline. In other countries, sometimes a more pragmatic approach may be asked for.

In practise, all projects funded by EIB need to be justified in economic, financial, technical and environmental terms. As part of the project appraisal, an environmental fiche is generally completed, describing the significance and magnitude of the likely effects of the project, and the actions to be taken to mitigate the negative ones.

Hitherto, environmental effects have not been systematically valued in economic terms though in a few cases some efforts at quantification and valuation have been undertaken. The Bank's Project Directorate does, however, have an ongoing programme of studies (including this one), aimed at promoting the use of monetary valuation as a component of project appraisal.

1.4 Appraisal practices at other multilateral financial institutions

To get a better understanding of the current state-of-the-art in the field of project appraisal of external environmental effects, an inventory was conducted among various multilateral financial institutions (MFI), including International Finance Corporation (IFC), World Bank (WB)¹, Inter-American Development Bank (IADB), Asian Development Bank (ADB) and European Bank for Reconstruction and Development (EBRD). Experts from these organisations have been approached by the research team to gather information about their experiences with monetary valuation in the water and waste sectors.

The inventory serves two purposes. First, it gives a comprehensive overview of the current knowledge base among practitioners at these institutions. Second, it generates a valuable collection of data and information on economic valuation in different parts of the world which can be used in the design of standard values, where possible.

The first part of the inventory deals with the current practises at MFIs with regard to environmental effects which are appraised. The majority of the MFIs base their procedures

¹ The guidelines of the World Bank are often fully or partially adopted by international financial institutions such as the EBRD. Given their international importance, these guidelines are explained in more detail in the Volume II of this report. Most of the information of this Section is derived from the World Bank's Environmental Assessment document (1997).

on the categorisation given by the World Bank (see Appendix I). The first condition which has to be met is the Bank's information requirement. Comparison is generally made with a baseline scenario (environmental situation without the project). Most MFIs do not have a standard list of effects to be evaluated but professional experience of the experts is used to determine this list on a project by project basis. The next part of the inventory focuses on how the various environmental effects are combined in the final decision. Although a uniform approach for this is lacking, local or international standards generally serve as the guideline. Often project officials reason that, as long as the project has positive environmental effects, it should be approved. As far as monetary valuation is concerned, the World Bank, IFC, ADB and to some extent IADB take the lead. Although it is not yet an integral part of procedures and is generally applied on a rather ad-hoc basis even in these MFIs, it is gaining importance. Various reasons exist why monetary valuation is not yet adopted by other MFIs. First, officials lack the time to apply monetary valuation. Second, some officials claim that proper methodologies for doing so are lacking. Moreover they often consider the outcome of monetary valuation EVA as controversial.

The inventory showed that the perception of monetary valuation differs regionally. Developing countries tend to emphasise primarily the practical effects such as the cost of additional water supply, loss of industrial production, cost of worsened irrigation conditions, loss of recreational function, loss of fishery values, and even loss of property values. It is typical that, in developing countries, the Willingness To Pay (WTP) for waste services such as waste collection are significant, even in low income neighbourhoods, but that the WTP for the further processing such as transferring or sanitary landfilling, is practically absent. Values, such as WTP for nature are generally only considered in industrialised countries. Benefit transfer is generally considered to be rather difficult to apply in the water and waste sectors as a result of the extreme site and time specific characteristics of these projects.

The inventory also revealed that there exists a disciplinary difference in perception. The perception of monetary valuation depends very much on the background of the experts involved. Engineers are generally more sceptical, not only because of the aversion for economic tools but also because of their awareness of the uncertainty of the physical effects. Nevertheless, MFIs contacted do consider monetary valuation as a promising approach for the future. This explains why many take the position of 'wait and see' what other MFIs and mainly the World Bank will do on the topic.

In conclusion two main bottlenecks for monetary valuation have been identified: (i) practical constraints such as time pressure, lack of appropriate data (both economic as well as physical) and the reluctance of the client and, (ii) organisational constraints such as the absence of a co-ordinating department for environmental appraisal. For example, as a consequence of the reorganisation in 1994 at the IADB the synthesis of information has been reduced due to lack of communication between the various departments.

1.5 Structure of the report

The report is divided into two volumes. Volume I contains the methodological background and the guidelines for monetary valuation. It starts with Chapter 2 in which the

methodology is presented and a theoretical background of valuation is provided (Section 2.1). Valuation techniques are explained in Section 2.2 and the main issues, the underlying assumptions, and the strengths and weaknesses of monetary valuation, are discussed in Section 2.3. Some parts of these sections are based on Beukering et al. 1998. In Chapter 3, guidance is given for the application of monetary valuation in project appraisal. First, the underlying principle, the 'impact-pathway approach', is introduced in Section 3.1. Next, the general guidelines for the EIB staff is presented (Section 3.1). In order to demonstrate the application of the guidelines, various case studies on respectively wastewater and freshwater projects and solid waste related projects, are worked out in Section 3.3. The main conclusions of the study are summarised in Chapter 4, which considers the future applicability of the guidelines for EIB as well as the present caveats in the methodology. Suggestions for potential improvements are also made.

Volume II of this report covers the current guidelines for environmental appraisal at the World Bank (Appendix I), an annotated bibliography (Appendix II), an explanation of the ExternE project which plays an important role in the valuation of air pollution (Appendix III). Most important are a series of case studies in which economic valuation is applied to EIB projects (Appendix IV to Appendix IX). These case studies are a more elaborate version of the summaries given in Chapter 3.

2. Methods

2.1 General Approach

This section presents the overall approach on which the guidelines are based, the theoretical background of external effects subject to the guidelines and the techniques used for their valuation.

2.1.1 Impact Pathway Approach

In this project, the impact pathway approach will constitute the basis for the valuation methodology. The impact pathway approach is designed with the following principles in mind:

1. Transparency: the methodology should create a clear understanding of how the result was achieved, which assumptions were made, and which data were used;
2. Comprehensiveness: the methodology should include all relevant environmental impacts;
3. It should address the issues of time and spatial dimensions;
4. It should be sufficiently flexible to allow the consideration of a wide range of water and waste management options.

In the case of project appraisal at the Bank one important principle should be added:

5. Practicality: the methodology should take into account the short appraisal period and the scarce professional resources available, and should thus be relatively simple and practical to apply.

In Figure 2.1, the various stages of the impact pathway approach are depicted.

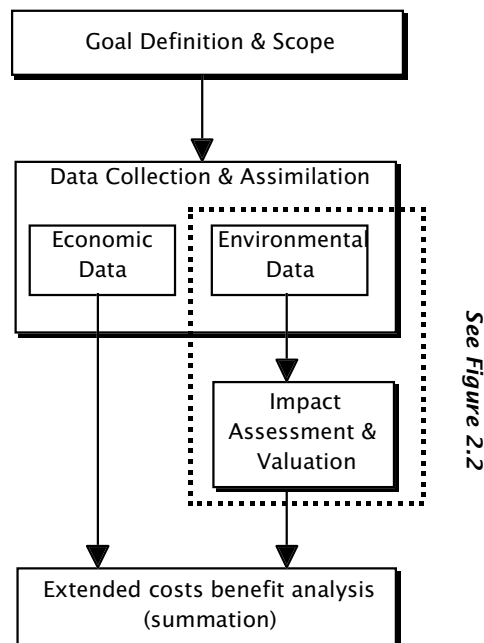


Figure 2.1 The Impact pathway approach

In the first step (goal definition and scope) the scope of the water and waste projects is determined. The various project options are identified. For example, a municipality has the alternative to trade off various types of landfill (with or without gas recovery) against increased recycling efforts (kerbside collection, bring system). This stage is particularly important as it will be difficult to add other options in a later stage of the analysis.

The second stage consists of the collection of economic and environmental data relating to the project. Depending on whether these data are readily available, additional literature sources may have to be explored. The economic data mainly consist of financial details such as capital and labour costs. The environmental data are reported in physical units and predominantly contain process related emission levels.

The impact assessment and valuation stage is the third and probably most laborious step in the impact pathway approach. Various steps within this stage are depicted in Figure 2.2 (Dorland et al. 1997). The guidance presented in Chapter 3 of this report is, in fact, an elaborate version of this step.

Given the requirement of easy applicability, only the most important externalities or effects are identified with reference to knowledge of the system under study and the goal of the study. For instance, in the case of designing a waste collection scheme, traffic congestion should certainly be included while eutrophication is likely to be of less importance. Similarly, eutrophication, and not traffic congestion, will be the dominating impact category in the choice between a biological and chemical wastewater treatment. The 'impact categories' relevant for water and waste related projects may include:

- resource depletion
- global warming
- acidification
- eutrophication
- human health and eco-toxicity
- traffic congestion
- visual, noise & odour (dis)amenities

Next, the pathways to be used to relate the environmental pressure to the impact areas are described. The choice of pathway will be decided by considering such constraints as data availability and the requirements set by the goal of the study. In general, the closer the defined pathway can match the actual impact pathway, the greater the transparency and accuracy of the analysis but also the greater the data requirements. Since the appraisal will be performed under strict time constraints of the staff of the EIB, more general pathways (or short cuts) will be developed through the use of rules-of-thumb and standard dose-response relationships. In doing so, particular attention should be paid to the increased risk of double counting of impacts.

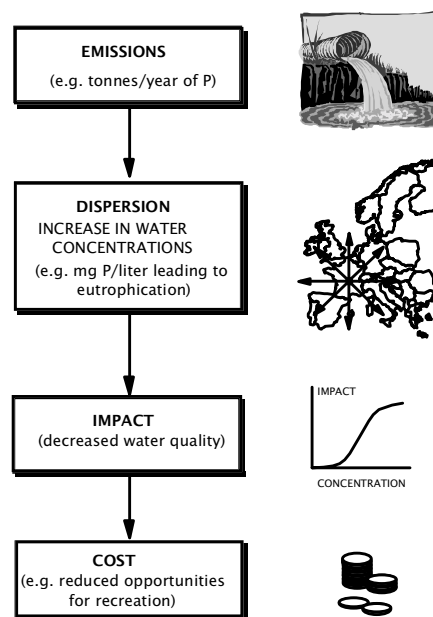


Figure 2.2 The Impact Assessment and Valuation Stage

In order to value the impacts, the emission levels will have to be considered in the appropriate context. As a result, additional information needs to be recorded in the inventory. This may include description of the receiving environment - demographic factors, meteorological conditions and background emission levels. In the cases where no information can be generated, standard data should be available to fill this gap. The use of general data reduces the quality of the estimates but still allows for an approximation of the impacts. If even general data are not available, the impact can not be quantified. This should then be made explicit to the decision maker.

An important step, concluding the analysis, is the sensitivity analysis and the assessment of the uncertainties occurring in various phases of the *impact pathway approach*. These uncertainties arise from a large range of sources such as data variability, extrapolation from the laboratory to the field, data transfer between countries, human behaviour and political issues. There are various approaches to deal with uncertainty.

2.1.2 Externalities

In economics, an *external effect*, or *externality*, is said to exist if an economic agent's decisions impact on another agent's well-being or production possibilities and the former does not (properly) take these effects into account in his economic behaviour. The classic example of an external effect is that of an upstream factory polluting a river which has a negative impact on catches in a downstream fishery. When deciding upon how it will produce and consequently how much pollutant it will emit into the river, the upstream factory will not take this effect into account. This is an example of a firm-firm-externality where one firm's economic actions affect another firm's production.

Externalities can be both negative and positive. A negative externality is called an *external diseconomy*, or *external cost*. The example given in the preceding paragraph is an

example of an external cost. A positive externality is called an *external economy* or *external benefit*. Although much less common, such effects do exist. For example, it is thought that emissions of NO_x from, say, power plants may benefit the growth of crops through the fertilisation effect of increased nitrogen deposition.

The internal versus external cost terminology might give rise to some confusion. Readers with a background in the conventional environmental impact assessment might assume that by external costs refer to those costs that occur outside the borders of the system under study, while internal costs refer to those costs that occur within the system. However, this is *not* what is meant by an external cost in economics. External refers to the fact that these costs are not taken into account by the individual firm or household that decides upon the level of its economic activity. This does not mean that the firm or household that experiences the external costs is outside the borders of the system under study. Only if the system under study in an environmental impact assessment is an individual firm or household, do the system-theoretic and economic interpretation of external coincide.

It is important to note here that if an economic activity negatively influences a person's well-being and/or a firm's production, then this represents an external cost whether or not this involves any financial costs by the party suffering the externality. For example, if the emissions from a waste incinerator cause an increase in asthma attacks in the population, then this is an external cost, whether or not this has any financial consequences in terms of, say, increased costs of medical treatment. And even if these emissions result in increased costs for treatment, these costs will only partly reflect the total external cost because they do not include the valuation of the pain and suffering by the person experiencing the attack.

Another example is the external costs caused by increased traffic congestion from waste collection trucks. Increased congestion may lead to increased petrol use by other motorists. Thus, there is a direct monetary cost associated with this external effect. Another effect of increased congestion might be people losing leisure time when getting stuck in traffic jams. Although this does not involve any direct financial costs, it does represent a real cost in the sense that it impacts negatively upon peoples' well-being. Externalities are therefore sometimes classified into monetary (pecuniary) and non-monetary externalities.

If an externality is present, the marginal private costs and the marginal social costs of an economic activity do no longer coincide, resulting in an inefficient allocation of resources. By the social costs of an economic activity are meant the costs borne by all households and firms in an economy, that is, the private (internal) costs *and* the external costs of an activity. A condition for a Pareto efficient ('optimal') allocation of resources in an economy is that the marginal social costs of an activity equal its marginal social benefits. If an externality is present, a firm will only consider its own (private) marginal costs when deciding upon the level of a certain activity and will not take into account the external costs (benefits) it imposes upon others, resulting in too high (low) a level of this activity or too low reduction (not enough) of the external effect. The theoretical solution to this mismatch between marginal social costs and benefits is the imposition of a so-called Pigovian tax on this activity, so named after the English economist Arthur Pigou.

In order to secure an efficient allocation of resources, the Pigovian tax should be equal to the marginal value of the externalities caused by this activity.

Many external effects do not have a readily observable economic value which is defined in Section 2.1.3. In order to be able to value these effects, special valuation methods are needed. Section 2.1.4 discusses the different sources of value distinguished in environmental economics. Section 2.2 describes some techniques that can be used to estimate the value of external effects.

2.1.3 Economic value

By monetary valuation is meant assigning a monetary value to a good or service. The economist's monetary measure of economic value is the Willingness-to-Pay (WTP). The WTP is defined as the maximum amount of money a person is willing to pay so as to obtain a good or service. An individual's WTP for a good is a reflection of his preferences for this good relative to other goods. This can be shown formally using welfare theory, but it also seems intuitively clear. If a person is willing to pay at most 50 ECU for good A while he is willing to pay 100 ECU for good B then he must prefer having good B to having good A. In the absence of conventional markets, by valuing environmental goods such as clean water and clean air using the WTP for these goods, one can measure preferences for these goods in a way that makes them comparable to marketed goods.

