Costs and Benefits associated with the implementation of the Water Framework Directive, with a special focus on agriculture: Final Report

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Acronyms

BAG - Benefits Assessments Guidance

CAFE – Clean Air For Europe

CAP – Common Agricultural Policy

COD – Chemical Oxygen Demand

CV – Contingent Valuation method

CBA – Cost Benefit Analysis

CEA – Cost-Effectiveness Analysis

EEA – European Environmental Agency

EVRI – Environmental Valuation Reference Inventory

FTE – Full time employee

GES/GEP – Good ecological status / good ecological potential

GIS – Geographical information system

HMWB – Heavily Modified Water Body

IRENA – Indicator Reporting on the integration of Environmental concerns into Agricultural policy

MCA – Multi-Criteria Analysis

MTFR – maximum technically feasible reduction

NPV – Net Present Value

PoM – Programme of Measures

PV – Present Value

USEPA – United States Environmental Protection Agency

UWWTD – Urban Waste Water Treatment Directive (European Union)

WISE – Water Information System for Europe

WFD – Water Framework Directive

WTP – Willingness to Pay

WWTP – Waste Water Treatment Plant

Glossary

(Note: see Box A for a more general discussion on terminology and consistency with WFD.)

Administrative costs - all costs related to water resource management, that do not lead directly to the reduction of pollution or an improvement in the environment. Examples include costs of administering a charging system, permitting, control, research, monitoring costs and reporting obligations.
Baseline scenario - projection of the development of a chosen set of factors (cost and/or benefits) in the absence of (new) policy interventions.
Benefit transfer - involves the application of unit value estimates, functions, data and/or models from existing studies to estimate benefits associated with the resource under consideration, for example, value of cleaner water.
Contingent valuation - valuation of commodities/benefits not traded in markets, for example, clean air, landscapes and wildlife. The valuation is based upon the responses of individuals to questions about what their actions would be if a particular hypothetical situation were to occur. When the average of responses has been calculated, with weighting if necessary, the valuation of a public good is ascertained.
Contour cultivation - contouring entails performing all tillage and planting of crops on or near the same elevation or "contour." It is applicable on relatively short slopes up to about 8 percent steepness with fairly stable soils. By planting across the slope, rather than up and down a hill, the contour ridges slow or stop the downhill flow of water. Water is held in between these contours, thus reducing water erosion and increasing soil moisture.
Costs of environmental measures - total costs of measures taken to improve the status of water.
Cost-benefit analysis - (often referred to as CBA, or in the United States as Benefit-cost analysis) is an important technique for project appraisal: the process of weighing the total expected costs against the total expected benefits of one or more actions/projects in order to choose the best or most profitable option.
Cost-effectiveness analysis - assessment of the costs of alternative options which all achieve the same objective. The costs need not be restricted to purely financial ones. With a cost-effectiveness analysis the least-cost way of achieving the objective can be assessed. In the context of the WFD it is used to select appropriate measures.
Discount rate - the rate used for discounting future values to the present. In cost-benefit analysis, there is a distinction between a private and a social rate of discount. A private rate of discount reflects the time preference of individual private consumers and/or opportunity costs on private capital market. A social rate of discount reflects the government's view, which can be more long-term as it attempts, in most cases, to take into account the welfare of future generations (see Section 3.5.1).
Dose-response functions - measure the relationship between exposure to pollution as a cause and specific outcomes as an effect.
Ecological status - an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V of the WFD
Environmental costs - represent the costs of damage that water uses impose on the environment and ecosystems and those who use the environment (for example, a reduction in the ecological quality of aquatic ecosystems or the salinisation and degradation of productive soils) (WATECO).
Environmental benefits - welfare effects (mostly gains) from a changed (mostly improved) status of water bodies. Benefits may be both positive (welfare gains, avoided damages) or negative (loss of welfare, additional damages (= environmental costs).
Explorative CBA - aims to enlighten the debate on the costs and benefits of an objective or set of measures by discussing types of costs and benefits with some reference to indicator numbers. It is distinguished from a full CBA that does estimate the overall costs and benefits.
Fish migration - many types of fish undertake migrations on a regular basis, on time scales ranging from daily to annual, and with distances ranging from a few meters to thousands of kilometres. The

purpose usually relates to either feeding or breeding; in some cases the reason for migration is still unknown.

Migratory fish are classified according to the following scheme:

- **Diadromous** fish travel between salt and fresh water *(Greek: 'Dia' is between):*
    - **anadromous** fish live in the sea mostly, breed in fresh water *(Greek: 'Ana' is up);*
    - **catadromous** fish live in fresh water, breed in the sea *(Greek: 'Cata' is down); and,*
    - **amphidromous** fish move between fresh and salt water during some part of life cycle, but not for breeding *(Greek: 'Amphi' is both).*
- **potamodromous** fish migrate within fresh water only *(Greek: 'Potamos' is river);* and,
- **oceanodromous** fish migrate within salt water only *(Greek: 'Oceanos' is ocean).*

GAP-analysis - to identify the gap between the optimized allocation of water and the achievement of good ecological status or potential.

Hedonic pricing - the hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes. The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics, or the services it provides. For example, the price of a car reflects the characteristics of that car—transportation, comfort, style, luxury, fuel economy, etc. Therefore, we can value the individual characteristics of a car or other good by looking at how the price, people are willing to pay for it, changes when the characteristics change. The hedonic pricing method is most often used to value environmental amenities that affect the price of residential properties.

Heavily Modified Water Body - a body of surface water which as a result of physical alterations by human activity is substantially changed in character, as designated by the Member State in accordance with the provisions of Annex II of the WFD.

Marginal benefit - the additional benefit from increasing consumption by one unit or improving the GES with one unit

Multi-criteria analysis - establishes preferences between options by reference to an explicit set of objectives that the decision-making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved. MCA provides ways of aggregating data on individual criteria to provide indicators of the overall outcomes of different options.

Non-use values - are independent of the individual's present use of a resource and are variously described as "existence values", the value from knowing that a particular environmental assets exists (for example, endangered species); and "bequest values", the value arising from the desire to bequeath certain resources to one's heirs or future generations (for example, habitat preservation).

Net Present Value - the sum of the present value (see below) of benefits minus the present value of the costs. Costs and benefits will occur in different moments in the future, whereas benefits often occur later than costs. To enable comparisons of costs and benefits, despite the different timeframes in which they occur, use is made of the so called Net Present Value (NPV). In the NPV, all costs and benefits are summed, using discount rates.

Present Value - the total value of a series of costs – or benefits – over the relevant time horizon. To sum costs or benefits over time, a discount rate is used that considers time preferences of individuals (normally one would like to receive benefits as soon as possible, whereas one would like to postpone payments as much as possible). This time preference is taken into account by applying a discount rate (of, for example, 4% to 6%)..

Opportunity costs - the value of the alternative foregone by choosing a particular activity.

Rent - in economic terms, the premium that the owner of a resource receives over and above its opportunity cost. A scarcity rent is an economic rent that is due to something being scarce.

Resource costs - the welfare losses due to the difference between the economic value of a current water use and the optimal water use.

Resource benefits - scarcity rents resulting from a more efficient use of water resources, leading to an overall welfare gain.

Sub-soiling - to plough or turn up the subsoil.

Travel cost method - is a means of determining value figures for things which are generally not bought and sold, and therefore fall outside of the market's pricing system. The non-market assets, which it is most often applied to, are 'recreational resources which necessitate significant expenditure for their enjoyment'. The basic premise of the TCM is that, although the actual value of the recreational experience does not have a price tag, the costs incurred by individuals in travelling to the site can be used as surrogate prices.

Use-value - is the value derived from the actual use of the water resource. Examples of use-values are: water as an input into dairy production; the energy potential in water to generate electricity; and, water used for angling.

Water services - "all services which provide, for households, public institutions or any economic activity: (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, (b) waste-water collection and treatment facilities which subsequently discharge into surface water." (WFD, art 1(38)).

Water use - refers both to water uses as described above and any other activity with an impact on the status of water (for example, in-land shipping).

Willingness To Pay - generally refers to the value of a good or service to a person in relation to what they are willing to pay, sacrifice or exchange for.

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1 EXECUTIVE SUMMARY

1. An overview of current information on costs and benefits of WFD implementation.

The objective of the study was to provide an overview of the current information available concerning the costs and benefits associated with the implementation of the WFD. All Member States were surveyed on the basis of a questionnaire to identify what studies on costs and benefits associated with the implementation of WFD are available today, or have been started. In addition, a literature review was carried out to obtain information about costs and benefits associated with specific WFD measures or issues of particular interest to the European Commission, with a special focus on agriculture. The survey and literature review illustrates that most Member States are in an early stage of economic analysis. This means that it will require a long process to develop and use information on costs and benefits for planning in the context of WFD.

2. Member States are in the early stages of gathering information on costs and benefits of the WFD.

The information provided by Member States or from the literature review indicates that:

a. The majority of the Member States have started the process of assessing costs and benefits of the WFD. Most of these, however, are still at an early stage including the commission of first studies and/or the development of tools. The objectives of the planned or ongoing studies are broad, including the analysis of costs and benefits and cost-effectiveness.
b. Only a few Member States (United Kingdom, Netherlands, France) are far enough in the assessment process to have produced first results and estimates of costs and/or benefits of the WFD at a national or regional level. These results will be further completed and updated.
c. For seven Member States that neither participated in the workshops nor answered the questionnaire, there is no clear picture to which extent they have started economic analysis in association with the implementation of the WFD.

The results of the early economic analysis studies from the France, Netherlands, UK, are used to gain insights into the methods and tools used. The study provides an overview of the preliminary (order of magnitude) costs and benefits estimates, the main underlying factors and the uncertainties that need to be accounted for. Published data need to be handled with care because they are only snapshots of the WFD process, based on assumptions or scenarios developed for specific purposes or objectives. Most of these data and analyses are in the process of being updated and/or revisited in consultation with stakeholders. The information is therefore often very specific to the particular Member States (or regions), water bodies and issues.

3. Factors determining costs and benefits.

There are a number of factors identified that are important for both costs and benefits. The size of the gap between the reference situation (basic measures) - and the required supplementary measures required by the WFD to reach good ecological status (GES) or potential (GEP) is an important factor. The gap size depends both on current status and physical characteristics of the water bodies, measures in the pipeline and the ambition level for WFD implementation. As both reference situation and ambition level are uncertain or may vary, most studies analyse different scenarios. Costs and benefits will both depend on the measures selected. In addition, costs will largely depend on the degree of cost-effectiveness and efficiency of implementation. Benefits will depend on the type of water body and the functions it delivers (drinking water, recreation,…), the number of users of that water body and people affected, the extent to which there are alternatives available, and the preferences of users and their income levels. Finally, some factors relate to parameters such as the time horizon, discount rates, etc. that do not depend on the water body or ambition level, but may be study specific.

4. Costs of the WFD depend on the level of ambition and cost-effectiveness.

The current data available are too specific and/or uncertain to indicate the likely costs of WFD implementation. They do, however, offer some insights:

a. The implementation of EU water legislation is likely to involve substantial costs, with large variations and uncertainties. A main factor is the gap between the reference scenarios (full implementation of pre-WFD legislation) and scenarios for WFD implementation.
b. In practice, the distinction between pre-WFD and WFD measures is not always clear and uncertainty is a key issue.
c. Both New and Old Member States are still likely to face important increases in costs due to the pre-WFD measures.
d. In the available case studies, the costs vary by a factor of up to 3, depending on the gap to be closed.
e. As an indication of the order of magnitude, the first estimate for the Netherlands indicates that the additional costs of the WFD, compared to the business as usual scenario, ranges from 5 to 30%. This range and early estimates for the UK indicate that costs of additional measures required by the WFD are likely to be smaller compared to current costs and costs of measures in the pipeline mainly related to pre-WFD measures.
f. There is a large potential for efficiency gains if the most cost-efficient measures (for basic and additional measures) are chosen.

It should be noted that Member States do have a possibility to apply the exemptions of the WFD for instance prolonging the deadline for achieving the objectives, and hence spreading the costs over a longer time-period.

5. The WFD will deliver a wide range of benefits for different beneficiaries.

The WFD will bring environmental benefits for the users of water bodies, including:

a. avoided costs for treatment of drinking water;
b. reduction of disposal costs for contaminated dredging material;
c. more and better opportunities for informal recreation (walking, cycling) and water sports; and,
d. improved health and living environments.

Most of these benefits are non-market ones, although some will result in reduced costs. In addition, the WFD will deliver non-use benefits associated with an improved protection of nature and biodiversity.

At the level of the water body, it will be more difficult to distinguish the benefits from the basic and supplementary measures, as the benefits are related to the impacts of all measures combined.

The magnitude of these benefits are location and case specific, depending on the type and magnitude of the improvements under WFD compared to the reference situation, the number of people affected, their income and their preferences. The current information indicates that no particular type of benefit seems to dominate others, and that total benefits may be substantial.

Information concerning the size of the benefits is only partially documented for a few Member States. Even for Member States with relatively more information and experience, it is challenging to improve tools and expertise to assess these benefits and use them as an input into the WFD process. The main challenges relate to the integration of information from impact assessments with economic valuation, the valuation of non-market “goods and services”, and the aggregation across different benefit categories and water body types.

6. Comparison of costs and benefits is a stepwise process.

The study illustrates that the comparison of costs and benefits (where possible) has to account for uncertainties and incompleteness. In the first steps of the process for the selection of measures, the ranges for costs and benefits can be used to identify the most promising measures. Improved site or region specific data is needed to carry out a the final selection of measures.

7. Costs and benefits of specific WFD measures and issues.

This study looked into costs and benefits for a few selected topics and measures that are specific to the WFD. In general, the review of current information indicates that there are measures with different cost-benefit ratios. More site specific data is needed to identify the most efficient package of measures and understand how costs and benefits relate to each other.

*a) **Administrative costs and benefits:***

In comparison to previous legislation the WFD introduced a number of provisions which lead to new administrative tasks, in particular international cooperation, public participation, economic analysis and data and information management. Only very few studies are available on the information on administrative costs of WFD. These studies have made assumptions about administrative requirements and how they are likely to be implemented under the WFD. There is not enough information to evaluate the efficiency of the administrative measures. On the other hand, increases in administrative costs may be mitigated because of availability of resources and cost savings due to more efficient planning and stakeholder involvement.

Although in absolute terms the administrative costs of water management is assumed to increase (in line with additional expenditures due to implementation of policies in pipeline and the WFD), it is reasonable to assume that administrative costs in relation to total costs will remain constant.

The proportions of costs and benefits indicate that these additional costs can be recovered if the WFD process succeeds in selecting more efficient policies and measures compared to the reference scenarios.

b) Wetlands:

Costs and benefits of wetland restoration or protection have been well documented but are both location and type specific. Costs will depend on the required infrastructure works and alternative land uses. The potential benefits relate to welfare gains from flood protection, recharge and water quality improvements and depend on physical factors related to water management and efficiency of alternative measures. The benefits for nature development depend on the habitat types created (which may vary from unique tidal systems to more common wet nature types), whereas recreational benefits depend on nearby population densities and accessibility.

As the benefits from wetlands are very different, ranging from flood protection, water quality, hydro-morphology, biodiversity, amenity,… it is not straightforward to take all these issues into account in the more traditional process of the selection of measures or a cost-effectiveness analysis. A cost-benefit type of framework will help to identify these categories, but it will need further steps to quantify and monetise these, building on literature and site specific studies.

c) Fish migration:

There is little economic assessment of fish migration measures as well as many remaining uncertainties regarding their efficiency, although there is sufficient technical analysis available to build on. The literature review indicates how different potential measures are likely to rank in terms of cost-effectiveness analysis, but the ranking may change for different locations.

Fish migration measures are of direct relevance to the hydropower sector, which needs to take into account likely electricity production losses and costs for the wider environment. Benefits relate to improved recreational and commercial fishing and non-use values such as improved biodiversity. There are not enough specific studies on benefits of fish migration measures in Europe to draw general conclusions on their relative importance.

d) Reducing agricultural diffuse phosphorous emissions:

The costs for reducing on-farm phosphorous emissions depend on the gap between current status and ambition level for the WFD. Several studies provide examples of efficient phosphorous uses at little or no additional cost (for example, better targeting of fertiliser applications, use of phytase in animal foodstuff etc.). High ambition levels may lead to substantial costs as they require the application of more costly measures, including changes in land use (away from agricultural production). Most of the nationwide cost estimates of achieving WFD objectives to reduce phosphorous levels in inland waters correspond approximately to 2.6% (DK), 2.2 – 4.4% (NL), 0.9 – 1.3% (UK 1999) and 1.0 – 5.6% (UK 2007) of the net value added of the agricultural sector. These are countrywide average figures, hence the share will be higher for some sub-sectors of agriculture, and may effect particular regions significantly.

The benefits of reducing P emissions relate primarily to the reduced risk of eutrophication. Several studies however indicate a relatively high willingness to pay for the reduction of eutrophication. However, as these studies refer to the impact of a larger set of measures, they cannot simply be weighted against the costs of P reductions from agriculture.

e) Measures in the agricultural sector to improve water quantitative status

One of the main impacts of the WFD on irrigation water demand will be through the implementation of the cost recovery principle for water services, including environmental and resource costs, which will augment the price of irrigation water. The actual costs and impacts will be region and crop specific, and will depend on the marginal productivity of irrigation water and the price elasticity of crops. Water demand for higher value crops such as fruits and vegetables will be less affected than for lower value crops such as cereals, sunflowers or cotton. The measures will especially affect regions with water scarcity and relatively high demand for irrigation (in terms of high water use per ha of agricultural land).