More importantly, valuation enables one to compare the benefits of some environmental improvement with the associated costs. If the benefits, as measured by the WTP for these benefits, are less than the costs, then the conclusion would be that the individual prefers having this improvement to not having it. For example, suppose a program designed to reduce air pollution would result in asthma attacks. If some person is willing to pay 75 ECU for preventing this adverse health impact while the costs of the program to him would be only 50 ECU, then one can conclude that he would prefer the situation with the reduced air pollution even though this would mean he has less (50 ECU) to spend on other goods.

Besides valuing environmental improvements, economic values can also be used to value negative effects on the environment. In such a case, this value would not represent a benefit, but a cost. For example, building a waste incinerator, would result in higher levels of air pollution and an increase in asthma attacks, the value of 75 ECU for preventing such health effects would be counted as a cost of this development. In other words, costs are just the mirror image of benefits and vice versa; it just depends on the reference point.

An alternative measure of economic value is the Willingness-to-Accept (WTA). WTA is defined as the minimum amount of money an individual requires as compensation in order to forego a good or service. Whether a WTP or a WTA measure is most appropriate is essentially a matter of property rights. A WTP measure implies that the property rights do not lie with the individual; he or she has to pay to obtain the use of a good or service. A WTA measure implies that the individual holds the property rights; he or she has to be compensated for the loss of the good or service. Which measure is most appropriate, is therefore not an economic, but rather a legal or perhaps even an ethical matter.

In practice, researchers have encountered serious difficulties in trying to estimate the WTA for the loss of some environmental good. Whereas theory predicted that in most cases the difference between the WTA for a loss and the WTP for an equivalent gain should be in the order of a few per cent, in practice it was found that the WTA could be up to five times as large as the WTP (Bateman and Turner, 1992). Many interpreted these findings as resulting from a flaw in the method that was used to measure WTP and WTA (e.g. Contingent Valuation; see following sections). They concluded that although the method might be able to estimate WTP, it could not reliably estimate WTA. Most researchers therefore prefer to estimate a WTP value, even if a WTA value would be more appropriate.

Other interpretations suggest that this difference is not due to a methodological flaw but that there are good grounds to expect such a difference in some cases, especially if it concerns the loss of a unique good with only a few or no substitutes (Hanemann, 1991). See Bateman and Turner (1992) for an overview of possible explanations.

Nevertheless, it remains common practice to estimate a WTP value. The majority of the values from CVM studies used in the present study are also WTP values. In some cases, one could seriously question the appropriateness of a WTP value. Take, for example, adverse health impacts caused by emissions from a waste incinerator. Although, it seems clear that the 'property rights' to health are held by the individual and not by the polluter. Still the damage is valued through the WTP of individuals to prevent these impacts, whereas the WTA of these individuals to accept these health impacts seems a more appropriate way to value them. However, even in such cases, there are good arguments for the use of a WTP value (see Mitchell and Carson, 1989). This basically has to do with the fact that ultimately the costs of preventing or decreasing these health impacts will be borne by the individual. For example, in order to reduce emissions scrubbers will have to be installed, the costs of which will ultimately be borne by the individuals, for example in the form of higher fees for waste collection.

2.1.4 Sources of value

In environmental economics, a distinction is usually made between two main sources of value: use value and non-use value. Together, they are called the total economic value. Usually, option value is added to this as a third component.

Use values arise from an individual's use of environmental goods and services. One can distinguish between direct and indirect use values. Direct use values refer to an individual's direct use or interaction with environmental goods and services. For example, clean water is directly of value as drinking water. Indirect use values refer to the indirect support and protection provided to economic activities by the environment. For example, a stable climate has an indirect value for agriculture, since any change in climatic conditions might have an effect on agricultural yields and thus have an indirect use value.²

² This definition of direct and indirect use value is based on Barbier (1992), and differs significantly from the definitions given in the ExternE report (EC 1995a).

Non-use values, on the other hand, are derived neither from current direct nor from indirect use of the environment. If, for example, paper recycling can preserve old growth forest from being cut down, this may generate benefits for some individuals simply because they appreciate a pristine environment to exist, even if they do not intend to use it for recreation or other purposes. Non-use values have, amongst others, been termed 'existence values', 'intrinsic values' or 'bequest values', all having slightly different interpretations. These terms should best be seen as representing possible motivations underlying the non-use value.

The option value is often mentioned as a third component of the total economic value. Option value refers to an individual's WTP to keep open the option of using a good in the future. Extending the example of the old growth forest in the preceding paragraph, suppose an individual is uncertain whether s/he will visit ('use') the forest in the future. In such a situation it might well be possible that s/he is willing to pay something to keep open the option of visiting the forest in the future. Option value is sometimes compared to an insurance premium: it is the amount of money an individual is willing to pay to 'insure' himself against the possibility of the forest no longer being available for use should he wish to do so in the future. Note that option value is not equal to the value of actually visiting the forest in the future, but only the amount of money an individual is willing to pay just to keep open the option of visiting the forest. Option value and the expected value of an actual visit together are known as the option price. Nowadays, however, many authors doubt whether the option value should be seen as a separate category of value.

2.2 Valuation methods

In the preceding section it was explained that the value of a good or service is measured as an individual's WTP for this good or service. This section is concerned with methods that can be used for measuring this WTP. We will first discuss how WTP can be measured from demand curves and market prices. However, for the valuation of environmental goods, these methods are of limited use because often no market exists for these goods. For the valuation of such goods so-called non-market valuation methods have been developed and these will be discussed next. These methods are generally classified into values that are derived from 'stated preferences' and values that are based on 'revealed preferences'. Revealed preference methods calculate WTP for environmental goods indirectly by using the relationships between environmental goods and expenditures on market goods. The following 'revealed preference' methods will be discussed here: hedonic prices, travel cost method, averting behaviour and production function (or productivity) analysis. Stated preference methods do not make use of such relationships but ask the individuals their WTP for the environmental good directly by using structured questionnaires. Here we will only discuss the contingent valuation method (CVM). The other main stated preference method, contingent ranking, is a variant of CVM.

A detailed description of all these methods is clearly beyond the scope of this study, and the descriptions will be very brief. More extensive discussions can be found in Braden and Kolstad (1991) and in Freeman (1993). These two references provide extensive dis-

cussions of the micro-economic foundations of these methods and also of the econometric issues involved in their application. The discussion provided here is meant to provide the reader with a first overview of some of the most commonly used methods.

2.2.1 Demand curves

The relationship between the quantity demanded of some good and its price is called the demand curve. It can be shown that for most goods, the demand curve will be downward sloping, that is, the higher the price, the lower the quantity demanded. An example of a demand curve is shown in Figure 2.1. It can be shown that the demand curve for a good can be interpreted as a marginal WTP curve. That is, for every quantity of the good, it gives the maximum amount of money the individual is willing to pay for one extra, marginal unit of the good. For example, from the demand curve in Figure 2.1 it can be seen that the individual would be willing to pay at most 5 ECU for the fourth unit of the good.

Suppose the individual faces a market price of 5 ECU for this good. From the demand curve it can be seen that at that price the consumer will demand 4 units of the good. He will be required to pay an amount of money equal to area OABC for these 4 units. Since points on the demand curve give the WTP for an extra, marginal unit of the good in question, areas under the demand curve up to a certain quantity give the total WTP to consume this quantity of the good. Thus, the consumer's total WTP for these 4 units equals an amount of money equal to the area under the demand curve from 0 to 4 units, or area ODBC. It can be seen that this total WTP consists of two parts: the amount of money he is actually required to pay (area OABC) and the amount of money he would have been willing to pay over and above this amount but is not required to pay (area ADB). This latter amount is called the consumer surplus.

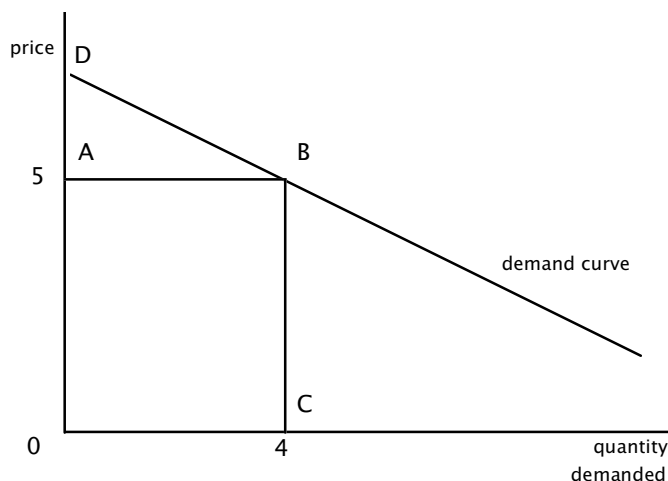


Figure 2.1 Willingness to pay and the demand curve

2.2.2 Market prices

As shown in the preceding section, for those goods which are marketed and for which a demand curve is known, WTP can be measured by evaluating areas under the demand curve. For this market prices can also be used. When markets are in equilibrium, the

market price will equal the marginal WTP, that is, the WTP for the last unit of the good. Multiplication by the quantity consumed gives an estimate of total WTP. However, this ignores the consumers' surplus.

How serious this omission is depends on the elasticity of the demand for the particular good in question. The elasticity of demand is a measure of how strongly demand reacts to price changes. A highly elastic demand means that small price changes will result in relatively large changes in quantity demanded. This implies a relatively flat demand curve. For such goods the consumers' surplus will make up an insignificant part of the total WTP and the error resulting from ignoring consumers' surplus is probably negligible.

In any case, when valuing externalities we are often concerned with valuing relatively small changes. For example, we are interested in the value of the agricultural production lost due to a small increase in ambient SO₂ concentrations resulting from the operation of a waste incinerator. For such small changes ignoring changes in consumer surplus is unlikely to result in large errors.

If markets are distorted, for example because of subsidies, prices will not reflect the true marginal WTP and they should be corrected for these distortions to obtain the so-called shadow price which reflects the true scarcity price of the good.

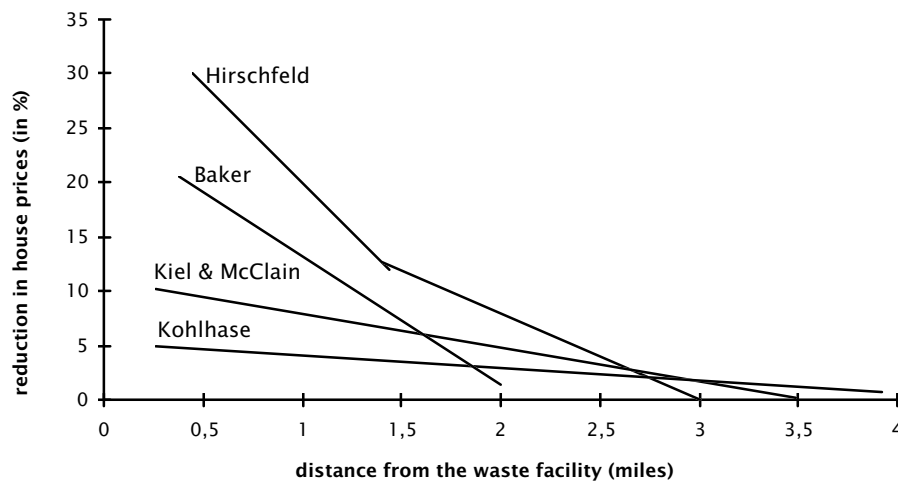
2.2.3 Hedonic prices

The idea underlying this method is that the price of a good is a function of its attributes, including environmental attributes. The Hedonic Prices Method (HPM) has, for instance, been used to analyse house prices. House prices are seen as a function of characteristics of the house itself (e.g. number of rooms, heating system), neighbourhood characteristics (e.g. proximity to schools and shops), and also environmental variables such as ambient air quality, or its proximity to a forest. The HPM proceeds by estimating a so-called hedonic price function by regressing house-price on the relevant characteristics. In the simplest form of the method, a measure of the value of an environmental characteristic of interest can be deduced by differentiating the hedonic price function with respect to the characteristics of interest. If, for example, a landfill site causes odour problems in the surrounding neighbourhood, the value of this external cost can be measured by the HPM by statistically isolating the price differential which is due to the nuisance caused by the odour. An example of hedonic property prices is given in Box 2.1.

Box 2.1: Hedonic Property Price Studies of Disamenity from Waste Facilities

Brisson (1997) conducted a survey of hedonic property price studies of disamenity effects from waste facilities. The studies included in the survey suggest that a close proximity of a landfill site or an incinerator has a substantial impact on the house prices in the neighbouring properties. Clearly, as indicated in the figure below, the exact distance within a diameter of at least four miles is a crucial parameter. According to, for example, the Hirschfeld estimate, a house at a distance of half a mile undergoes a reduction of 30% in value. The figure also illustrates the large range in available estimates. Also, it should be noted that it is plausible that this relationship is tempered by the fact that incinerators and landfills are often build where land is cheap, or in poorer neighbourhoods where people are less likely to offer resistance. More information on the hedonic pricing method is provided in the case study on waste incinerators in Southern and Western Europe (Volume II).

Reduction in Property Prices as a Function of Distance from Waste Facilities



Source: Brisson 1997, p.250

HPM has also been used in the valuation of a change in the risk to human life: the so-called wage differential method investigating the wage difference that workers accept for jobs with a higher risk of death or injury. The discussion on the value of human health is continued in Section 2.3.

For the HPM to give a valid measure of the value of the external costs, some crucial assumptions have to be fulfilled. The households have to be aware of the differences in environmental quality between different houses and perceive them in the same way. Furthermore, the housing market has to fulfil certain conditions. See Palmquist (1991) for an in-depth treatment of the economic and econometric aspects of the HPM.

2.2.4 Travel cost method

This method is used mainly for estimating the recreational value of a specific area. The intuition that lies behind the Travel Cost Method (TCM) is that, in the absence of en-

trance fees, the travel and other costs related to visiting the area give an indication of the WTP for visits to the area.

When applying the TCM, one estimates a demand function that explains the number of visits to an area as a function of the total costs incurred in visiting the area such as travel costs, travel time (valued at the appropriate opportunity costs), possible entrance fees and others such as the costs for fishing gear when valuing recreational fishing at a watercourse). Usually this demand function also includes visitor characteristics such as income, age or any other characteristic which is expected to influence preferences for visits to the area. The area under this demand curve gives the total WTP for visits to the area. Box 2.2 gives an example of the TCM for eutrophication at the Swedish coast.

Box 2.2: A Travel Cost Study on eutrophication of the Swedish coast

Sandström (1996) developed two sets of data for the construction of a travel cost model aimed at the valuation of the effects of eutrophication in Sweden: data on travel behaviour, and data on environmental quality. Travel behaviour was captured by collecting data on seaside recreational trips to the Swedish coast for the summer month of 1990-1994. The environmental quality set consisted of information on eutrophication measured by sight depth. To account for other factors related to the attractiveness of the site, variables such as the number of beaches, and hours of sunshine were included as independent variables.