The benefits of measures to improve water quantitative status relate to more efficient water management and allocation of scarce water resources (i.e. scarcity rents), and include:

- a further development of sectors with higher productivity of water use, both agricultural and non-agricultural;
- avoided costs related to temporary water scarcity and reduced uncertainty about water abstraction rights;
- a better knowledge base and improved institutions for the management of water scarcity (also important in relation to adaptation strategies for anticipated climate change impacts); and,
- benefits from avoided low flow conditions that are detrimental to amenity and recreational functions and for the protection of water-dependent ecosystems (such as wetlands).

8. Recommendations.

General Recommendations

The use of economic analysis in the water sector requires a long term strategy and stepwise process. Information gathered and analysed should be made available for use by different stakeholders. Improved information can be assessed at different policy levels and scales (river basin; national). This requires a coherent framework and different building blocks based on the costs of measures, administrative costs, effectiveness and benefits. The development and use of economic analysis will require a combination of local knowledge with nationwide multi-disciplinary experts. Economic assessment in the water sector can currently build further on existing generic guidelines for economic assessment (e.g. from national finance ministries,…)

Specific Recommendations

The development of **appropriate tools and capacities** will be challenging. It is important to define a wide set of competing measures so that cost-effectiveness analysis can be used to select the most promising ones.

Benefit assessment will have to integrate results from environmental impact assessment with economic analysis. It will have to strive for completeness which in turn will require – especially in the short run - a pragmatic approach that builds on benefit transfer, indicator data, and other parameters such as the number/density of users.

Capacity building is essential to use results of economic assessment in the context of WFD decision making at several policy levels. Issues here relate to the use of these results for communication with the public, development of strategies to finance the programme of measures and the development of the policy instruments to implement cost-effective measures.

To progress efficiently, MS could profit from **improved exchanges of information and common efforts**. Further work should involve national experts in these areas and build on their work in the Member States. At the EU level, the WFD Common Implementation Strategy provides a platform for sharing experiences as many Member States are working on these issues now. The new Water Information System for Europe (WISE[1]) could be used to share relevant data.

[1] For more information: water.europa.eu

2 INTRODUCTION

2.1 Background

The European Parliament and the Council adopted the Water Framework Directive (WFD) (EC/2000/60) in 2000 in order to integrate existing legislation on water resources management and to introduce several novelties. The WFD establishes a legal framework within which to protect surface and ground waters using a common management approach and following common objectives, principles, and basic measures. It also integrates the existing European water legislation into a single, common framework.

The two main objectives of the WFD are (i) to restore good ecological and chemical status for all water bodies across the Community by 2015 and (ii) to integrate water management activities at the river basin level.

To this purpose Member States have identified river basin districts and designated the competent administrative authorities. The next step is to produce River Basin Management Plans, which is an ongoing process until 2009. The implementation of these management plans will then take place in three phases: 2009-2015, 2015-2021 and 2021-2027.

The preparation of the River Basin Management Plans, involves two important steps:

- Gap analysis: evaluation of the gap between the desired good ecological status and the reference situation (current situation and taking account of likely developments).
- Identification and selection of measures to close the gap. Distinction is made between the so called “basic measures” which are already required by the “old” water directives and “additional measures”, to be taken if the basic measures are insufficient to reach the desired objectives.

The WFD gives an important place to economic methods, tools and approaches. Economic elements of the WFD include:

- The polluter-pays principle enshrined in the cost recovery article and the 2010 water pricing requirement with the purpose of achieving sustainable water use(Article 1 WFD);
- Establishing the principle of cost recovery, including environmental and resource costs (Article 9 WFD);
- Selecting the most cost-effective combinations of measures to achieve the WFD objectives (Article 11 WFD); and,
- Assessing whether achieving the WFD objectives would be disproportionately costly, leading to a request for exemptions (Article 4 WFD).

At the EU level guidance on the approaches to developing River Basin Management Plans are being developed in a Common Implementation Strategy (CIS), making use of experts from Member States and stakeholders. The WATECO (2002) guidance documents focuses on the implementation of the economic elements in the broader context of the development of integrated river basin management plans.

2.2 The Water Framework Directive in the context of previous EU legislation

The Water Framework Directive is the most comprehensive and influential piece of water-related legislation in Europe. However, it does not mark the beginning of European legislation in this area. European Water Policy can be traced back to the 1970s and the first Environmental Action Programme. Since then, two generations of water-related legislation can be discerned: the first generation, from 1973 – 1988, legislation mainly focused on the protection of water for human use. This included drinking water standards and emission controls for particular harmful substances (Hansen and Kraemer 2000). These early instruments were mainly intended to protect public health, but also to harmonise environmental legislation in Europe, so as to remove trade barriers and reduce distortions to competition. The first generation included the following Directives:

1975 Surface water directive (75/440/EEC) and its daughter directive (79/869/EEC)
1976 Bathing water quality directive (76/160/EEC)
1976 Dangerous substances directive (2006/11/EC(ex 76/464/EEC))
1978 Fish water directive (78/659/EEC)
1979 Shellfish water directive (79/923/EEC)
1980 Groundwater directive (80/68/EEC)
1980 Drinking water quality directive (80/778/EEC) and its revision (98/83/EC)

The second generation of water-related legislation completed the initial phase with a set of more specific measures, relating to urban wastewater treatment (in the 1991 Urban waste water treatment directive 91/271/EEC), or limitation of manure spreading (in the 1991 Nitrates directive 91/676/EEC). The Directives' main focus was on pollution prevention, in order to limit and reverse the environmental degradation from sewage pollution as well as nitrates and phosphate emissions from agriculture. While the Directives mainly adopted command-and-control approaches, such as compulsory timetables for the provision of treatment plants in all urban areas, the set of instruments also included informative instruments (for example, harmonised labelling and packaging of pesticides), voluntary measures (for example, the code of good agricultural practice) and economic instruments (for example, fees on water discharges).

In this sense, the Water Framework Directive (WFD) could be considered as the third generation of water policy in the EU. Negotiations on the WFD started in the early 1990s; the Directive finally entered into force in 2000. The WFD responded to Member States' difficulties to implement the existing Directives in a cost-effective way, and introduced several innovations into European water policy, such as integrated water management at river basin scale, the use of economic concepts, principles and approaches, and the prominent role given to public participation.

The Water Framework Directive encompasses and integrates previous Directives in terms of objectives and approaches. Thus, the WFD's good status objective encompasses the various quality objectives established by the previous Directives. At the same time, the WFD extends the focus of European water policies in several respects:

- The WFD provides a unified framework for the protection of still and standing surface waters, groundwater and coastal waters, in contrast to the segmented approach in previous Directives;
- Whereas previous Directives were predominantly targeted at public health objectives, the WFD objective of good status also includes the functioning of aquatic ecosystems;
- The WFD adds new foci for water policy, most notably regarding quantitative aspects of water management. In relation to emissions, the WFD maintains the existing approaches (emission limits for emissions into the water as well as emission levels for maximum allowable concentration of pollutants in the water), and unifies them as a combined approach;
- In terms of target groups, the WFD continues to address industry and farmers (as previous legislation did), but also included private households and navigation as water users.

In this way, the WFD has taken over several requirements of previously existing Directives. As a consequence, several of the "old" Directives were effectively replaced by the WFD, such as the 1975 surface water Directive and its related directives on monitoring and exchange of information; the Directives on fish water, shellfish water, and groundwater; and the Directive on dangerous substances. These Directives will therefore be repealed.

The relation between the WFD and the second-generation water protection Directives (on nitrates and urban waste water) is somewhat more complex. The implementation of these two Directives will provide a major contribution to the achievement of the good status required by the WFD. Measures required under the Nitrates Directive and the UWWD are included as "basic measures" in the WFD programme of measures. Formally, the two Directives themselves, as well as the objectives and requirements they established, will continue to exist alongside the Water Framework Directive. In the practical implementation, synergies can be gained if the Directives are implemented in an integrated manner.

2.3 Objectives of the present Project

The objective of the Project is to provide an overview of the current information available concerning the costs and benefits associated with the implementation of the WFD, The project is the outcome of a statement from the European Commission:

> " … the Commission in its report under Article 17 (3) will, with the assistance of the Member States, include a cost-benefit study" (OJ L 327, 22.12.2000, p.73)

This study focuses on the relationship between the WFD and the agriculture sector for particular issues and addresses the costs and benefits of specific measures not included in "old" Directives.

2.4 Scope and outline

This study sets out to describe the types and the factors underlying the costs and benefits associated with WFD measures – for some key issues. The report gives an overview of what has been done by MS in assessing the costs and benefits associated with the implementation of the WFD, with a focus on cost-benefit analysis at national level. The report highlights some of the economic tools and approaches currently used by Member States and provides ranges of potential costs and benefits based on different case studies. On the basis of this review of current information a number of recommendations are put forward. The aim is to produce a readable report that is accessible to the non-specialist.

Given the information available today, a cost-benefit analysis at the European level is not yet possible because:

- the final objectives of the WFD have not yet been specified,, and neither are the measures to achieve these objectives;
- the baseline against which costs and benefits have to be measured is not well defined;
- there is no overall common framework for the assessment of costs and benefits against a common baseline; and,
- effectiveness of costs and benefits have not yet been assessed.

As a number of studies are available related to both costs and benefits of the implementation of the WFD or certain aspects of the WFD, this study reviews the types of costs and benefits to be expected, provides some indications about the orders of magnitude of costs and benefits, identifies some potential steps to take in the future and emphasises some of the most critical issues. In more concrete terms this study provides an overview of:

- the methodologies for the assessment of the costs and benefits of WFD implementation;
- how far Member States (MS) have proceeded in assessing costs and benefits;
- indicator data and first lessons learned from selected case studies, that allows us to illustrate some of the main issues MS will be facing for implementing the WFD;
- how costs and benefits of the additional requirements of the WFD relate to the requirements of the 'old' directives.;
- the important issues in relation to the agricultural sector in relation to water use and phosphorous emissions;
- lessons to be drawn from the existing studies to improve assessments of costs and benefits; and,
- the added value of the WFD in relation to previous water directives.

The study does not specifically address the issue of the chemical status of waters as this is being addressed by a complementary study on Priority Substances, prepared in the context of the recent Commission proposal[2].

[2] For more information see: http://ec.europa.eu/environment/water/water-dangersub/surface_water.htm

3 METHODOLOGIES FOR THE ASSESSMENT OF COSTS AND BENEFITS

3.1 Introduction

There are several methodologies for economic appraisal of policies and projects, including cost assessment, benefit assessment, cost-effectiveness analysis, cost-benefit analysis, financial analysis, economic analysis, These different tools are well defined and distinguished, but it may be less clear for non-economists In addition, the application of economic analysis to the implementation of the WFD requires attention to issues that are very context specific, such as gap analysis, valuation of environmental benefits, which are issues an economist may be less familiar with. Therefore, this section aims to introduce and define the most relevant concepts and issues, with a focus on the assessment of costs and benefits and cost-benefit analysis related to the WFD implementation in Member States. It does not aim to give a methodological guidance or an in-depth discussion on all issues, nor does it attempt to be complete in addressing all feasible methodologies.

The report introduces concepts and issues from a top-down perspective, and gradually introduces more detail and context specific information.
Generic definitions and issues:
1. What is a cost-benefits analysis of WFD implementation?
2. Methods and issues related to cost assessment
3. Methods and issues to benefit assessment.

Issues directly related to costs and benefits of WFD:
4. Factors determining costs WFD implementation
5. Factors determining benefits of WFD implementation
6. Comparing costs and benefits of WFD.

Issues related to costs and benefits of specific WFD measures:
7. Costs and benefits of specific WFD measures.

In order not to overload the current section, some methodological issues will be addressed in the following section where current studies or more specific issues are discussed.

Textbooks and guidance documents describe methods and required data for economic assessment from an ideal-world perspective, whereas available studies have to cope with real-world limitations concerning the availability of data, time and budget for additional studies, etc.

In case the same terminology has a different meaning in the context of the WFD than in economic analysis in general, we follow the terminology of the WFD: this is discussed in Box A.

3.2 Cost-Benefit analysis of WFD implementation.

Cost-Benefit Analysis (CBA) is a tool to perform an economic evaluation of alternative management and policy options by comparing the predicted beneficial against the expected adverse effects of that action, , both assessed against the same reference situation. We can distinguish the 5 essential steps of a CBA (Eigenraam, 2000):
1. A good definition of the scope of the analysis.
2. A clear definition of the package of measures to be evaluated.
   - definition of the baseline or reference scenario
   - definition of the objectives (qualitative/quantitative)
   - definition-selection of the package of measures
3. Tools and data to assess the costs of the measures.

4. Tools and data to assess the benefits.
5. Comparison of costs and measures in a CBA.

The general steps necessary to perform a CBA of the Water Framework Directive are presented in Figure 1. All CBAs start with a problem definition and the determination of the baseline scenario. The problem or target in this case are the requirements stipulated in the WFD. The baseline scenario is the business as usual case or the position where we would like to be in the absence of the Directive. This means that the likely developments that take place between now and 2015 are included. Likely developments include exogenous developments (for example, change in industrial emissions due to economic growth), the impact of "old" water directives such as the Nitrates and Urban Wastewater Directives, and the impact of national policies which are in the pipeline. Based on the gap between the baseline scenario and the WFD requirements, a Program of Measures is designed. Article 11 and Annex III of the WFD require that the most cost-effective selection of measures is implemented, which means that economic efficiency is an important basis to select measures. A next step in the selection process consists of the assessment of the impacts of this program.

Cost-benefit analysis should aim to identify, assess and monetise all impacts:

- Costs should refer to the total economic costs which is a measure of the welfare losses due to the implementation of policies or projects. It includes the direct, financial costs that relate to expenditures for the additional investments, operational and administration costs of additional measures. In addition, there may be direct effects which are reflected in expenditures, such as foregone opportunities and furthermore there may be indirect effects in different sectors of the economy (see Section 3.3.2).
- Benefits are the welfare gains realised by implementing these measures. They can take the form of market effects (e.g. avoided treatment costs, returns in commercial fisheries) or of non-market effects (e.g. improved amenity, informal recreation) through a better provision of "goods and services" by water bodies reaching a better status (for example recreation, bathing) or through improvements in use of scarce resources.

Cost-benefit analysis requires the aggregation of costs and benefits over time:

- The assessment of costs and benefits needs to be defined over a particular time period. Achievement of good status is designated as the year 2015. However, many actions need to be taken before that to achieve this target. Therefore the base year to start the comparison needs come early in the process.
- the time horizon needs to be long enough: typical 40 to 100 years.
- both costs and benefits are aggregated over time, using discount rates.

After the estimation of both costs and benefits, they are compared systematically to assess the net benefit of implementing the planned measures. The robustness of these conclusions are tested by conducting an uncertainty and sensitivity analysis.

BOX A: Definitions and terminology in WFD and economics

This study can be regarded as being at the crossroads between environmental economics and WFD analysis. Some important terms have a very different meaning in environmental economics literature compared to how these terms are defined in the WFD and related documents (for example, WATECO guidance document). As this study is oriented towards a broader public involved in WFD implementation, we have chosen to be (as much as possible) consistent with WFD terminology. This has implications for the following terms:

- We use the term '**costs of environmental measures'** for the costs of environmental measures (although in economics these costs are often referred to as '*environmental costs').*
- We avoid to use the term **'environmental costs'** because it has a different meaning in literature on the estimation of costs of measures and WFD texts, where it relates to loss of welfare due to a poor status of water bodies. When it is used in this report, it follows the WFD and WATECO terminology ("environmental costs represent the costs of damage that water uses impose on the environment and ecosystems and those who use the environment (for example, a reduction in the ecological quality of aquatic ecosystems or the salinisation and degradation of productive soils").
- **"environmental benefits"** is used to describe the welfare effects (mostly gains) from a changed (mostly improved) status of water bodies. Benefits may be both positive (welfare gains) or negative (loss of welfare).
- **"scarcity rent"** is the term used to describe the benefits related to a more efficient use of water resources. In other studies, this may be referred to as resource benefits or avoided resource costs.
- Environmental economics uses the terms "**goods and services**" provided by water bodies to describe the different benefits of improved status of water bodies, and will make further distinctions between goods (for example, drinking water) and services (for example, recreation). We only use the term "goods and services" together in the methodology section when we refer to the literature. For the rest of the report we mainly use **"benefit categories**" to describe these different "goods and services". This is to avoid confusion with the term **"water services"** which is defined in WFD, as "all services which provide, for households, public institutions or any economic activity: (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater, (b) waste-water collection and treatment facilities which subsequently discharge into surface water". (WFD, art 1(38).
- We follow the WFD definition of "**water use"** which refers both to water uses as described above and any other activity with an impact on the status of water (for example, shipping).

Note: the WFD Art. 9 requires "environmental and resource costs" to be reflected in the water pricing, as specified in of the WFD. Indicators to measures these costs are not necessarily the opposite or mirror image of the Benefits of WFD implementation and should not be confused.

- Indicators to assess "environmental costs" for the purpose of pricing policies can be based on both on the costs of environmental damage or, if this information is not available, on the costs of measures to avoid this damage (damage avoidance costs) (see WATECO, ECO2).
- For any CBA of WFD measures the costs of environmental protection measures are compared to the benefits defined as avoided the environmental damages that are is addressed through the measures. A comparison between costs of environmental protection measures and benefits assessed through damage avoidance costs would not make sense, as both sides would be equal by definition.
- Benefits of WFD implementation refers to the benefits of the specified measures, which may not take away all environmental damages.