Models were developed for travellers coming by car, public transport, and private boats. The chosen quality index had a measurable impact on travel behaviour. Assuming a uniform change of the nutrient load along the Swedish coastline, simulations indicated that the consumer surplus from a reduction of the nutrient load by 50% varies from SEK 240 to 540 million per year (ECU 28 to 64 million), depending on the type of model used. The corresponding per trip consumer surplus is SEK 140 and 315 (ECU 17 and ECU 37), respectively.

These results are considered lower bounds of the true welfare change due to nutrient reduction for various reasons. First, the surplus obtained only accounts for the use of the coast for recreational purposes. Alternative functions such as commercial fishery and existence values are not included. Second, the study only account for the increased value per trip and ignores the possible increase in the total number of trips. Not surprisingly, CVM values for the water quality of the Swedish coast are considerably higher than the above TCM values.

Source: Gren et al., 1996, p.29

The TCM can also be used to obtain a measure of the value of a change in certain characteristics of the area. We might, for example, want to calculate what the value of improving water quality at some recreation site would be. This value can be measured if we would know how the demand curve would shift if water quality was to improve. The area between the old and the new demand curve gives a measure of the value of the improved water quality. The crucial element in such an exercise is determining how the specific characteristic we are interested in influences demand. Several approaches have been suggested, each with its own problems (see Freeman, 1993). Major problems with

the TCM are: how to value travel time, how to treat multiple purpose trips, and how to deal with substitute sites. A further problem with values derived using the TCM is that they are extremely site specific.

2.2.5 Averting behaviour

Averting behaviour methods value environmental quality by looking at the expenditures people make for goods that can substitute or avoid for a decrease in environmental quality. For example, expenditures on bottled water can give an indication of the WTP of people for preventing the adverse health effects from using polluted water, or (increased) expenditures for cleaning the facades of houses can be used as an estimate for the cost of soiling from particulate pollution. There are numerous problems with this method and in most cases the expenditures on substitute goods will underestimate the true value of a decrease in environmental quality. This is true even if the substitute good is a perfect substitute for the loss.

2.2.6 Productivity analysis and exposure-response techniques

These techniques are extremely important for the valuation of effects on agriculture, forestry and human health from pollution. Using exposure-response relationships these methods calculate the effect of changes in environmental quality on a certain impact category and then value them. The simplest of these methods values the calculated impacts by simply multiplying the impact by some unit value. For example, an experimentally derived relationship between wheat yields and ambient SO₂ concentrations provides an estimated loss in wheat yields from a 1 ppb increase in SO₂ concentrations. The value of the lost yields is calculated by multiplying the yield loss by the market price of wheat.

Although widely applied, economists are generally sceptical of this simple approach, because it ignores adjustments in prices and inputs. Only under very restrictive assumptions does this approach give the economically correct value estimates. A more sophisticated approach requires information on demand and supply conditions in the market of the particular good we are concerned with in order to analyse the impacts on prices and inputs correctly. However, for the present project, we are probably dealing with such small, marginal changes in environmental quality that the simple approach can be justified. Box 2.3 gives an example of the productivity analysis.

2.2.7 Contingent valuation method

The Contingent Valuation Method (CVM) estimates the WTP for a change in the quantity and/or quality of an environmental good by using survey techniques (Mitchell and Carson, 1989; Hoevenagel, 1994). In the questionnaire a hypothetical change is described and the respondent is asked directly for his WTP for this change. For example, we might ask respondents what would be their WTP to preserve a pristine forest in its current state instead of it being logged over for the purpose of pulp production. These valuation questions are usually supplemented by questions on socio-economic characteristics and relevant attitudes and preferences regarding the good in question. This infor-

mation is used to estimate a valuation function which 'explains' WTP as a function of these variables. The valuation function can be used for validity checks (for example, testing whether WTP is positively related with income, as theory would predict) and for correcting average WTP in the case of certain response biases (for example, an overrepresentation of high income groups). In order to obtain a valid response it is crucial to provide an accurate and meaningful description of the change that is valued, and further that all relevant characteristics of the hypothetical market are described (for example, in which way and how frequently the respondent is expected to pay).

Box 2.3: Productivity analysis for commercial fishery and mangrove forests

Mangroves play an important role in the stock of fish due to their function as a feeding and breeding ground. Applying the productivity analysis, Barbier and Strand (1997) studied the relationship between mangrove forests and commercial shrimp fisheries on the coast of Campeche (Mexico). An equation (the production function) was developed which includes the main factors influencing the shrimp harvest, i.e. the fishing effort and the change in mangrove area.

Using estimated parameters of the production function, the authors simulate the effects of a change of mangrove area on harvesting and gross revenues of shrimp fishing in the area over the period 1980-90. On average over this period, a marginal (in km²) decline in mangrove forest produces a loss of 14.4 tonnes of shrimp harvest and nearly US\$140,000 (ECU 128,000) in revenues. However, also a significant impact of the fishery effort on shrimp harvest was detected. The conclusion of the study therefore is that, as long as effort levels continue to increase, shrimp harvest will fall, even if the mangrove resources are fully protected.

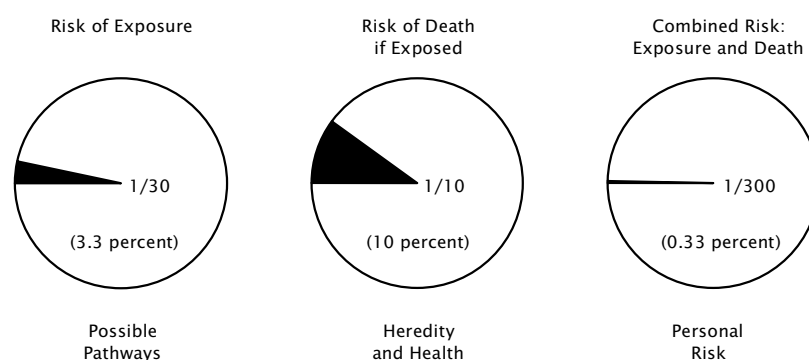
This case study demonstrates the main advantage of applying the production function approach: this method does not ignore ecological or economic complexities but instead enables the user to understand and actually quantify these complicated relationships.

Source: Barbier and Strand (1997)

In recent years, the CVM has attracted much attention and is regarded by many as one of the most promising valuation methods. This is due to two important characteristics of the method: (i) it is the only method capable of estimating non-use value and/or option value; and (ii) it can be used for valuing hypothetical changes in environmental quality. Critics of the CVM question the reliability and validity of answers to hypothetical WTP questions, and point to biases the method seems to be vulnerable to. A great deal of research has been done to detect such biases and on how to prevent them. This has resulted in the setting up of guidelines for conducting good CVM research (Arrow et al, 1993). An example of a CVM study is presented in Box 2.4 below.

Box 2.4: A CVM to estimate the WTP for reducing exposure to hazardous waste

Smith and Desvousges (1987) have estimated the WTP for reducing the risk of exposure and premature death from hazardous waste using CVM. In the questionnaire, the respondents were first explained that eventually they would have to pay for the costs of government actions aimed at reducing exposure to hazardous waste in the form of higher product prices and taxes. Respondents were then given a hypothetical example of a nearby company disposing of its toxic wastes on a landfill at the plant site. The associated risk of premature death from exposure to these wastes, were explained to them. This was done using so-called risk pies. An example is given in the pie charts below.



Risk pies expressing the WTP for reducing exposure to hazardous waste

The first risk pie from the left depicts the probability of exposure to hazardous wastes, while the middle pie gives the conditional probability of death if one is exposed. The pie on the right depicts the risk of death from hazardous waste which is the product of the risk of exposure and the risk of death if exposed. A hypothetical additional government regulation which would reduce the risks of exposure was then introduced, and the new levels of risk were again explained to the respondent using risk pies. Then the valuation question followed which read: 'How much would you be willing to pay each month in higher taxes and in higher prices for products you buy to lower your (and your household members') risk of exposure from the level on card A (the initial risk) to the level on card B (the risk after government regulation)?'

The study used a rather complicated design in order to test certain theoretical hypothesis. It is beyond the scope of this example to report the values for all the resulting sub-samples and the results of the tests. It suffices to mention here that it was concluded that the mean WTP ranged from US\$ 8.06 to US\$ 31.02 per household per month depending on the baseline risk and the proposed level of reduction in this baseline risk. Regression analysis further showed that a respondent's income and his or her concern over hazardous waste were statistically significant determinants of his or her WTP.

Source: Smith and Desvousges, 1987

2.3 Some further issues in valuation

Despite being rather general introductions, the preceding sections identify the main areas of interest in monetary valuation. However, several issues require special attention in this context. These are discussed in the present section.

2.3.1 Economic valuation versus other weighing methods

In recent years, various methods have been developed to weigh different emissions and other environmental parameters against each other, in order to make alternative projects with multiple impacts comparable. Some of these methods have specifically been designed for application in environmental impact assessment such as Life Cycle Assessment (LCA). Broadly speaking, these methods can be classified as follows:

- *distance-to-target approaches*: the importance of a pollutant is determined by the difference between the actual environmental situation and some objective (e.g. a politically or scientifically defined target, 'sustainability level' or 'no effect level');
- *scoring techniques*: relative weights are attributed to pollutants by a panel of experts, interested parties and/or the general public;
- *abatement and control cost methods*: the (monetary) value of a pollutant is based upon the costs associated with the prevention of its emission or neutralising the damage it causes;
- *welfare theoretical approaches*: these methods are based on the (monetary) value individuals appear or say to attach to changes in the environment.

Although all these methods have their pros and cons (which cannot be elaborated upon here), the methodology developed in the present study is mainly based on welfare theoretical approaches. In this way, it corresponds as closely as possible to the individual preferences regarding the environment. Only in some cases it was necessary, due to data constraints, to use abatement and control cost estimates to arrive at monetary values for certain impact categories. For the appraisal of water projects, it is sometimes also necessary, again due to data constraints, to present non-monetary indicators for environmental impacts along the lines of scoring techniques mentioned above.

2.3.2 Discounting

Discounting is the practice of placing lower numerical values on future benefits and costs as compared to present benefits and costs (EC 1995a). There are two main reasons why people value the present higher than the future. The first is time preference (for example, people rather have sufficient money today than in ten years) and the second is the productivity of capital (investing an amount of money in some kind of feasible economic activity now will probably generate profits in the future). In economic terminology, these two rationalities are called the social rate of discounting or pure time preference, and the opportunity cost of capital, respectively.

In the context of recycling processes, the future may be relevant since many external effects will only be felt in the future such as soil contamination at landfill sites, depletion of natural resources, and global warming from CO₂ and CH₄ emissions from landfill sites. The usual way to deal with temporal effects in the analysis is to apply a discount rate to future impacts. Suppose a damage of the value X ECU will occur over a period of T years, and a discount rate of r per cent is applied, then the present value of the damage is:

$$\sum_{t=0}^T X / (1+r)^t$$

This value of the damage in years $t > 0$ is smaller than the value X in year $t = 0$. From the equation it can be seen that the higher the discount rate r and the higher the number of years (t), the lower the value of future damage. The main issue for this study is at what rate or rates future effects should be discounted. The choice of the appropriate discount rate remains a controversial issue. As demonstrated in Box 2.5, this choice may have a significant impact on the outcome of the analysis. The usual way to deal with this issue is to report values for several different discount rates so that the decision maker can choose which one is the most appropriate rate. In the present project we follow this practice and report values for several discount rates for the main impacts where possible.

Box 2.5: Monetary valuation of nuclear energy in France

The ExternE study on nuclear energy is a very illustrative example of the effect of the discounting on the outcome of economic valuation (EC 1995g). The study which evaluated the external costs of the nuclear fuel cycle as it exists today in France applied three levels of discount rates (0%, 3% and 10%). Due to the long half-life of some of the radionuclides, low-level doses will exist very far into the future. As a result, the choice of the discount rate for this analysis is of crucial importance. In the table below, the total monetary values of the three scenarios are reported. As can be seen, not discounting future effects leads to significant external effects (2.48 mECU/kWh). However, if future damage is discounted by 10%, the value of the external effects is a factor of 50 smaller.

External Costs of Nuclear Energy.

Discount rate	Total External Costs (mECU/kWh)
0%	2.48
3%	0.095
10%	0.0497

Source: EC 1995a, p.301-303

For non-economists, the arguments for discounting future values may not be convincing. Indeed, economists have been debating the issue of determining an appropriate discount rate for the long term and irreversible (environmental) damage and continue to disagree. The practical applicability of monetary valuation methods is not affected significantly by such disagreement. One can easily devise a procedure which enables the user to choose his preferred discount rate and to perform sensitivity analyses with alternative rates. Different rates could even be applied to different kinds of impacts. As a default value, a discount rate of for instance 5 per cent could be used.

2.3.3 Generalisability and transferability

Environmental assessments generally consist of an emission factor: unit of emissions per unit of activity. The damage caused by that emission, however, depends on when, where and how this emission occurs (including the pattern of emissions, stack height etc.). A substance entering the environment may travel a long distance before causing its damage. In the meantime, it may get involved in chemical reactions with other substances, it may get diluted or transformed due to physical influences. It may be transferred between the different environmental media (air, soil, water). It may be stocked somewhere for a long time before being released again. Finally, the objects and organisms exposed to the substance may differ widely and may show a large variation in sensitivity and vulnerability. All this implies that, even if we knew with some precision the impact of a specific substance at a specific time and place on a specific object or organism, this knowledge would not tell us what the damage will be if the same substance is emitted at some other time and place under different conditions. All (physical) damage estimates attached to a given emission are therefore surrounded by a margin of uncertainty. The size of this margin is usually unknown, but it may cover several orders of magnitude.

Improving the compatibility of output of physical environmental assessments and economic analysis will require two developments. Firstly, the physical outputs (e.g. emission levels) should become more detailed in terms of the parameters that determine the level of the impacts associated with the emissions in the inventory analysis. For example, in the case of air pollution, information on where, when and at what height certain emissions to air take place should be added to the output. Secondly, from the side of economic valuation there is a need to develop a database containing values for each emission for different values of these parameters or giving correction factors for these parameters. This would enable one to select the value that is most appropriate for the specific inventory analysis one is valuing. In Appendix II an example of such a data base is provided. Moreover, the transferability of data should be better understood and standardised. This issue is described in the next Section.

2.3.4 Benefit transfer

Because it is practically impossible to estimate each exposure-response relationship or value at the respective time and place, it is inevitable to use data from previous studies which focus on a different region or time period. Therefore it is important to know when data from other studies can be used and under what conditions. For the transfer of monetary values, this practice is known as benefit transfer.³ The definition of benefit transfer is ‘an application of monetary values from a particular valuation study to an alternative

³ The term ‘benefit transfer’ should not be taken to mean that only benefits are transferred, it also applies to the transfer of costs. The use of the term benefit transfer stems from the fact that most valuation studies value improvements in environmental quality. The values these studies measure therefore represent benefits. As explained earlier, costs are just the mirror image of benefits: the value of a decrease in environmental quality (cost) is just the negative value of the equivalent gain (benefit).

or secondary policy decision setting, often in another geographical area than the one where the original study was performed' (Navrud 1994).