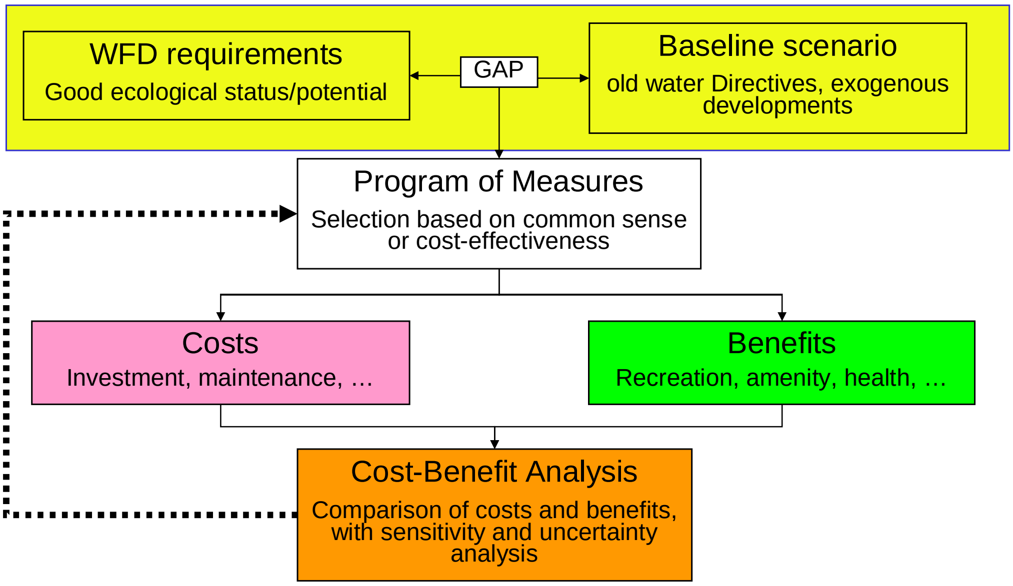

Figure 1: Necessary steps to perform a cost-benefit analysis of the Water Framework Directive.

3.2.1 GAP analysis results in scenarios

For any assessment of costs and benefits, a clear description of the objectives of the projects are essential. In the context of the economic appraisal of the WFD, this relates to a detailed description of the GAP between baseline scenario and WFD objective. As there is uncertainty for both elements, and ambitions related to WFD objectives may differ, studies have used scenarios that represent these differences.

The literature review shows that GAP analysis has been elaborated in different ways:

- in the 1999 WRC study for the UK, two GAPS are defined: a minimum and a maximum: both referring to different baselines and different ambition levels. The minimum GAP refers to a maximum implementation of measures already agreed, in combination with a low ambition level. The maximum GAP refers to a minimum implementation of measures already agreed and a high ambition level (see Section 6);
- in other studies, different scenarios for GAP are defined referring to a fixed baseline with different ambition levels (see Figure 2).

Differences in the GAP analysis may reflect the reference scenario, the ambition level and the number of water bodies affected. In addition, differences may apply to the timing of measures and how fast different ambition levels for WFD implementation can be reached. Achievement of good status is designated as the year 2015. Alternatively, further objectives can be planned for 2027 or some time in between.

GAP analysis is an important issue and it is further discussed in Section 3.3.1 as well as in Section 5 for both costs and benefits. It seems evident that the GAP-scenario should be identical for the assessment of costs and benefits. It is already difficult to distinguish additional WFD measures from baseline scenarios for cost assessments, and it is even more difficult to distinguish the environmental benefits of additional WFD measures from the improvements of the status of waters that will occur under the baseline scenario. Therefore, some studies estimate the benefit from going from the current status to reaching good ecological status. These benefits may not be directly compared to the costs of smaller GAP closures, but may be very helpful to gain insight in the factors that determine benefits. This is further discussed in Section 3 and Section 5.

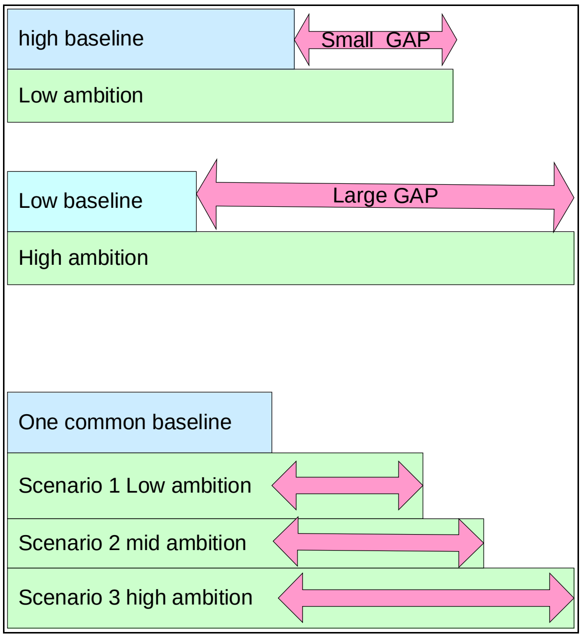

Figure 2: Schematic presentation of different approaches to GAP definitions

3.2.2 Purpose and accuracy of the assessments

The scope of the analysis and required accuracy needs to be adapted related to the context of the decision to be taken and the availability of information. Following the guidelines for the CBA of infrastructure projects in the Netherlands, we can distinguish 3 levels (Eigenraam, 2000):

A) "Explorative CBA": description of the type of costs and benefits to be expected from the envisaged objectives, with some reference to indicator numbers.
B) "Indicator-number CBA" based on indicator numbers that indicate the order of magnitudes of all aspects, for the specified packages of measures.
C) Full CBA: a full analysis of costs and benefits of (different variants) for the selected packages of measures.

The choice depends on the scope and nature of the objectives, the level to which the objectives and measures are already clearly defined and the time and budget constraints. An explorative CBA is especially useful at the start of a longer process in order to identify which types of measures are more likely to have good CBA ratios and which factors have to be taken into account. An indicator number or full CBA is required towards the end of the process to make final selections on measures (see Figure 3).

As Member States are still in the process to further define the objectives of the WFD, and availability of tools and data to assess costs and benefits is limited, the information available today is likely to be more at the level of an explorative or an indicator CBA. This status has to be taken into account for the interpretation of the results and for comparing costs and benefits. This is further illustrated for the CBA of the WFD in Section 5.4.

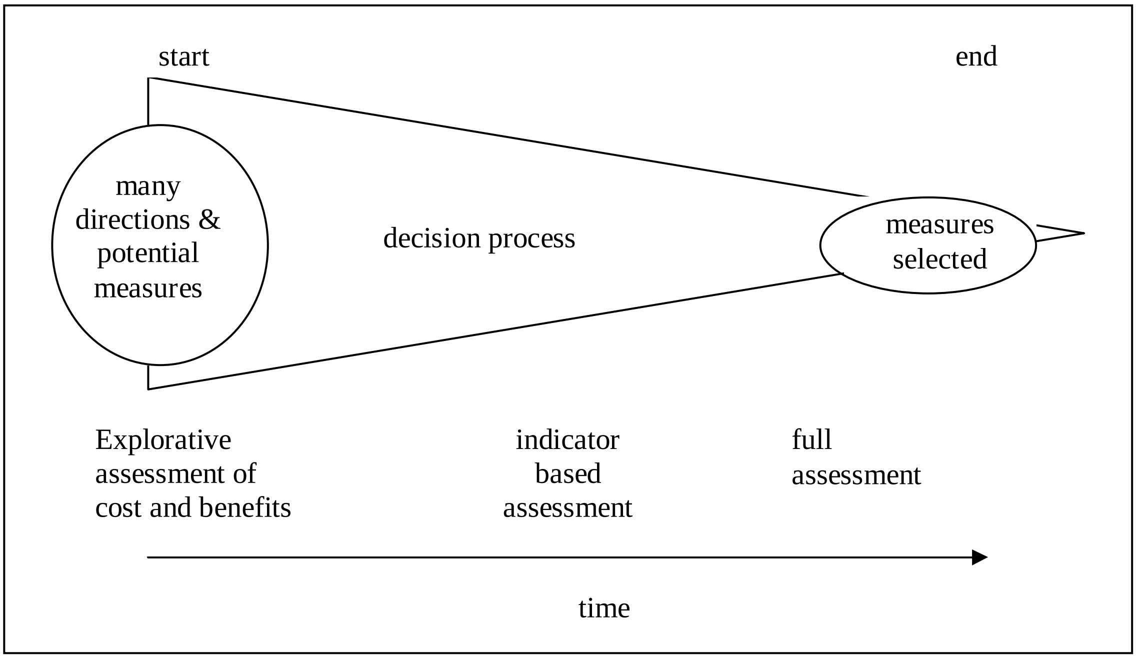

Figure 3: Schematic presentation of the role of different types of CBA following the stepwise decision process to select measures

3.2.3 Availability of tools and indicator data

An indicator or full CBA is only feasible when the appropriate tools and data are available. If not, a CBA study would first require a more research type of analysis to develop these tools. In this context, it has to be noted that for the economic analysis of water problems in Europe, these tools are not readily available.

This is a different situation to energy or air quality issues, for which a longer tradition of economic analysis has resulted in the elaboration of adequate tools. The example of air quality shows that if tools are available, these tools can be used as building blocks to inform different types of decision making and policy questions at national and international levels. In 2005 a cost-benefit analysis was set up for the Clean Air for Europe (CAFE) programme. The analysis aimed to compare three policy options (A, B and C) and the maximum technically feasible reduction (MTFR), with a business as usual scenario. As health benefits largely exceeded abatement costs, all options had net benefits. However additional costs relative to benefits started to increase steeply at around the mid-range. This argued in favour of choosing a level between the low (option A) and mid range (option B). This analysis succeeded in comparing area specific costs of measures with monetized area specific health benefits for several policy options between 2000 and 2020 for the entire EU. This was possible due to the existence of European reference models and methodologies in the field of emissions modelling (RAINS, TREMOVE, PRIMES), dispersion modelling (EMEP) and the monetization of impacts (Extern-E).

Similar data have been used to develop indicators for environmental costs of energy use in electricity and transport. These indicators have been integrated in economic models to assess energy and transportation policies at the EU level and within Member States.

3.3 Methodological issues related to costs assessment.

The different steps for cost assessment are summarised in Figure 4. In this section we deal more in detail with GAP analysis and costs assessments, and the relationship to cost-effectiveness analysis. Issues related to aggregation will also be further discussed in Section 3.5, as they are also relevant for benefit assessment.

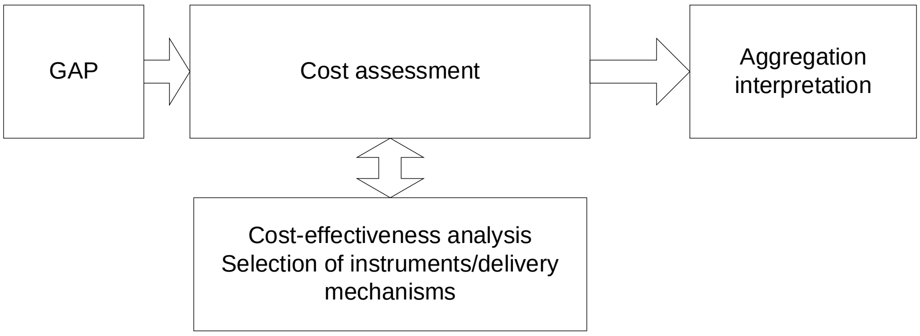

Figure 4: Steps for cost assessment

3.3.1 Issues related to GAP analysis.

To assess the costs of the implementation of the WFD, one needs to separate these from the costs incurred by pre-WFD implementation. In practice, this means that a baseline or business as usual scenario needs to be developed, describing the costs and effects of the implementation of existing pre-WFD policies. By comparing the results of the full implementation of the baseline scenario with the WFD requirements, the need for additional measures and their costs can be assessed.

Different types of costs can be distinguished and delineated, as follows:

- costs of already implemented water related policies (existing water supply and sanitation infrastructure);
- costs of water policies that need to be implemented according to the existing pre-WFD EU legislation, but not yet implemented completely; and,
- costs of additional measures needed to achieve the targets of the WFD.

The first two types of costs are often referred to as the costs of the "baseline" or the "business as usual" scenario. This is more or less in line with the so called "basic measures" referred to in the WFD (article 11.2 and 11.3), as the third type of costs relates more or less to the "supplementary measures" as defined in the WFD (article 11.4)[3].

Another angle can also be applied to delineate pre-WFD costs:

- assess the costs of implementing source related water regulation (for example Urban Waste Water Directive, Integrated Prevention and Pollution Control Directive for larger industries);
- assess the additional costs to achieve the pre-WFD directives on ambient quality (Bathing Water, etc.).

The following example illustrates that this approach has also difficulties. Imagine as a theoretical

[3] Although in the WFD the issues of "cost recovery" and the "polluter pays principle" are also included in the distinction between "basic" and "supplementary" measures.

example two different Member States and the development of the costs of the implementation of three types of water related policies (“source”, “effect”; WFD). In the more advanced Member State, by 1990 large sections of the source related policies are already implemented, and also a start is made with effect related policies (e.g. the Bathing Water Directive (76/160/EEC)). For this Member State, by 2010 all source related policies are implemented, and by 2015 all effect related Directives. By 2000 the implementation of the WFD starts and will be ongoing after 2015. For the other - less advanced Member State - by 1990 only 50% of source related policies is implemented and the implementation of effect related policies starts only are after 1995. By 2015 in this Member State the source related policies are implemented, whilst the implementation of the effect related policies and WFD is still ongoing.

If one uses this approach to GAP analysis, the implementation of WFD in practice will be mixed with both source and effect related water policies. This makes it a special challenge for the implementation of the WFD, as by the time that WFD measures have to be prepared, the outcome of the other policies for future years is unknown (this is especially the case for the ecological quality of water, which is difficult to predict). So not only the costs of baseline and WFD implementation will be mixed, but it will also be harder to relate certain actions to particular Directives (Article 10 of WFD).

In practice, for each Member State the implementation of the WFD will require different measures. It may be so that due to the implementation of the existing pre-WFD EU water directives, almost no additional measures are needed. But in other Member States, the goals of the WFD can only be achieved by additional measures, on top of the pre-WFD Directives.

The implementation of WFD measures may interact with other water related measures (resulting from pre-WFD or national legislation). In this case, it will not always be easy to separate costs. Ex post, it will be even harder or impossible to distinguish which costs can be related to the implementation of policies in the pipeline or the additional requirements of the WFD (due to the statistical limitations). This also implies, therefore, that it will be difficult to monitor the costs of the implementation of the WFD.

3.3.2 Definition of costs

The costs of any measure linked with the implementation of environmental protection measures can be classified as follows:

- financial costs[4] (also referred to as direct costs); and,
- wider, economic costs (including external effects, changes in output, prices, etc.).

As economic appraisal (CBA or CEA) is aimed at the allocation of scarce resources, it should aim at estimating cost in terms of economic social welfare. For this purpose opportunity costs are relevant (HM Treasury 2003, RPA 2004). This would require studies to look into a broad range of direct and indirect impacts, which include (RPA 2004):

- the costs of complying with the requirements (including any savings in costs arising from the adoption of ‘win-win’ measures);
- any welfare losses to consumers, including gains or losses arising from changes in product quality or availability (assessed in terms of changes in consumer surplus);
- induced effects to the wider economy as a result of readjustments to changes in the affected industry or sector;

[4] In the financial costs of environmental measures VAT is excluded (as it can be reclaimed), but other taxes are (normally) included as they form a real cost. Due to calculation conventions, subsidies and revenues from user charges are also excluded in the assessment of financial cost.

- transaction costs effecting industry and regulators associated with structural changes to systems, education and training, etc;
- any environmental costs arising from the introduction of a measure;
- the costs to government agencies in administering, monitoring and enforcing requirements.

The relevant costs categories to include for the analysis will depend on the type of measure and sector. A common pragmatic approach is to start from financial costs, correct for transfers (such as VAT and subsidies), and look at other cost categories when important. In many cases, the financial or direct costs based on market prices will be an adequate indicator. This category is discussed in section 3.3.2.1. For some measures or sectors, a broader category of costs will be important, and this will require specific analysis. This is discussed in section 3.3.2.2 and will especially be important for impacts on agriculture (see also Section 9). Other impact categories such as lost opportunities may also be relevant for some specific measures (e.g. when opportunities for shipping or hydro power are limited (see section 3.3.2.2 and Section 8). Environmental costs may be relevant for limiting hydropower, as discussed in Section 8. Administrative costs for governments are discussed in Section 7.

3.3.2.1 Financial costs

To assess the financial costs of the Water Framework Directive, the environmental protection expenditures[5] linked with the implementation of measures have to be estimated.

For expenditures to be classified as environmental, two criteria are relevant:

- the measure should be taken with the main objective to protect or improve the environment (excluding for example health at the workplace);
- the measure should lead to additional costs. This excludes measures that are taken for economical reasons (profitable measures).

Moreover, a division can be made between investments and operational and maintenance costs. By annualising investment costs (depreciation plus interest payments) and adding this to the operation and maintenance costs, total annual costs can be estimated for environmental protection. In a CBA, usually the investments and annual operational costs are summed in the Present Value of all future costs (this may be 40 years or even 100[6]), applying a discount rate. If the results of the cost assessment are used for cost-benefit analysis, the economic parameters (time horizon, discount rate) should be geared to those used for benefit assessment.

Financial costs are often estimated by dividing the actions needed to implement a policy, in concrete measures (mostly technical, sometimes administrative or managerial). For each of the different types of measures estimates are made (this can be either bottom up, or top down by cost-engineering studies). The more experience there is with the implementation of certain measures, the more accurate cost estimates may be.

Table 1 gives an overview of the types of measures that can be related to the implementation of the WFD. The costs of these measures are normally roughly estimated by applying unit costs (for

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[5] The definition of annual expenditures differs from annual costs in the sense that annual expenditures normally refer to investment expenditures made in a certain year and the operational and maintenance expenditures in the same year. Annual costs, on the other hand, refer to annualised investment expenditures and annual operational and maintenance costs (which are the same as annual operational and maintenance expenditures). See further, section 3.5

[6] In studies for entire UK and for the region of Scotland a 40 year discounting period has been applied with a discount rate of 6%, whereas in a study for the Netherlands a 100 year discounting period is used with a 4% discount rate. See further, section 3.5.

example expressed in costs per km river bank, € per kg P removed, etc.).