Three approaches to benefit transfer can be taken (Bergland et al, 1995). The first is transferring mean unit values. For example, suppose that a study undertaken in the USA has estimated that the mean unit valuation of an extra asthma attack from increased concentrations of ground-level ozone is \$500. In the absence of a European study, such a unit value could be used to value asthma attacks in a European context by using the exchange rate between US\$ and ECUs..

The second approach is using corrected mean unit values. For example, if in the above study it was found that there is a relationship between income and the value placed on an asthma attack, the unit value can be corrected for differences in income between the USA and the European country in question.

The third is transferring the complete valuation function. Besides income, most studies find that other socio-economic and demographic factors have an influence on the valuation. Using statistical techniques (regression analysis) most valuation studies estimate a valuation function, that explains the value placed on a good or service as a function of these factors. This function can then be transferred to another site and by inserting the local values of the explanatory variables one can calculate an adjusted value.

2.3.5 Valuation of mortality and morbidity

Although this section is meant to give a general overview of valuation issues and we do not want to be concerned too much with the approach that is taken to value specific impacts, we feel that the controversy surrounding the valuation of impacts to human health warrants some further elaboration. Air pollution (but also other forms of pollution) can have many impacts on human health, ranging from short periods of coughing to premature death. The valuation of human health impacts remains one of the most controversial aspects of any valuation study. The authors believe that much of the reactions to the monetary valuation of these impacts are partly caused by the unfortunate choice of terminology such as the 'Value of a Statistical Life'. Unlike the name might suggest to non-economists, a concept like 'the Value of a Statistical Life' is not 'the value of a life' as used in everyday language, but is simply a convenient way to summarise information about people's WTP for small reductions in mortality risks for themselves and others.

Values for health impacts can be derived in a number of ways. Values for mortality impacts are mostly based on studies using the CVM and the hedonic wage method. Using CVM, people are directly asked for their WTP to reduce mortality risks. Using the hedonic wage method, differences in wages between professions with high and low mortality risks are used to derive a value for these mortality risks. Note that these studies thus do not value *life* but rather value small differences in mortality *risks*.

For example, suppose it was found that the mean WTP for a reduction in the risk of a fatal accident from 10 in a million to 1 in a million is ECU 10. Suppose further that the total population consists of one million persons. Then the aggregated WTP for this risk reduction is ECU 10 million. Reducing the mortality risk from 10 in a million to 1 in a million for a total population of 1 million people means that statistically 9 lives will be

saved. The VSL is then ECU 1.11 million (10/9). Thus, this Value of a Statistical Life is nothing but a convenient way to summarise information on the WTP for the reduction of mortality risks. This makes it easier to compare the benefits of some measure designed to reduce mortality risks with the associated costs, if the number of lives saved is known.

The VSL, essentially a measure of WTP for reducing the risk of premature death, is an important parameter in the monetary valuation. A major review of studies from Europe and the US, covering three valuation methods (wage risk, contingent valuation and consumer market surveys) is described in earlier work conducted by the ExternE programme (European Commission, 1995b). The value derived for the VSL was 2.6 MECU. This value has been adjusted to 3.1 MECU, to bring it into line with January 1997 prices.

However, in the ExternE programme a number of questions were raised regarding the use of the VSL for every case of mortality considered. These originally related to the fact that many people whose deaths were linked to air pollution were suspected of having only a short life expectancy even in the absence of air pollution. Was it logical to ascribe the same value to someone with a day to live as someone with tens of years of remaining life expectancy? Furthermore, is it logical to ascribe the full VSL to cases where air pollution is only one factor of perhaps several that determine the time of death? In view of this, the project team explored valuation on the basis of life years lost. For quantification of the value of a life year lost (YOLL) it was necessary to interpret the estimate of the VSL as the present value of a number of life years. This is not ideal by any means (to derive a robust estimate primary research is required), but it does provide a first estimate for the YOLL.

A valid criticism of the YOLL approach is that people responding to risk seem unlikely to structure their response in terms of their remaining life time expectancy. It has been noted that the VSL does not decline anything like as rapidly with age as would be expected if this were the case. However, one of the main reasons for this appears to be that a major component of the VSL is attributable to a 'fear of dying'. Given that death is inevitable, there is no way that policy makers can affect this part of the VSL. They can, however, affect the life expectancy of the population, leading back to the assessment based on life years lost.

Within ExternE, it was concluded that VSL estimates should be restricted to valuing fatal accidents, mortality impacts in climate change modelling, and similar cases where the impact is sudden and where the affected population is similar to the general population for which the VSL applies. The view of the ExternE project team is that the VSL should not be used in cases where the hazard has a significant latency period before impact, or where the probability of survival after exposure is altered over a prolonged period. In such cases the YOLL approach is recommended. However, in view of the continuing debate in this area among experienced and respected practitioners, and continuing and genuine uncertainty, the VSL is retained for sensitivity analysis.

The YOLL approach is particularly recommended for deaths arising from illnesses linked to exposure to air pollution. The value will depend on a number of factors, such as how long it takes for the exposure to result in the illness and how long a survival pe-

riod the individual has after contracting the disease. Given the more comprehensive nature of the YOLL approach, we adopt it as the main principle to base health effects on.

2.3.6 Marginal versus average costs

Sometimes values for external costs are *average* values. For instance, total damage from a given amount of, say, emissions has been divided by the amount of emissions to obtain an ECU/kg estimate. It is far from certain that one additional (marginal) kg of pollutant emitted will cause the same (average) amount of damage.

The marginal damage may be higher or lower than the average. A typical example of increasing marginal costs may be observed in the cases of certain pollutants and damage to (increasingly) rare species and ecosystems. Destroying the first animal of a common specie may cause only limited damage, but killing the last animal of this specie will be 'unaffordable'. Another peculiar situation occurs if species have a certain threshold level, below which no damage takes place but above which the damage may be fatal.

The opposite relationships exists for noise for which the marginal damage costs are generally lower than the average. This may be encountered in the case of the noise produced by one additional truck adds less than proportionally to the noise nuisance caused by all trucks which are already on the road. A similar reasoning may be applied in the case of landfill sites. It is mainly the landfill itself which causes environmental harm and nuisance. One additional load of waste deposited on an existing landfill adds relatively little to the total damage. However, if landfill capacity is exhausted and a new landfill site has to be created for the additional amount of waste, the marginal damage is higher than average.

These examples show that using average instead of marginal values may lead to underestimates as well as overestimates. Although marginal values seem to give better estimations of reality, without detailed information on the specific circumstances of the considered case the marginal damage figure cannot always be estimated and average values may have to be used as a proxy.

2.3.7 Doublecounting

Doublecounting can be a problem for aggregating both financial and environmental costs and benefits. For example, assume that the operating costs of an incineration plant are 1 million ECU a year and the costs to households in terms of collection fees are 100,000 ECU a year. Thus, besides possible other financial costs, the financial costs to the households of this option are 100,000 ECU and the financial costs to the operator of the waste incinerator are 1 million ECU. However, if the collection fees are used to finance the operation of the incineration plant, then adding these fees to the ECU1 million of operation costs would obviously lead to double-counting when we want to estimate the financial costs of the complete waste management system under study. In other words, if transfers take place between different agents (households, local authorities, waste handling companies, etc.) within the system one should be extremely careful of possible double-counting.

Double-counting can also occur between financial and external costs. In that case, the financial costs are often referred to as internal costs. The distinction between internal and external effects lies in the fact that external costs are those from which third parties suffer (or benefit) and receive no compensation (or reward), while internal effects are those for which the sufferers are compensated. For example, if a firm has a liability insurance against the risk of accidents or environmental damage, then the damage covered by the insurance should not be counted as an external cost, because it is already included in the insurance premium (which is an financial cost to the firm).

2.3.8 Indirect impacts and other omitted parameters

The method presented in this study is basically only concerned with the valuation of direct environmental impacts. Implicitly, therefore, it is assumed that indirect impacts are relatively unimportant and do not affect the outcome of the analysis. For example, if air pollution causes a reduction in crop yield, the economic valuation approach only includes the value of the production loss. It ignores the indirect macro-economic effects, such as a possible reduction in agricultural employment, an increase in the trade balance deficit, price increases on the market for the affected crop, and the ensuing substitution by other crops. Such impacts could only be analysed in a general equilibrium setting. This is not only unfeasible; it is also questionable how for instance employment impacts should be valued. If the labour market is in equilibrium, one job lost does not affect social welfare, because the unemployed person will easily find a new one. In a situation with high unemployment figures, the 'willingness to pay' for a job may be higher than zero, but the 'shadow price' for a job is hard to determine.

In order to account for this omission, the above mentioned assumption of each project leading only to a small or marginal change is made. However, cumulative effects of such projects remain to be analysed.

The combined impact pathway approach not only omits indirect and macro-economic impacts; it also excludes some direct (environmental and other) variables. This is mainly due to the standard environmental assessment methodology incorporated. This method does not, for example, assess the impact of buildings, installations and road infrastructure on wildlife habitats with the exception of some for water projects. Such impacts are largely site specific and do not lend themselves to the generalising approach. Several non-environmental impacts, such as labour conditions (apart from occupational health) are also outside the scope of the impact pathway approach. A complete method would mention at least qualitatively these omitted variables.

2.3.9 Uncertainties

A distinction can be made between uncertainty that is a bias and uncertainty that is reflected in the wideness of the interval of confidence. A bias will occur when parts of the estimate, either value components such as consumers' surplus, or certain external effects, are omitted, and lead to an underestimate. If the interval of confidence is wide, then the accurateness is low but there is no systematic tendency in the estimate.

Both types of uncertainty in externality estimates arises in several ways, including:

- The variability inherent in any set of data;
- Extrapolation of data from the laboratory to the field;
- Extrapolation of exposure-response data from one geographical location to another;
- Assumptions regarding threshold conditions;
- Lack of detailed information with respect to human behaviour and tastes;
- Political and ethical issues, such as the selection of discount rate;
- The need to assume some scenario of the future for long term impacts; and
- The fact that some types of damage cannot be quantified at all.

It is important to note that some of the most important uncertainties listed here are not associated with technical or scientific issues, instead they relate to political, ethical, impact assessment and valuation issues. Traditional statistical techniques would ideally be used to describe the uncertainties associated with each of our estimates, to enable us to report a median estimate of damage with an associated probability distribution. Unfortunately this is rarely possible without excluding some significant aspect of error, or without making some bold assumption about the shape of the probability distribution. Alternative methods are therefore required, such as sensitivity analysis, expert judgement and decision analysis. The uncertainties of each stage of an impact pathway need to be assessed and associated errors quantified. The individual deviations for each stage are then combined to give an overall indication of confidence limits for the impact under investigation (Dorland et al, 1997a).

2.3.10 With and without principle

Project appraisal generally requires a reference or baseline scenario to compare the costs and benefits of project alternatives with. Only if the environmental impact analysis is performed in order to check whether the local standards are obeyed, or whether the additional financial costs of mitigation do not exceed the environmental benefit of the mitigation measure, can comparison be avoided. There are two possible definitions for the baseline scenario, or the case without the project alternative appraised: 'do nothing' in which case all the parameters continue with the same trends, and 'alternative' project in which case different alternatives of the same project takes place and their outcomes are compare in relation to each other over and above the 'do nothing' baseline. The first step of the appraisal, in the case of making the comparison, is to identify this alternative project. Secondly, the costs and benefits of this alternative project should be estimated following the similar procedure as the focal project. The (avoided) costs of the alternative become the benefits of the focal project. The (avoided or lost) benefits of the alternative, if any, should be added to the costs of the focal project.

Whether in practice the alternative is totally avoided or only postponed depends on the magnitude of the avoided environmental damage. However, this should not affect how the benefit of focal project is calculated since the benefit is, in fact, 'permanent' and should be credited to the project over the whole of its economic life.

3. Guidance

These guidelines cover the monetary valuation and non-monetary indicators of external effects of water and waste related projects. The various categories of water and waste related projects are summarised in Table 3.1. This categorisation is based on the most common types of projects considered by the Bank and may therefore not be exhaustive.

Table 3.1 A selection of water and waste related projects.

Categories	Targeted at	Selected projects
<i>Water Projects</i>		
Customer-side management	customers' consumption, comprising plumbing losses and end-use	<ul style="list-style-type: none"> • Metering of freshwater use • Metering of sewerage outflow • household toilets • Recycling and re-use of water • Education and awareness on water efficiency measures & appliances and personal hygiene
Distribution-side management	activities on the distribution side and up to the point of consumption	<ul style="list-style-type: none"> • Customer pipe leakage reduction • Distribution pipe leakage reduction • Increased distribution capacity
Production and resource management	activities between the points of abstraction and distribution input	<ul style="list-style-type: none"> • New abstractions • Upgrading or building freshwater works • Influencing water yield • Recycling treated water from sewage treatment works
Wastewater management	collection and treatment of used water.	<ul style="list-style-type: none"> • Sewerage collection systems • Upgrading or building sewage treatment works • Sewage and sewage sludge disposal
<i>Waste Projects</i>		
Incinerators	combustion of solid waste to reduce municipal waste flows and generate energy	<ul style="list-style-type: none"> • Air emission control • Material recovery • Recovery of residues such as fly ash and slag
Sanitary landfill	safe storage and decomposition of municipal solid waste	<ul style="list-style-type: none"> • Gas recovery • Leakage control
Prevention and recovery	reduce harmful impact of waste generation	<ul style="list-style-type: none"> • Public campaigns • Recovery infrastructure

Note: Esrey et al (1990) define sanitation as the proper disposal of human excreta. Based on this definition, sanitation projects are covered within customer-side and water management projects.

The term ‘water projects’ is used to include both fresh and wastewater projects. Effects on commercial fisheries and commercial uses of water (such as irrigation) are excluded as we assume that such effects can be internalised by the project promoter. For both water and waste related projects, second order effects such as the environmental costs of energy used in pumping stations are excluded from this analysis.

While these projects may be different in nature, there is in principle no difference from the point of view of economic analysis: all have associated costs and benefits. The difference is more one of practical difficulty in assessing the full range of costs and benefits. For example, projects aimed to control water demand may impose costs on households, e.g. possible disruption due to metering in households, and these have typically not been the subjects of monetary valuation studies.

3.1 Overall approach

Figure 3.1 shows the assessment procedure for determining the environmental costs and benefits of water and waste projects. The approach consists of five successive steps, which form respectively the environmental appraisal (steps I and II) and the valuation phase (steps III to V). Figure 3.1 also contains a final stage ‘Evaluation and Interpretation’, which follows naturally after the valuation stage. This stage is not part of the guidelines.