Table 1: Overview of possible measures for the implementation of the WFD

Type of measure	**Addressed status:**
MUNICIPALITIES	
decoupling of rainwater sewerage	Chemical
storage basins	Chemical
sewerage / wwtp remote buildings	Chemical
ecological management water	Ecological
WATERBODIES / REGIONS	
dredging	Ecological / Chemical
ecological management water banks	Ecological
improve wwtp's	Chemical
fish passages	Ecological
restore natural water table levels	Ecological
STATE	
policy making (also for air / soil)	Chemical / Ecological
main ecological structure	Ecological
AGRICULTURE	
use less pesticides	Chemical
less use of nutrients	Chemical / ecological
biological agriculture	Chemical / ecological
reduce water use	Ecological
storage of rainwater	Ecological
ecological management water banks	Ecological
INDUSTRY	
decoupling of rainwater sewerage	Chemical
use of environmental friendly building mat.	Chemical
CONSUMERS	
dog toilets	Chemical
centralised car washing	Chemical
no discharge dangerous substances sewerage	Chemical

Source : TME

3.3.2.2 Indirect costs

An assessment of only financial costs in a CBA is however not sufficient, as they only form the basis for the assessment of economic costs. Economic costs refer to wider economic impacts (also referred to as indirect effects). For example, if, due to WFD measures agricultural products become more expensive, less will be sold and processed, affecting not only farmers, but also the industries linked and the consumers.

An assessment of economic costs can be made by using a macro economic model (for example PRIMES). This however, requires structured data collection and processing (comparable with RAINS), and is currently not available for water in the EU. And for certain sectors (especially agriculture) such models often lack the detail to really make clear the (sub)sectoral effects. So instead of making use of such complex models, often indirect impacts on sectors or groups that are (thought to be) heavily affected are assessed in sectoral impact studies. Examples of indirect effects for agriculture are discussed in Section 9.

Another example relates to the impacts of fish migration measures on hydro electricity power plants, which may lead to less hydro electricity production and less income for the affected hydro electricity power company . In addition there could be indirect impacts on the electricity sector with additional costs, and environmental costs if hydro electricity power is replaced by more polluting alternatives.

3.3.2.3 Estimated costs (ex ante) and real costs (ex post)

It is often argued that *ex-ante* cost assessment overestimate the costs, and that *ex-post* costs from environmental directives differ from *ex-ante* costs. This is clearly shown in several studies on the costs of environmental policies (see IVM, 2006; RIVM, 2000; TME, 1995). For a follow-up, real costs needs to be monitored. Monitoring the costs of the implementation of the WFD will be far from easy. As shown in Section 6, the information on costs of water related policies in the EU is incomplete, and still is being developed. Separating the costs of pre-WFD and WFD policies remains a difficult (statistical) task.

The accuracy of the cost estimates will be better if the assessment has already taken cost-effectiveness into account (looking for cheaper measures) and if the most efficient policy instrument or delivery mechanism is chosen. For this purpose, the methodological framework developed in the UK corrected costs in function of the delivery mechanism used (Metroeconomica, 2006). On the other hand, cost assessment approaches need to correct for cost-optimism bias if they are based on indicator numbers.

3.4 Methodological issues related to benefits assessment

3.4.1 Environmental and other benefit categories.

The WFD will deliver a wide range of benefits. They can be grouped in categories following different points of view. A first classification is given in Table 2 and identifies five types of benefits which are very different in nature and require different approaches for their assessment. The information status is also mixed, with the best information currently being related to environmental benefits. The methodological issues related to these benefit categories will be further developed in this section.

Table 2: Different types of benefits related to the implementation of the WFD

Benefit type	**Definition**	**Information status**	**discussed in Section**
Environmental	Improved status of water bodies and related aquatic systems (expressed in terms of increased “goods and services”)	Methods : good Data: limited to a few MS and to specific measures	5,7,8,9
Scarcity rent	More efficient use of water resources	Methods an data: emerging, limited to a few case studies	9
Administrative	More efficient water related policies and avoided costs at the end of the policy cycle (control)	Poor, based on assumptions	7
Indirect	More opportunities due to more efficient water use and improved technologies	Qualitative	-
Social	Avoided conflicts, improved cohesion through river based planning	Qualitative	-

Source: VITO

In Section 6, an overview is given of the different types of environmental benefits. So far, environmental benefits have been the best studied and documented, whereas the other benefit types have only really been assessed theoretically.

3.4.2 What are the environmental benefits of the WFD?

Environmental benefits refer to welfare gains and avoided costs for citizens, administrations and companies (for example, drinking water companies), due to a better provision of “goods” (for example, drinking water, fish, hydropower) and “services” (for example, recreation, control of the water cycle), as a result from an improved (ecological) status of the water bodies within a river basin or country. Most of these benefit categories relate to non-market benefits, although some of these benefits will also be market ones, for example, less treatment costs to produce drinking water from polluted ground- or surface waters, improved conditions for inland shipping. The impact of benefits can be related to other secondary issues (for example, wetlands and more natural river banks contribute to the regulation or capture of CO_2 emissions and other air pollutants).

Impacts may also be negative, either directly (for example, less opportunities for shipping or port activities; limitations for hydro-electricity generation) or indirectly (for example, less fish production because of lower nutrients in inland waters). In addition, there may also be some overlapping with scarcity rents, but this is only important in relation to the possibility of double counting.

3.4.3 How to assess and value environmental benefits?

The different steps for benefits assessment are summarized in Figure 4. First we will discuss impact assessment and valuation issues, and we will discuss GAP analysis when we look at two different methods (bottom-up and top-down). Issues related to aggregation will also be further discussed in Section 3.5. This section does not intend to discuss in detail the methodological issues and methods related to valuation, but focuses on their application for benefit assessment of WFD. The WATECO guidelines offer more information on definitions and illustrations of the methods themselves.

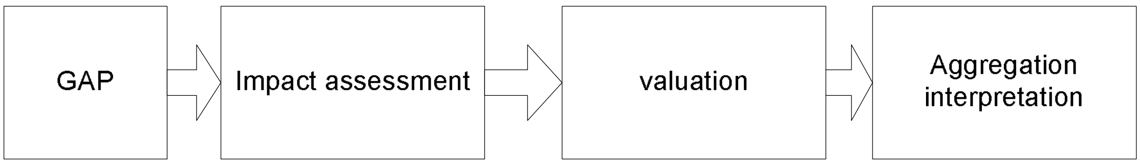


Figure 5: Steps for benefit assessment

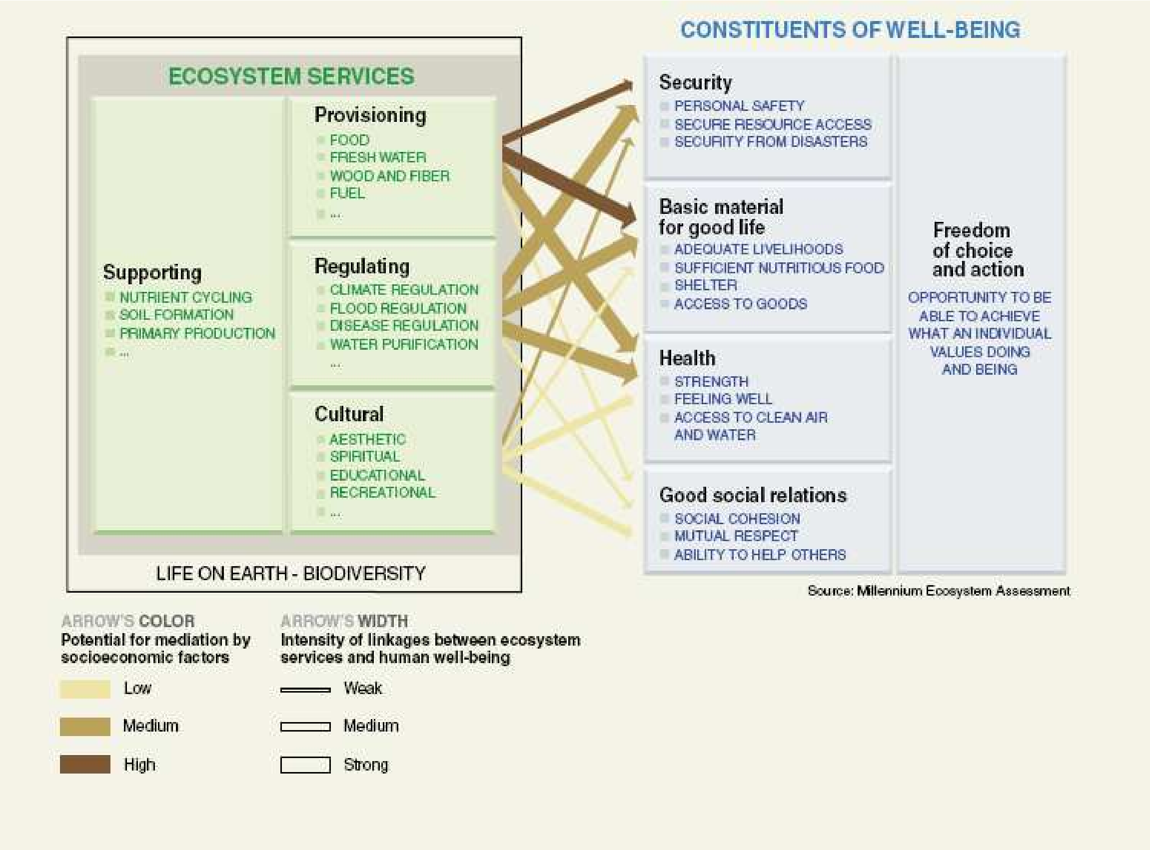
3.4.3.1 Impact assessment using an environmental services framework.