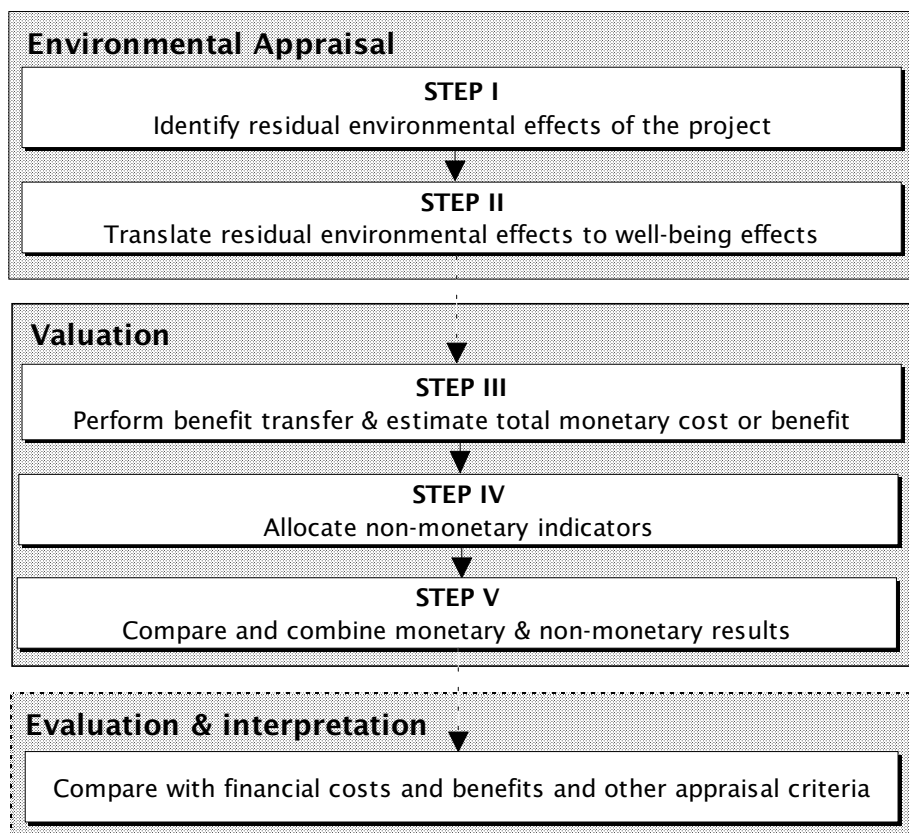


Figure 3.1 Overall methodology.

These guidelines assume that the project under investigation has already been narrowly defined. In other words, mitigation measures have already been included in the defined project. By definition, the environmental effects which are considered are therefore 'residual' effects⁴.

Both the classification of effects and their appraisal suggested here are based on the general rules of environmental impact assessment. Therefore, we have taken an approach which highlights the main concerns for each category of environmental effect. The reader should follow the description of each issue and try to assess the environmental effects of the project and whether these are residual (after possible mitigation) and significant based on the information provided by the environmental impact assessments accompanying the project application.

The final step of environmental appraisal is to translate the environmental effects to well-being effects, which are defined as any *change in human well-being* brought about by a project, programme or policy measure.

This can be problematic when physical effects are described and perhaps measured in a manner which makes them non-amenable to monetary valuation. A common example is measuring water quality changes in terms of biochemical oxygen demand (BOD). Individuals using a river would not 'value' BOD. Rather they would perceive the effects of BOD, i.e. a change in the attributes of the river – loss of biodiversity, appearance, and even smell. So, what people are willing to pay for is a change in the perceived quality of the river. Of course, if BOD changes can be expressed as changes in perceived water quality (may be by the use of a computer model), the link from measured quality to perceived change can be made.

The valuation stage presents steps to identify and measure the changes in the society's well-being due to the environmental effects identified in environmental appraisal stage. Such changes can be positive (a *benefit*) or negative (a *cost*). For example, the experience of disamenity is a cost, and the experience of aesthetic pleasure is a benefit. The former would be measured in terms of individuals' WTP for avoiding the disamenity, or their WTA compensation for tolerating the disamenity. The latter would be measured by the WTP to secure the benefit, or the WTA compensation to go without the benefit. While the concepts of WTP and WTA are clearly and deliberately expressed in money terms, there may in fact be no associated cash flow. In short, monetary values used in these guidelines reflect WTP or WTA, which, in turn, reflect people's preferences.

As a rule, environmental effects should, wherever possible, be expressed in units that are capable of translation into monetary values. To find monetary values for the resulting effect based on WTP or WTA, certain *monetary valuation techniques* are employed (See Section 2.2). The cost of undertaking new valuation studies, should always be seen in proportion to the cost of the project, rather than as an absolute cost. The costs of studies

⁴ Technically, the mitigated effects should themselves be the subject of a benefit-cost appraisal. That is, costs of mitigation should be compared to the benefits of mitigation. It is assumed here that what is mitigated depends on judgements about statutory or legal requirements, and that no cost-benefit appraisal of mitigated effects takes place.

tend to be small relative to overall project costs for large investments, but can be high for small projects.

Where it is thought that new studies are too expensive or time consuming, resort is made to *benefit transfer*, the process of ‘borrowing’ valuations from studies of other, similar projects. Great care needs to be taken in adopting benefit transfer because the potential for error is significant. Considering the limitations of monetary valuation literature and benefit transfer in the face of site-specific effects especially from water projects, it is inevitable that the residual effects will generally be measured partly in monetary terms and partly in non-monetary terms. Uncertainty is inherent in all stages of project appraisal: monetary valuation, environmental appraisal and indeed in financial analysis. Therefore, even simple sensitivity analysis in the form of using ranges rather than point estimates, and testing of the influence of various assumptions on the final results, will improve the reliability of the whole exercise.

A final additional element to the guidelines, namely *time and discounting*, is introduced since well-being effects will occur over time. Some may occur only for short periods of time, e.g. temporary disruption and congestion from construction activity, whereas some will relate to the whole ‘lifetime’ of the project or beyond, e.g. changes in ecosystems.

Tables 3.2 and 3.3 presents the table form of Figure 3.1, which should assist in identifying the different types of environmental effects of water and waste projects respectively. The column numbers and headings correspond to the steps in the methodology and are discussed in detail in the following Sections. Assumptions for environmental appraisal can be recorded at the bottom of the table. Remember that each project or component of project requires a table like this to be filled out, even though some cells for some projects will be empty. To show how each step of the methodology is taken, a summary of three case studies (wastewater, freshwater and incineration) have been added in Section 3.3. An elaborate version of these case studies is included in Volume II of this report.

Table 3.2 The standard appraisal table for water projects.

Project Title:

Steps	I	II	III			IV-V
Environmental issues	Residual environmental effects	Residual effect on well-being	Valuation study	Adjustments	Specific data requirement	Compare monetary value and non-monetary indicators
Water environment						
Biodiversity						
Visual amenity						
Recreation						
Heritage & archaeology						
Traffic						
Noise & vibration						
Waste management & contaminated land						
Community effects						

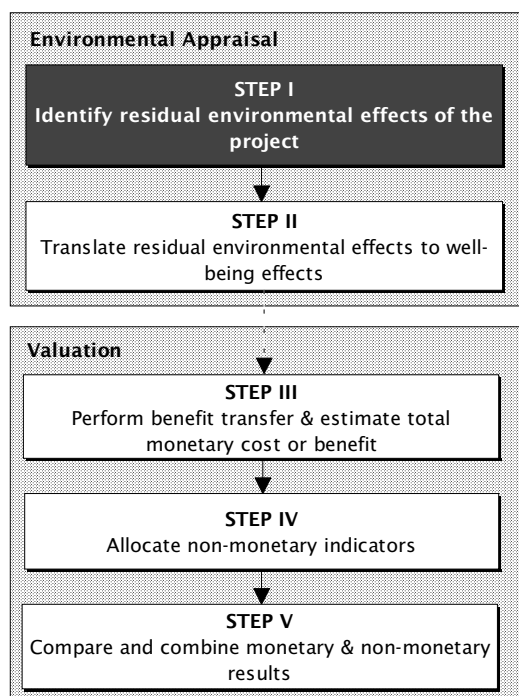
Table 3.3 The standard appraisal table for waste projects

Project Title:

STEPS	I	II	III			IV-V
Environmental issues	Residual environmental effects	Residual effect on well-being	Valuation study	Adjustments	Specific data requirement	Compare monetary value and non-monetary indicators
Health effects						
Traffic						
Visual and odour disamenity						
Ground water environment						
Buildings						
Global warming						
Community effects						

3.2 The guidelines

This section covers Steps I to V highlighted in Figure 3.1. Each step forms a column in the project appraisal Table 3.2 and Table 3.3.



Step I: Identify residual environmental effects of the project

When developing the projects to be assessed, all of the project components should be considered. For example, a new groundwater project may require a new borehole, a pipeline to an upgraded water treatment plant, and upgrading of the water distribution system. The effects of each of these should be assessed individually within their relevant categories. For example, the borehole is a water resource project, the pipeline and mains are distribution projects and the upgraded water treatment works is a production side project.

Only first order effects should be evaluated. Second order effects from, say, electricity used in water treatment works are considered being beyond the remit of these appraisals. The rows of Tables 3.2 and 3.3 list the standard environmental issues assessed for water and waste projects, respectively.

The principle result of Step I is a list of quantified environmental effects which adhere to three criteria: the effect should be external to the project, significant in impact and residual to the project. The underlying approach which is implicitly embedded in Step I is depicted in Figure 3.2.

External / Internal Environmental Effects

Environmental effects may be external or internal. External effects are those from which third parties suffer (or benefit) and receive no compensation (or reward). Internal effects are those for which the sufferers are compensated. For example, if a water company affects a commercial fishery due to water abstraction, this impact is potentially an external one (since water company receives benefits and the fishery suffers the costs). If, however, the water company compensates the fishermen for the loss of output, the effect becomes an internal one for the water company. Similarly, effects on the availability of irrigation water can be settled between the affected farmer and the water company internalising the effect. Note that there may still be some externalities left after such compensations are paid out, which are excluded from the analysis here.

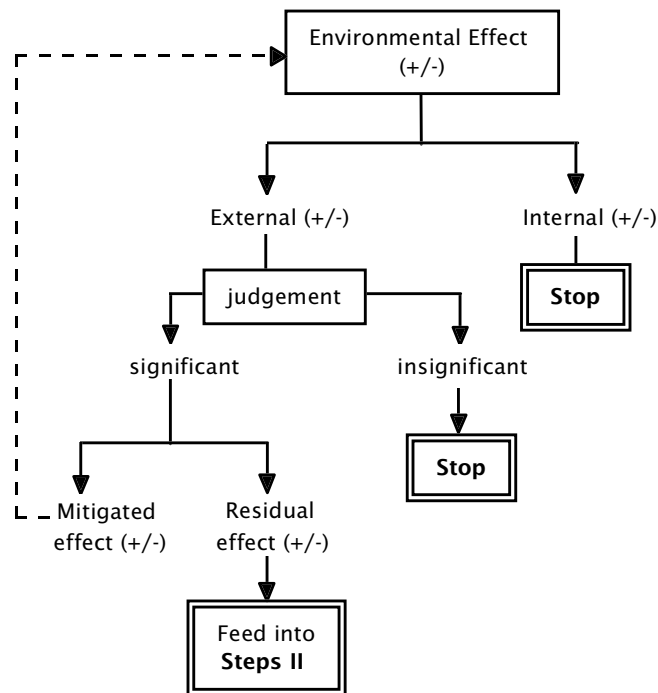


Figure 3.2 Translating environmental impacts into economic values.

Note: + denotes benefits and – denotes costs

In addition to direct compensation, the prevailing taxation system may be internalising some external effects such as landfill tax in the UK for solid waste disposal to landfills. Only external effects are relevant to this analysis.

Significance / Insignificance of Environmental Effects

External effects may be *significant* or *insignificant*. Only the former are relevant to this appraisal. Inevitably, judgement must be used in deciding what is and is not significant. In order to judge the magnitude and significance of environmental effects, a range of criteria may be identified:

- The effect on the natural, human, chemical and physical environment depending on their relative sensitivities,
- The location of the effect, whether within the confines of the site and beyond (local, regional, national and international scale),
- Timing of the effect, whether during the construction, operational and post-operational phases,
- Whether the effect is reversible or irreversible, and
- Whether the effect is positive or negative.

Based on these physical and other criteria⁵, each residual effect should be assigned a certain level of significance (positive or negative). The judgement of the physical effect can be reported in a qualitative manner. For this purpose, the range from major negative/positive to negligible can be applied (see Step IV).

For example, if a project will have a permanent negative residual effect on an internationally important wildlife habitat or species, then the effect will have a 'major negative' significance. Conversely, diversion of a local footpath for a short period may only have a 'slight negative' residual effect. The judgement will necessarily be qualitative, but should be substantiated by the assumptions and uncertainties used in the assessment. The assessment of environmental significance should be undertaken by personnel expert in environmental assessment.

Prediction of effects should be quantitative (where possible). It is important to note that the level of significance of the same effect in different locations can be different. The significance depends not only on the physical indicator used but also on the economic value attached to it. Therefore, monetary values should be checked to see which effects are given high importance by individuals⁶.

In the absence of quantitative information, a thorough qualitative assessment should be performed. If qualitative predictions are necessary, the assumptions made must be clearly stated below the project appraisal tables.

Mitigation Measures

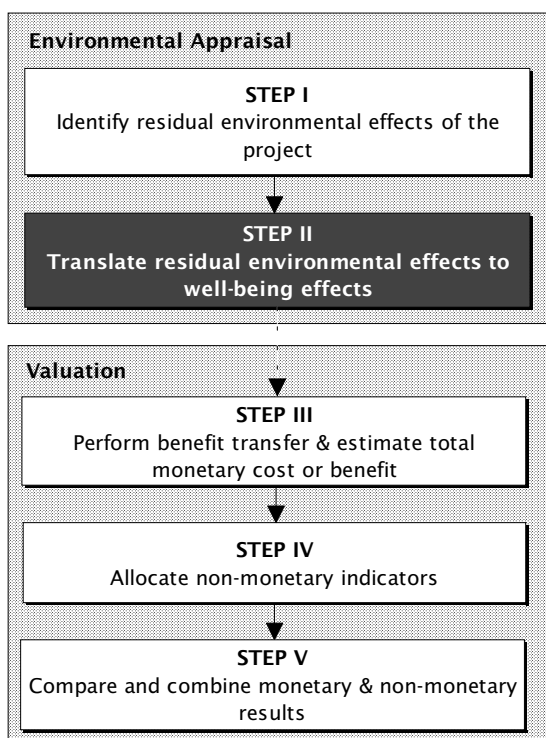
Many of the potential negative environmental effects of water and waste projects may be avoided by application of suitable mitigation measures. These may range, for example, from ensuring effective application of good practice on site to designing pumping stations underground thereby reducing visual effects. The scope of mitigation is clearly wide, and note should be made of mitigation that would be employed. An important factor when considering mitigation measures is that they should be integrated within the engineering design.

The main outcome of mitigation is to either eliminate or reduce the initial negative environmental effect, even though mitigation itself may have other negative or positive environmental effects. It may also be possible to develop enhancement opportunities, which could confer a benefit to the project. This is shown by the feedback from mitigated effects to environmental effect in Figure 3.2.

If the result of mitigation is to internalise (all or part of) an initially external effect, then the financial cost (or benefit) of this mitigation must be included in the financial analysis. Once the effect becomes *internal*, the analysis of that effect stops. Any environmental effects remaining after application of mitigation measures are termed *residual effects*.

⁵ The user can add compliance with the existing national and EU legislation since this is a factor that has been considered in the EIB's project appraisal procedure.

⁶ The higher the aggregate WTP / WTA estimate for an effect, the more significant that effect is.



Step II: Translate residual environmental effects to well-being effects

Having established and tabulated the full range and significance of residual environmental effects, monetary valuation should be applied. However, recall that not all residual environmental effects can be valued in monetary terms. The first stage to identifying whether an effect can be valued in monetary terms is to express it in terms and units that have a meaning in monetary valuation. In other words, effects identified by experts should be defined in a way that will be perceived by the general public. Table 3.4 demonstrates how this is achieved for the most commonly encountered effects.

The residual effects are the ones that will be the subject of valuation. They may be capable of having monetary values attached to them or they may not, depending on:

- whether they can be translated into effects causing changes in the society's well-being,
- whether any valuation studies relating to the effect exist: if not, no monetary value can be attached, and
- if the relevant literature exists, the credibility of using this literature in the appraisal, i.e. benefits transfer.

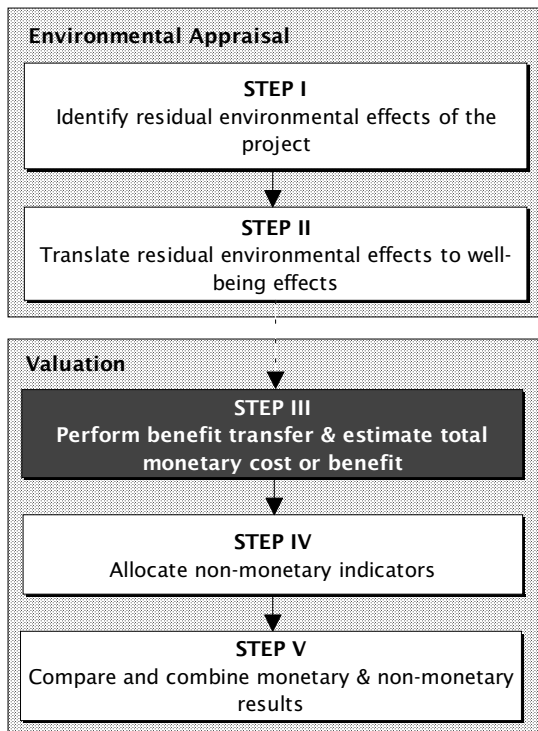
For water projects, it should be noted that changes in 'water environment' may lead to any one of the water related effects listed in the rest of this column 'Residual well-being effect' depending on the site-specific characteristics. Care, therefore, needs to be taken to ensure these effects are not valued twice within different categories (double counting). Also note that in most cases, the effect 'waste management' of water projects will be small since most waste will be inert. It is possible that one environmental effect could lead to a number of changes in social well-being: for example a reduction in water quality could affect recreational activities, visual amenity and human health.

Conversely, a number of different environmental effects may all lead to the same change in social well-being: for example changes in water quality and quantity may both affect the same recreation activity. The change in the society's well-being includes both marketed and non-marketed goods and services. For marketed goods and services (such as commercial fisheries, irrigation for agriculture) this is straightforward: we need to identify and measure the change in the output and multiply this with the real price (market price net of subsidies or taxes). The data needed for these calculations are site-specific and usually available. It is these calculations that compensation payments to affected parties are usually based on.

Table 3.4 Translation of environmental effects to well-being effects.

Environmental Issues	Residual Well-being Effect	Available literature reported in Appendix II
<i>Water projects</i>		
Water environment	Human health and a mixture of effects listed below	Changes in water quality, quantity and flow
Biodiversity	Biodiversity – changes in species diversity and habitats	Habitat preservation
Visual amenity	Visual amenity	Landscape
Recreation	Fishing Boating Walking Other recreation	Fishing General recreation Reservoir recreation Canal related recreation
Heritage/archaeology	Archaeology	-
Traffic	Air pollution Odour Global warming Congestion and accidents	Traffic related effects
Noise and vibration	Noise	Not available
Waste management and contaminated land	Air pollution, disamenity, traffic effects etc.	Not reported here but see the bibliography on waste projects
Community effects	Disturbance and disruption Change in lifestyle Severance effects	Not available
<i>Waste projects</i>		
Air pollution	Human health Damage to buildings and materials Damage to forest resources and agriculture	mortality and morbidity
Global warming	Human health Damage to buildings and materials Damage to forest resources and agriculture	Global warming
Visual and odour amenity	Visual and odour (dis)amenity	Disamenity
Traffic	Air pollution Noise Global warming Congestion and accidents	Traffic related effects
Ground water	Groundwater pollution	Not available
Community effects	Disruption of recovery efficiency Change in lifestyle Severance effects	Not available

Steps III to IV focus on the less familiar case of changes in the non-marketed environmental goods and services.



Step III: Perform benefit transfer and estimate total monetary costs or benefit

Now that the well-being effects have been judged on significance and a quantifiable measure has been set, a monetary value for each effect should be determined which is representative of the location and the time. For this purpose, benefit transfer will be necessary in practically all projects. It will be a very rare occasion that the WTP values are actually retrieved from the field itself. Therefore, a relevant study has to be selected from the literature and specific criteria for adjustment will have to be defined. These procedures are depicted in columns 4 to 6 in Table 3.2 and Table 3.3.

Appendix II presents a summary of currently available monetary valuation literature from Europe, North America and some developing countries related to the most commonly encountered environmental effects of water and waste projects. The table is comprehensive but by no means exhaustive. The literature is expanding rapidly and, due to the lack of a formal database of valuation studies, some studies may have been left out⁷. This is especially the case for studies which are not published in journals or elsewhere and may explain the bias in the review towards studies originating in the USA and the UK. Therefore, periodic reviews of the literature with the purpose of adding to what is summarised here are of great importance.

The studies mentioned in Appendix II have different levels of reliability or suitability for benefit transfer. Those with larger samples and smaller standard errors or confidence intervals of estimates are statistically more reliable. By looking at the studies in Appendix II (especially 'location' and 'effects valued' columns), we should be able to answer the following questions in order to identify the suitable study(ies). Notice that these questions indicate two important factors in identifying the valuation study relevant to the appraised project: the type of environmental effect, and the characteristics of the site.

- Are there any studies measuring the effect appraised at the site?
- Are there any studies measuring an effect similar to the one appraised at the site?
- Are there any studies measuring the effect appraised at another similar site?
- Are there any studies measuring an effect similar to the one appraised at another similar site to the one appraised?

⁷ Some have been left out either because the methods were not reliable or comparable to methods measuring WTP or WTA or their coverage of sites or environmental effects was not suitable for benefit transfer.

The more similarities between the appraised project and a valuation study from the literature can be identified, the more relevant will that study be for that project and hence the more suitable it will be for benefit transfer. That is why, in the ideal situation both factors are identical in both the appraised project and the valuation study. If the answer to this bullet point is 'no' but you can answer 'yes' to at least one of the other questions, then benefit transfer will be possible. If the answers to all four questions are 'no', then monetary valuation will not be possible. The alternative is to use non-monetary indicators, which are discussed in the next step.

There are three types of benefits transfer:

- *Transferring an average WTP estimate*: this involves taking an average (or median) estimate from a study and applying it to the effect in question. In most cases, this type of transfer is the easiest to implement but generates the least reliable estimates, since differences between the study site and the effect and the current site and the effect may be significant;
- *Transferring adjusted WTP estimates*: this is more detailed than the first type. It recognises that one or more of the following variables in a previous study may differ from those in the appraised project:
 - average income,
 - population size and characteristics,
 - background conditions,
 - levels of effect relative to the background conditions, and
 - other determinants for which there are accessible data for the appraised project.

A common adjustment is for income (using PPP ratios) and less frequently, for the population size and distribution of population characteristics, e.g. age. However, there is no consensus method for estimating adjustment factors for differences in other variables. The simplest way for adjusting for physical conditions is to assume a linear relationship. For example, assume that an original study estimates that the monetary cost of a x% decline in water level in a river is ECU y per year and the decline in the appraised project is 2x%, a linear relationship would imply a monetary cost of ECU2y in the appraised project (other things being equal). However, original studies rarely estimate this relationship. See RPA, 1998 for non-linear adjustment factors for different natural flows.

- *Transferring WTP (or demand) functions*: this is the best out of the three types of benefits transfer in terms of producing reliable estimates. It involves using an econometric equation from the original study, which estimates WTP or WTA as a function of independent variables. This will usually take the form of:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n$$

Where Y is WTP or WTA, $X_{1...n}$ denote determinants of WTP for the relevant effects of the appraised project such as socio-economic variables, site quality variables, etc., and $\beta_{0...n}$ are coefficients showing the relationship between variables (Xs) and valuation outcome (Y). In theory, this can be used to estimate WTP at the current site. However, using this technique involves collecting data from the current site for each of the variables

that determine the WTP estimate in the original valuation study. This is made difficult by the fact that not all original studies present the full WTP function and that collecting data may be time consuming and costly.

In all three types of benefit transfer, the WTP estimate can be taken from a single original study, a number of similar studies or the results of a meta-analysis.⁸ Note that the transfer is 'assumed' to be correct: no separate validation is carried out. The *fact* of transfer can therefore not be used as evidence that the transfer is *justified*.

Assuming we have already chosen a unit estimate of monetary value and adjusted it to fit the characteristics of the appraised project, the remainder of this step is straightforward. We need to multiply this unit monetary value with the physical quantity of the effect that leads to the change in the society's well-being, or the affected human population. The last column of the annotated bibliography table in Appendix II presents the information needed for estimating this total cost or benefit. Table 3.5 presents a few examples of this aggregation process.

Table 3.5 Estimating the total monetary cost or benefit.

Total monetary Value	=	Unit monetary value (adjusted if necessary)	X	Effect or affected population
<i>Examples:</i>				
ECU per year	=	ECU per person per trip (for recreation)	X	Total no. of trips per year
ECU per year	=	ECU per household per year (for conservation)	X	No. of households affected by a change in the society's well-being
ECU per year	=	ECU per tonne of CO ₂ (for global warming)	X	Total quantity of CO ₂ emissions
ECU per year	=	ECU per vehicle km (for transport related effects)	X	Total no. of vehicle kilometres travelled

Note that an increase in society's well-being or an improvement in environmental quality is a benefit and hence takes a positive sign. On the other hand, a decrease in society's well-being or deterioration in environmental quality is a cost and hence takes a negative sign.

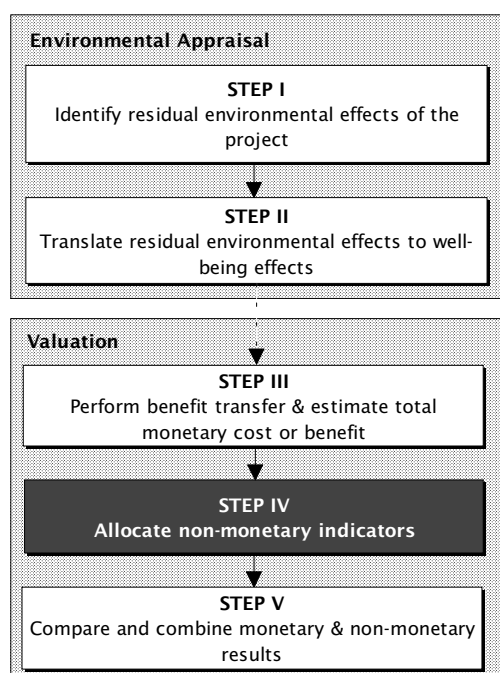
Although the actual estimation of total monetary values is straightforward, the assumptions behind this can be complex. For instance, it can be difficult to identify the affected population. For use values, this is relatively straightforward, as it is the population of users which is relevant, although data on user numbers may be difficult to obtain. Aggregation of non-use values is less straightforward.

⁸ Meta-analysis provides a means of synthesising the results from a number of studies in order to gain a better understanding of the consequences of the underlying modelling process. It is a statistical analysis, which combines the data, the functional form and the results of a number of original studies, and estimates a summary functional result. Therefore, the results of a meta-analysis are the best results to be transferred.

There are at least three assumptions that have been made in the literature for aggregating non-use values:

- applying the sample mean WTP to the whole population of the country the project is located, if the resource affected is thought to be unique,
- applying the sample mean to the population in some administrative area, e.g. population served by a water company, and
- applying the sample mean to an area beyond which it is thought that WTP tends to zero, which can only be defined on a case-by-case basis. This may also include non-nationals of the country of the project such as tourists (See Bateman et al, 1997 summarised in Appendix II).

Double counting can be a serious problem if we do not identify the different changes in the society's well-being clearly. There is another possibility when double counting may be a problem and that is if an original study measures people's WTP for more than one change in society's well-being, but does not distinguish between the different causes clearly or fully. This is somewhat clarified at the valuation studies themselves. If the summaries in Appendix II are thought to be insufficient in this respect.



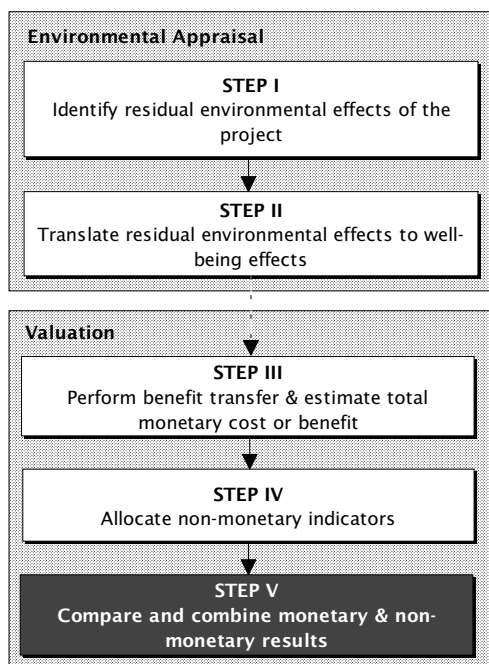
Step IV: Allocate non-monetary indicators

Although their number is decreasing in time, some environmental effects cannot be monetised at present, principally because of a lack of suitable valuation studies. Qualitative judgement is, therefore, needed to identify these non-monetised positive and negative effects for a given project. As described in Step I, each residual environmental effect should be allotted significance, ranging from negligible to slight, moderate or major. The level of significance is specified according to the sensitivity of receptors to the given effect.

The residual effects should be listed from the largest negative effect down to the largest positive effect. To aid in the visual presentation of the non-monetised residual effects, each level of significance should be displayed as follows:

Major negative	●●●●
Moderate negative	●●
Slight negative	●
Slight positive	○
Moderate positive	○○
Major positive	○○○

Many of the significant residual effects are site-specific and judgement on many of the effects is necessarily qualitative. Direct comparison of environmental significance of different issues, e.g. water quality and noise, is therefore considered inappropriate. Summation of qualitative assessment data, i.e. dots as shown above, is therefore to be avoided. The comparisons of non-monetary indicators for different project alternatives would require subjective weights to be assigned to dots based on local characteristics. No such generalised weights are suggested here. Whichever weighting method is used, all assumptions made for subjective assessments should be clearly stated.



Step V: Compare and combine monetary and non-monetary valuation results

This step provides guidance on ways in which monetary values and non-monetary indicators can be combined with financial costs and benefits. However, other considerations such as social and political issues, technical feasibility and ease of monitoring should not be ignored when final choice of projects is made. Since the prime focus of this report lies in the valuation of environmental externalities, the methodology does not explicitly address these issues.

As in financial appraisal, monetised environmental costs and benefits should also be discounted. Although the reasoning behind discounting in financial and environmental appraisal is similar, i.e. time preference, and opportunity cost of capital, the discount rates may differ. In the case of environmental costs and benefits, what matters is the society's well-being. Therefore, the relevant indicator should be the society's time preference. The best estimate of the social time preference rate is 2.4% with a range from 2% to 4% (Pearce and Ulph, 1995).

Monetary valuation only

Where all positive and negative environmental effects are measured in monetary terms, the aggregation is simple. Subtract the total costs from total benefits, which will give the total net benefits or the net present value (NPV):

$$NPV = B_m - C_m > 0 \text{ or } (B_m > C_m) \rightarrow \text{Proceed with the project}$$

$$NPV = B_m - C_m < 0 \text{ or } (B_m < C_m) \rightarrow \text{Reject the project}$$

Where B_m is all benefits (financial and environmental) over time expressed in monetary terms (discounted values) and C_m is all costs (financial and environmental) over time expressed in monetary terms (discounted values). Amongst those projects or project alternatives which are not rejected, the one with the highest net benefit (or NPV) should be most preferred.

It should be noted that WTP may change over time as incomes and environmental conditions change. Although there is no indication as to how the latter change takes place, the change based on income levels can be incorporated into the usual discounting process. One way of doing this is to assume that there is a direct relationship between income and WTP.

Mixed outcomes

It is likely that appraisal of each project will generate mixed outcomes, with some effects expressed in monetary units and some effects assessed qualitatively. First, compare all monetised costs and benefits as above (this should include financial and external costs) and list the non-monetised effects. There are four ways of dealing with mixed outcomes:

1. If monetised benefits exceed monetised costs and the non-monetised indicators are judged mainly to be positive, then proceed with the project since benefits more than outweigh the costs.
2. If monetised benefits exceed monetised costs and the non-monetised indicators are judged mainly to be negative, then compare net monetised benefits with the non-monetised costs. Using professional judgement, ask if the non-monetised costs are likely to be greater than the net monetised benefits. If they are, the project is not worthwhile. If they are not, then the project is potentially worth pursuing.
3. If monetised costs exceed monetised benefits and the non-monetised indicators are judged mainly to be positive, then compare net monetised costs with the non-monetised benefits. Using professional judgement, ask if the non-monetised benefits are likely to be greater than the net monetised costs. If they are, the project is potentially worth pursuing. If they are not, then the project is not worthwhile.
4. If monetised costs exceed monetised benefits and the non-monetised indicators are judged mainly to be negative, then the project is not worth pursuing.

Table 3.6 summarises these four possible outcomes.

Table 3.6 The treatment of mixed outcomes.

	$B_m > C_m$	$B_m < C_m$
$B_{nm} > 0$	1. <i>Proceed since benefits more than outweigh costs</i>	3. <i>Judge if $B_{nm} > [C_m - B_m]$</i> If so, proceed. <i>Judge if $B_{nm} < [C_m - B_m]$</i> If so, reject.
$C_{nm} > 0$	2. <i>Judge if $[B_m - C_m] > C_{nm}$</i> If so, proceed. <i>Judge if $[B_m - C_m] < C_{nm}$</i> If so, reject.	4. <i>Reject since costs more than outweigh benefits</i>

m denotes monetary estimates and nm denotes non-monetary indicators.

It is not possible to provide generalised guidelines for the professional judgement required in outcomes 2 and 3. This judgement is site and project specific and should be assessed on that basis. As long as assumptions behind such judgements are clearly stated and can be debated by different parties to the appraisal, the outcome should be efficient.

Non-monetary indicators only

This is the most common practice at the EIB at the time of writing of these guidelines. Due to the lack of data or valuation studies or because their insignificant scale, environmental effects of some projects will only be expressed qualitatively. If this is the case, compare financial costs and benefits as above and list the non-monetary indicators. The project or the project alternative with the highest number of positive scores for environmental effects per ECU of net financial benefit should be chosen as the best.

Note on Customer- and distribution-side management projects for freshwater supply

Customer- and distribution-side water management projects require a separate note. The environmental effects of these projects are more or less well identified in physical terms, but not all of them are monetised. In addition to costs and benefits that directly arise from these projects, there is a further benefit from water resource saving that will need to be considered.

This arises because they either:

- avoid the need for alternative production or resource management project⁹, or
- postpone the need for the alternative production or resource management project.

The first step of the appraisal, in this case, is to identify this alternative production or resource management project, where ‘alternative’ refers to both planned and existing

⁹ Note that distribution-side projects would avoid the need for some future repair work as well as reducing water consumption. Any reduction in future repair work would mean a reduction in traffic related environmental effects.

management projects. It is recommended that this alternative project to be avoided or postponed should be the most environmentally sensitive one in a given water resource zone. Secondly, the costs and benefits of this alternative project should be estimated following steps I to V. The (avoided) costs of the alternative become the benefits of the customer- or distribution-side project. The (avoided or lost) benefits of the alternative, if any, should be added to the costs of the customer- or distribution-side project.

Whether in practice the alternative is totally avoided or only postponed depends on the amount of water saved. However, this should not affect how the benefit of the customer- or distribution-side project is calculated since the benefit is, in fact, 'permanent' and should be credited to the project over the whole of its economic life¹⁰. Essentially, *with* the customer- or distribution-side project water flows are higher; *without* it, flows are lower. The fact that demand increases may return flows to the 'without' customer- or distribution-side project is not a reason to reduce the credit to this project. The flow would have been *even lower* had the demand increase occurred without the customer- or distribution-side project.

Note on waste incinerators and recovery projects

Similarly, waste incinerators and recovery projects require a separate note. The primary aim of these projects is to manage municipal solid waste. However, in addition to costs and benefits that directly arise from these projects, there is an obvious benefit from saving resources, energy from incinerators and raw materials from recovery projects, that will need to be considered.

3.3 Demonstration case studies

In order to demonstrate how the above presented approach can be applied in practice, case studies have been developed for respectively freshwater, wastewater and solid waste projects. An elaborate version of these and three other case studies can be found in Volume II of this report. It should be realised that, to increase the demonstrative value, simplifications and sometimes heroic assumptions have been made.

3.3.1 A wastewater project

The case study city is located on the western coast of a Mediterranean country with a residential population of 35,000 and an annual visitor population of almost 1,500,000. The project consists of a new sewage collection and treatment system in the greater urban area of the city. There are three alternatives to the project:

- A. Tertiary treatment and effluent reuse for urban irrigation
- B. Preliminary treatment and offshore marine discharge
- C. Preliminary treatment and inshore marine discharge

¹⁰ For a project that is postponed, the costs and benefits of this project should be entered into the analysis at the year that they are expected to occur rather than at the beginning of the planning time-frame.

The baseline scenario for all three alternatives is the continuation of the current practice, i.e. septic tanks and a large number of very small treatment plants, which are often poorly operated by hotels.

Step I: Identify residual environmental effects of the project

In order to determine the residual environmental effects of each of the alternatives, specific assumptions were made on

- Quantity and quality of discharged water;
- Daily average reuse water available to agriculture for irrigation (for A only);
- Impacts on the beach water quality;
- Abundance and diversity of marine species could potentially increase or decrease around the sewage outfall;
- Risk to recreation, odour problems and effects on human health, and
- The construction involves the following efforts.

Step II: Translate residual environmental effects to well-being effects

The four significant environmental effects of each alternative are:

1. Reduced demand for irrigation water from freshwater sources (alternative A only);
2. Changes in the beach water quality (highest improvement from alternative A, lesser improvement from B and no change from alternative C);
3. Construction traffic (for all alternatives at varying degrees);
4. Avoided traffic related effects due to the elimination of septic tanker movements (for all alternatives at the same level).

Step III: Perform benefits transfer and estimate monetary costs & benefits

Reduced demand for irrigation water from freshwater sources

There is no indication in the environmental statements accompanying the project as to what the current freshwater source is and what the magnitude of reduction in this demand would be if alternative A is accepted. Since this effect cannot be expressed in monetary terms, this step analyses the remaining effects.

Improved beach water quality

Whatever the alternative, the probability of septic tanks leakage and malfunction of hotel based treatment plants are reduced to zero since these will no longer be used. Although there is a chance that the proposed sewage system may overflow creating marine and freshwater pollution, this is not quantified.

Two original valuation studies from the literature are relevant for this effect. Machado and Mourato (1998) investigate the WTP for improvements in beach water quality in order to avoid visual impacts and public health impacts of polluted water. They report the mean WTP as US\$10.95 (1997 prices) or ECU10.5 per person per visit. This is used to estimate the WTP of tourists to keep the beach water quality at acceptable levels.

The other study (McConnell et al, 1989) took place in Barbados and estimated the local population's WTP for water quality improvements in terms of increased water bills to finance a new sewage collection and treatment system. They estimated this to be US\$178 or ECU170 per household per year and provides the most suitable estimate for the WTP of the local population in the case study city.

The only adjustment possible is that for income differences. Since the results of both studies are reported in US\$, we have used PPP conversions between USA (100) and the chosen Mediterranean country (42.2). The mean value from Machado and Mourato becomes ECU4.4 per person per visit and the mean value from McConnell et al becomes ECU72 per household per year. Note that the aggregate tourist and local population WTP estimates are additive.

The three alternatives appraised are likely to have different impacts on beach water quality. In the absence of water quality modelling, the assumptions are:

- no effluent discharge to the sea, which is a total improvement from the baseline conditions,
- 10% chance that the effluent may hit the coastline during specific weather conditions. Therefore, there will be a 90% improvement from the baseline quality of coastal waters,
- no change in the current beach quality. This is an optimistic assumption since it is likely that inshore discharge will cause decreases in the water quality even if this only affects the visual amenity.

Traffic related effects

There is no readily available information on the traffic flows and affected population to enable the calculation of the congestion and accident costs. Therefore, the only environmental damage costs used are those related to health and ecosystem damages from transport emissions using the study by Maddison et al (1996). The only adjustment that can be made to the air pollution effects of traffic is that based on the PPP conversion between UK (69.4) and the case study country (42.2). This means that the estimate of Maddison et al (1996) becomes ECU0.3 per HGVkm.

Since only the air pollution effects of HGV traffic are included in this appraisal, the aggregate effect is estimated by multiplying the unit cost of HGV traffic (ECU/HGV km) with the total number of HGVkm (either travelled or avoided).

Total monetised residual effects are calculated assuming a NPV at 5% over 19 years. The total includes both temporary and permanent effects. Although temporary effects would be over a number of years, for simplicity they are expressed in year 1 only.

Step IV: Allocate non-monetary indicators

The significance of the non-monetised residual effects is given in the final columns of Table 3.7.

Step V: Compare and combine monetary and non-monetary results

The appraisal results based on the above steps and assumptions presented are summarised in Table 3.7.

Table 3.7 Monetary values and non-monetary indicators.

Residual effect	Monetary value (ECU)		
	Alternative A	Alternative B	Alternative C
Temporary			
Air pollution damage caused by HGV traffic during construction	-25,700 (for year 1 only)	-69,000 (for year 1 only)	-14,000 (for year 1 only)
Permanent			
Improvement in beach water quality during operation	+578,000,000 (NPV - 5%)	+520,000,000 (NPV - 5%)	None
Avoided HGV traffic for septic tank disposal during operation	+1,100,000 (NPV - 5%)	+1,100,000 (NPV - 5%)	+1,100,000 (NPV - 5%)
HGV traffic during operation	-30,000 (NPV - 5%)	-30,000 (NPV - 5%)	-30,000 (NPV - 5%)
Total	+579,000,000	+521,000,000	+1,000,000
Non-monetised residual effects	Level of Significance		
Permanent			
Reduced impact on freshwater sources	○○○		
Visual amenity from STW	●	●	●
Heritage & Archaeology	●	●	●
Biodiversity	●	●	●
Temporary			
	none		

Note: A benefit is indicated by + sign and ○. A cost is indicated by – sign and ●.

3.3.2 A freshwater project

The reservoir will provide a water resource for two middle-sized towns, together with flow augmentation of a major river to allow abstraction downstream. The proposed reservoir area is currently not used for recreation, however, 200 ha of agricultural land would be displaced. It is anticipated that the reservoir would be used for recreation with a projected visitor numbers of 500,000 per year.

Step I: Identify residual environmental effects of the project

The following assumptions were made in the case study:

- Traffic generation during construction: (6 years): 10–20 HGVs per day, round trip of 50 km on rural roads;
- Visual effect mitigation: Grouping and design of structures to minimise intrusion, use of non-reflective materials and dull colours for cladding, restriction on lighting, retention of landscape features and screening;
- Route construction traffic away from sensitive receptors (e.g. schools, listed buildings),
- Follow best practice codes for construction;
- Code of practice on conservation, access and recreation, the details of which water supply undertakers are expected to follow.

Step II: Translate residual environmental effects to well-being effects

Four environmental effects of the reservoir construction can be monetised given the current literature:

1. change in appearance and biodiversity of the landscape;
2. creation of a new reservoir with recreational facilities;
3. damage due to vehicle emissions, risk of accidents and congestion from HGV requirements; and
4. damage due to vehicle emissions and risk of accidents from visitor traffic to the reservoir.

Step III: Perform benefit transfer & estimate total monetary costs and benefits

We consider two studies which could both potentially be used to estimate the value of a change in the landscape: those of Willis and Garrod (1993) and Hanley *et al.* (1998) (see Volume II). Willis and Garrod estimate people's WTP to preserve their 'most preferred' landscapes, as well as 'today's landscape' in various different areas of the Yorkshire Dales National Park. It is significant that in their study they found that semi-intensive and intensive agricultural landscapes were not chosen as the 'most preferred' by any respondent. However, their estimate of 'WTP to preserve today's landscape irrespective of its type' included some agricultural landscapes, and for this they found a figure of ECU43/person/year. Hanley *et al.* estimate the value of conservation benefits of an ESA in Scotland, an area of special landscape and conservation interest, where traditional farming methods are practised. They derive an estimate of ECU31/household/year, which is very close to that of Willis and Garrod. Since the type of landscape is more closely matched in this case, we have chosen to use this estimate, recognising that it is likely to be an overestimate given that the agricultural land in our case study is not a designated ESA.

Neither of the landscape studies actually examine WTP for a reservoir landscape and therefore it cannot be deduced whether a reservoir landscape is preferred to agriculture or vice versa. However, in practice when a new reservoir is under consideration, there are often strong local lobbies opposed to the new construction. Therefore it is desirable

to have some indication of the maximum social costs such construction is likely to entail.

In order to achieve this, we assume that agricultural landscape is preferred to a reservoir by all residents. It is recognised that in practice this is unlikely to be the case, and that some people would prefer a reservoir. However, obtaining an indication of local opinion would require some sort of public consultation process. This, if undertaken, could provide more accurate estimates of the relevant affected population¹¹.

We assume that the people affected by the change in landscape are the 250,000 people (or 100,000 households) in the area affected by the reservoir construction. Multiplying the affected population by the average WTP of ECU31 per household per year, the change in landscape could involve well-being costs up to ECU3,100,000. The 95% confidence interval quoted in the study (ECU21 - 42) gives us a range of ECU2,100,000 to ECU4,200,000 per year.

Creation of a new reservoir with recreational facilities

In this case, there is only one geographically relevant study which estimates WTP for reservoir related recreation by Pearson (1992). He reports an average value of ECU 27/household/year. The fact that this study is based on a site in the UK makes it preferable to the existing US studies for the purpose of benefits transfer. It is assumed that the mix of activities on the two reservoirs will be similar. However, Rutland Reservoir which is the site of the Pearson study has become a SSSI and one of the most attractive reservoir sites in the UK, and therefore the WTP estimates obtained should be treated as an upper bound.

It is estimated that the new reservoir will attract 500,000 visits per year after the full completion in year 7. In reality there would be a gradual increase in the number of visitors but this has been omitted for simplicity. This estimate needs to be adjusted to derive the number of visiting households. Pearson (1992) found that on average each household visited the reservoir 12 times per year. Using both of these estimates, the number of visiting households would be 16,700 (=500,000/(12*2.5) approximately). Multiplying this by the average WTP of ECU27 per household per year gives a total benefit of ECU451,000 per year. Using the standard deviation given in the study, this gives a range of approximately ECU0-ECU1,790,000.

Damage due to vehicle emissions, risk of accidents and traffic congestion

The relevant valuation studies are as follows: Maddison et al (1996) for air pollution costs; Newbery (1992) for congestion costs and DETR (1996) for accident risks. In this case, it is estimated that 10-20 HGVs would be required over 6 years of construction, with a round trip of 50 km along rural roads leading to between ECU86,000 and ECU172,000.

¹¹ In fact, we are implicitly covering the concerns of the population here and now. It is possible (and has been experienced elsewhere) that the new reservoir will become an appreciated part of the landscape creating a benefit. However, ex ante we have no means of estimating this and hence only the worst case is reported here.

Visitor traffic

Pearson (1992) estimates average visiting party size to be approximately 3.36 persons. Assuming one return car journey of 20km per visiting party this gives 148,810 car visits (500,000 visits / 3.36 people per car) with 2.976 million km driven (148,810 car visits times 20 km roundtrip). Using the health cost of ECU0.03 per passenger car kilometre (Maddison et al, 1996) and the cost of increased risk of accidents of ECU0.04/km (DETR, 1996) gives a total damage of ECU208,000 from year 7 onwards.

Step IV: Allocate non-monetary indicators

The significance of the non-monetised residual effects is given in Table 3.8. A new reservoir would probably result in some significant construction impacts. Depending on location there could be a major impact on landscape and visual amenity and only slight permanent effects on the impounded river.

Step V: Compare and combine monetary & non-monetary valuation results

The total monetary and non-monetary effects of a new reservoir are shown in Table 3.8.

Table 3.8 Monetary values and non-monetary indicators.

Monetised Residual Effects	Monetary Value
Temporary Damage caused by vehicle emissions (health + ecosystem damage) + congestion and accidents	-ECU 86,000 to ECU 172,000 (per year for years 1 – 6)
Permanent Reservoir as a recreational amenity	+ ECU 451,000 per year (year 7 onwards)
Landscape loss	-ECU 3,100,000 (year 1)
Visitor traffic	-ECU 208,000 per year (year 7 onwards)
Non-Monetised Residual Effects	Level of Significance
Permanent Creation of aquatic ecosystem	○○○
Change in water quality of the river	○○
Reduction in the risk of flooding	○
Change in micro-climate	●
Potential damage to archaeological features	●●
Change in the terrestrial ecosystem (from reduction in flooding)	●●
Change in hydrological regime	●●●
Temporary Change in runoff characteristics	●●

Note: A benefit is indicated by + sign and ○. A cost is indicated by – sign and ●.

3.3.3 A waste project

In this case study, an incinerator in a Western European country is analysed. In Volume II of this report, various comparisons are made with an incinerator in a Southern European country. This comparison is excluded in this section to prevent distraction from the step-approach. It should also be realised that the calculations for this case study are performed with a complex computer model which includes a very large number of parameters and relationships. It should therefore be realised that, although the results are reported in the relatively simple and straightforward step approach, more complicated and elaborate physical/monetary relationships underlie the final outcome. The ultimate objective of this case is to compare the additional financial mitigation costs with the avoided environmental costs of the Northern European incinerator to see whether mitigation is worthwhile.

The newly installed waste incinerator substitutes for two existing plants in the region. The new plant has a nominal installed capacity of 486,000 t/a, consisting of 3 incineration lines. Its life span is approximately 15 years. The maximum capacity for generating power is 42 MWe of which 7 MWe is used internally. This combined heat and power generating installation is equipped with modern emission controls, including dioxins and NOx reduction, according to the national legislation, which goes far beyond the EU legislation. Both slag and wastewater emissions are very low as most of these materials are recycled. These far-reaching mitigation measures has significant consequences for financial costs of the plant. The total cost of the project is 395 million ECU which is equal to 117 ECU/tonne (1992).

Step I: Identify residual environmental effects of the project

The residual environmental effects which result from the incinerator include:

- Air pollution (which?) causes increased local and regional health damage;
- SO₂ and NO_x emissions cause reduced agricultural yield, damage to ecosystems and damage to monuments and materials;
- Transport and operation increase the risk of accidents;
- An increase in vehicle movement creates additional congestion;
- Visual intrusion occurs from the incinerator and odour results from H₂S emissions from the landfill;
- The greenhouse gases resulting from incineration are considered climate neutral. Only transport related emissions are included;
- The generation of heat and electricity prevents emissions from other energy generating sources.

Step II: Translate residual environmental effects to well-being effects

- Increased local and regional health (mortality and morbidity) damage;
- Reduced agricultural yields results in reduced revenues;
- Damage to monuments and materials based on repair / replacement costs;
- Damage to ecosystems cause a reduced well-being effects from nature;
- Damage costs of construction includes costs of congestion;

- House prices are assumed to decline due to residents' concern for the health effect of polluted groundwater and toxic emissions;
- Global warming causes costs and benefits in terms of health effects, damage to forest/crops, sea level rise & other effects;
- Avoided external costs result from avoided emissions from displaced energy sources.

Step III: Perform benefit transfer & estimate total monetary costs or benefit

The values which are used in this case study are all retrieved from literature studies which focus on Western Europe. As a result no benefit transfer was deemed necessary. The calculation of the external costs of the new incinerator are depicted in the last column of Table 3.9.

Table 3.9 Calculation of the external value.

Category	physical effect and unit value	Aggregate monetary value (in ECU per year)
Health effects from air pollution	Restricted Activity Days 75 ECU, Acute Asthma Attack 37 ECU, YOLL acute effects 155,000 ECU, YOLL chronic effects 84,000 ECU	Mortality: 1,323,236 Morbidity: 157,873
Agricultural effects from air pollution	Damage costs via: SO ₂ 0.00014 ECU/tonne of MSW NO _x 0.119573639 ECU/ tonne of MSW	Agricultural damage: 34,164
Damage to materials and buildings	Zinc 25 ECU/m ² Galv. Steel 30 ECU/m ² Paint 13 ECU/m ²	Damage cost: materials: 17,330 buildings: 685
Health effects from traffic	VSL 3.1 million ECU	Health costs: 916,356
Other costs from traffic	Marginal congestion costs: non-central peak = 0.24 ECU/km HGV, non-central off-peak = 0.13 ECU/km HGV	Congestion costs: during construction 10,061 during operation 112,183
Visual and odour disamenity	Nr. of affected households: 11,879 hh Average disamenity value: ECU 318 hh/year	Disamenity value: ≈3,800,000
Global warming	ExternE range for 1 tonne CO ₂ : ECU 3.6	Global warming damage: 29,154
Avoided burden	Electricity generated: 35 MWe year	External benefit: 731,000
Total monetary costs		5,650,000 ECU per year (11.63 ECU / tonne MSW)

Step IV: Allocate non-monetary indicators

Although sometimes rigorous assumptions have been made, most external effects can be monetised. Only groundwater pollution from the landfilled incinerator residues (i.e. ash) could not be estimated because of the absence of dose-response figures. Still the magni-

tude of this effect is limited because of the small quantities as well as the good state of the landfill in the case study country.

Table 3.10 Estimation of the non-monetary effect.

Category	Effect	Non-monetary value
Ground water	groundwater pollution threatening water supply	●

Step V: Compare and combine monetary & non-monetary results

From step III and IV it becomes clear that the non-monetary effects are rather small compared to the monetary effects. One may therefore, base most of the decision on step III. An interesting elaboration of this step is to compare the financial costs of operation and mitigation with the avoided external costs. Especially for the investment decision makers, it is important to know whether a particular pollution abatement measure is worthwhile to take.

For this purpose, we also included a case in Southern Europe where an incinerator was financed (see Volume II). Compared to this incinerator, the operators of the Western European incinerator took substantial efforts to reduce its negative environmental impacts. Measures, far beyond the EU standards, were taken. Particular attention was paid to the reduction of emissions of dioxins, which retrieved substantial negative publicity. Also the recycling of residues was developed to a very sophisticated level. As a result, the external costs of the Western European incinerator are significantly lower than those from the Southern European incinerator (see Figure 3.3).

However, the additional abatement measures have a high price. Figure 3.3 reflects the efforts taken to minimise the environmental costs of the Western European incinerator. The financial costs of this incinerator amount to 117 ECU per tonne of waste while the Southern European incinerator operates at a level of 38 ECU. If the financial costs are added to the external costs, we get the so called social costs. These social costs represent the indicator on which a sustainable investment decision can be based, albeit partly. Given the higher level of social costs of the Western European incinerator (ECU 129 per tonne), this decision maker would be expected to have a preference for the Southern European plant (ECU 70 per tonne).

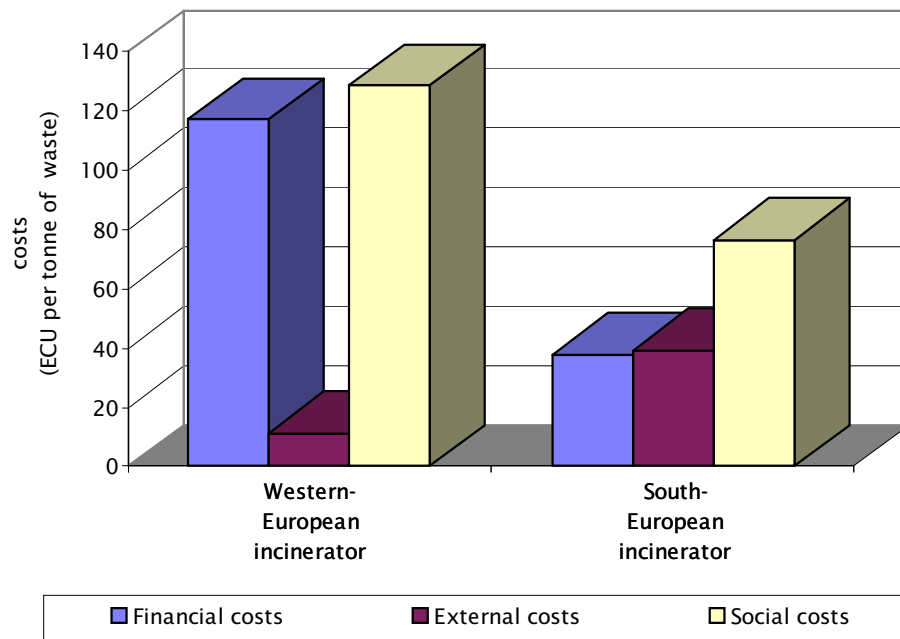


Figure 3.3 Composition of social costs of two incinerators.

4. Conclusions

The main lessons from the development of the guidelines are the following:

- Evaluation of external effects of projects always takes place, be it implicitly (by using common sense or by neglecting the externalities) or explicitly. Explicit evaluation increases the quality and the transparency of a decision. Explicit evaluation can be carried out with a multi-criteria method or with monetary valuation. The advantage of monetary valuation is that external effects can be added to financial effects.
- A certain reserve can be discerned in multilateral financial institutions with respect to monetary valuation of external effects. This has to do with the time constraint for assessing projects, and with controversiality of certain valuation methods or benefit transfer methods. Nonetheless, there is a tendency within the leading institutions towards applying monetary valuation more often. This tendency may become stronger when more and better standard values and valuation methods become available. By itself, application of monetary valuation will lead to improvements in the methods and data, resulting in a higher acceptance (learning by doing).
- Not all external effects can yet be valued in monetary terms, and not all components of value (e.g., non-user value, consumers' surplus) can always be monetised. This leads to a tendency to undervalue external effects. Moreover, estimates of important external effects (such as effect on human health) may have wide intervals of confidence.
- The case studies showed that there are differences with respect to the types of effects between the water and the solid waste sectors. Differences also exist with respect to the extent to which monetary valuation is possible. Monetary valuation is possible to a lesser extent in the water sector than in the solid waste sector.
- In the solid waste sector, air pollution related effects on human health can be valued relatively easily, due to the fact that much research has been carried out in that field. Standard values can be used for short-cut valuation (e.g., standard monetary values per tonne of PM₁₀, SO₂ etc.). But a superior method is the application of the Ecosense model (developed by DG XII's ExternE project), which incorporates many person-years of research and is easier to use than can be imagined. For valuation of excess mortality, an important choice is whether to value excess death with the VOSL approach (value of a statistical life) or the YOLL approach (years of life lost). The latter approach leads to lower estimates.
- The valuation literature related to water projects is less well developed and effects are more site-specific and hence benefit transfer is more speculative.
- For the water sector, a 5 steps procedure for valuation was developed. This procedure is also applicable for the solid waste sector.
- The case studies show that it is possible to indicate the order of magnitude of the monetary value of external effects, but that, in particular in the water sector, also many effects cannot be estimated in monetary terms.

- In view of the fact that still many effects cannot be estimated in monetary terms, research is necessary into mixed, i.e. monetary combined with non-monetary, evaluation methods.
- Research in the valuation of external effects developed rapidly in the last decade and is expected to continue to develop. Multilateral financial institutions should therefore keep continuous contact with the scientific community, so as to remain up to date. In fact, there could be opportunities for the MFIs to support and channel the monetary valuation research towards the practical issues concerning project appraisal.
- The methods for monetary valuation of external effects are also applicable in other sectors than water and solid waste. In particular the transport, industry and energy sectors can make use of the methodology that is developed in these guidelines.

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