An improved ecological status of water bodies in Europe will improve their capacity to provide environmental goods (for example, drinking water, fish, hydropower) and services (for example, recreation, control of the water cycle). The value of these additional goods and services are the welfare gains or environmental benefits of the WFD. This assessment framework using ecosystems services allows to link ecological and impact assessment with environmental economics. In Figure 6 the ecosystem services approach is illustrated, taken from the Millennium Ecosystem Assessment. It shows that an improvement of ecological status can result in the improvement of four categories of benefits:

1. provisioning functions: which relates to an improved provision of goods. In this context, drinking water and fish are relevant examples, which will be reflected in the related markets.
2. regulating functions: relate to an improved purification of water-related systems (e.g. in wetlands) that allows cost savings for emission abatement, better water regulation (drainage and retainment of water), which allows costs savings for water-management, capture of CO_2

or air pollutants which allows costs savings in that area.
3. cultural functions : improved services related to recreation, education, etc.
4. supporting functions, (e.g. nutrient recycling). These improvements may be important from an ecological point of view, but it can not be measured directly in economic terms. However, it is accounted for as they support the other functions.

Impact assessment can be applied in two ways:
- a bottom-up type assessment will require a detailed assessment of each function. This is explained later when we discuss this methodology.
- a top-down assessment will also have to make some impact assessment, but that is likely to be less detailed.



Source: Reid, 2005 , WRC, 2005.

Figure 6: Example of the ecosystems services assessment framework (used for the Millenium Ecosystem Assessment)

3.4.3.2 Valuation

These goods and services can be valued using market prices or other price indicators that reflect the value for their users. It can build on a wide experience and literature in the field of environmental economics. The steps and required information is discussed in more detail in Section 6. The terminology used in this type of studies mirrors the 3 categories mentioned above, but in addition distinction is made between use and non-use benefits. An overview of the different categories of the total environmental benefits is given in Figure 7:

- *Direct Use benefits:* The first category refers to those benefits for specific users of "goods or services" from water bodies. Typical examples are avoided costs for treatment of drinking water, which benefit water companies and their consumers more, and better opportunities for informal (walking, cycling) and water-related recreation, and more valuable natural environments. The welfare gains for these direct users is reflected in their willingness to pay for the related service, and reflects the preferences and values of current society for that service.. This can be estimated based on:
    - market prices, direct: some benefits are directly based on market prices, for example, the value of fish production, avoided treatment costs of water purification, permits for recreational fishing, entrance tickets for swimming facilities.
    - market prices, indirect: some benefits are reflected by peoples' willingness to pay higher prices for properties or rented accommodation nearby clean water; the willingness to pay travel costs to reach recreational fishing facilities etc. Hedonic pricing or travel cost studies are used to estimate the willingness to pay based on these market prices (revealed preferences).
    - surveys: the willingness to pay for a service can be estimated based on survey techniques in which these users are asked directly or indirectly how much they are willing to pay to make use of that service, or for a better service. (for example, for the improvement of recreational fishing, informal recreation, etc…) (stated preferences).

- *Indirect Use benefits:* Water bodies with a good status will improve the regulation functions of a water system and related ecosystems. The most relevant function is a better management of the water cycle to improve water supply and to limit or prevent economic losses associated with droughts and flooding. Another example is the capture of CO_2 and other air pollutant emissions by wetlands and more natural river banks. A clear set of definitions and an accounting framework are required to avoid double counting. Some of the impacts may already be accounted for in direct use benefits (water supply, nutrient removal by wetlands and more natural river banks), whereas other benefits (reduced flood risk, CO_2 capture) are not.

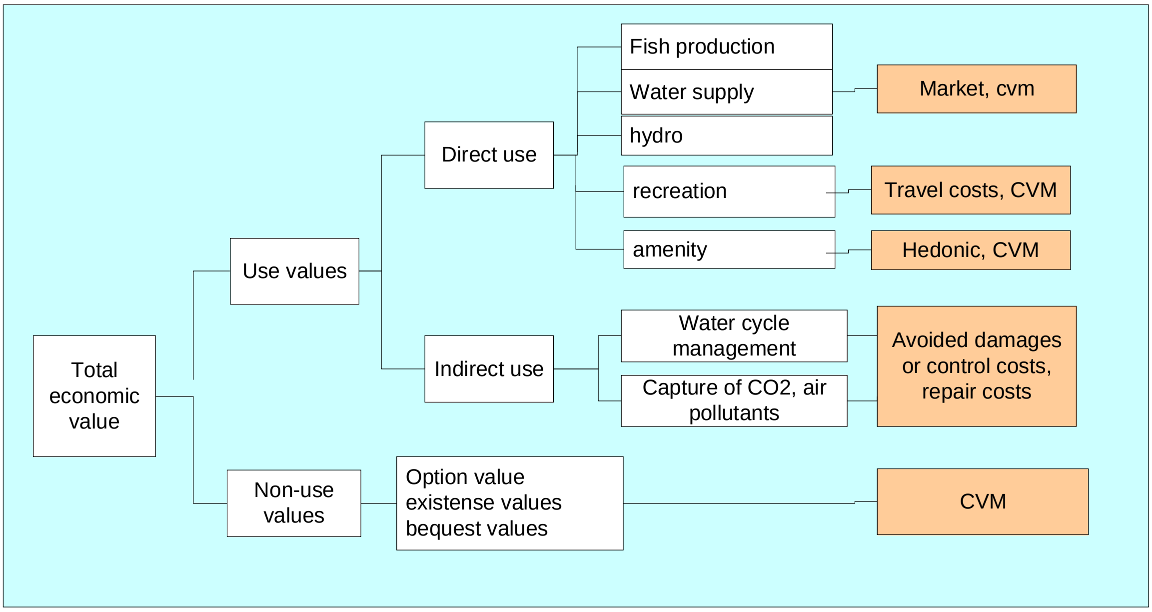
- *Non-use benefits*: The non-use value of improved ecological status of water bodies refers to the value European citizens attach to improvements, irrespective of their own use. It includes:
    - option values: referring to potential future use values for the current generation (for example, protection of groundwater as potential source for drinking water);
    - existence values: knowing that our water resources and biodiversity are well protected; and,
    - the bequest or inheritance values: passing well protected water systems onto the next generation.

    These benefits can only be estimated by means of surveys in which people are asked for their WTP to improve or conserve a specified water body (for example, groundwater) or environment.

Use benefit types are diverse and their valuations are based on a wide variety of approaches. Non-use values, however, are only based on stated preferences techniques, e.g. using contingent valuation surveys (Figure 7).

There is a trade-off between different "goods and services" a water body can deliver. Some may be so far developed or exploited that good status or other "goods and services" are limited. In this case, the economic assessment of WFD will show both losses and gains. Examples are the benefits of improved conditions for fishing, amenity and or recreation at the expense of less hydropower production. It should be noted that article 4 WFD provides procedures for finding the sustainable balance between such tradeoffs, for instance in relation to new modifications of water bodies.

Studies show two different approaches to estimate the environmental benefits of the WFD:
- a "bottom-up" approach that aims to identify and assess all the different benefit categories in detail, combining impact assessments with WTP and other data for economic valuation; and,
- a "top-down" approach, which assesses the total benefits in a more comprehensive way, asking citizens for their WTP to improve water status.



(Source: Hanley et al., 1993)

Figure 7: Methods to value different environmental benefit categories of the WFD

3.4.3.3 Benefit assessment of WFD using bottom-up impact assessment.

The first approach is a bottom-up approach that follows the overall approach of a classical CBA, trying to identify, quantify and monetize the different benefit categories to assess the total economic value. It involves the following steps, which are in line with the overall approaches for a CBA:

a) development of (packages of) measures to close the GAP, setting out from the analysis of pressures and impacts;
b) assessing the physical effects of measures: how measures affect the status of the water bodies, (physical-chemical, hydro-morphological, biological, …). This step requires the use of integrated modelling and environmental assessment techniques. The results of this assessment step need to be consistent with the input requirements for the benefit assessment step (see below), and can either be quantitative (concentrations of pollutants) or more qualitative (quality classes…);
c) benefit assessment: how changes in the status of water bodies affect "goods and services". It requires:
   - an accounting framework to identify all relevant uses and impacts, and to ensure consistency and avoidance of double counting.
   - ideally dose-response functions or at least information on threshold values that describes and quantifies the extent to which "goods and services" are affected by changes in the status of water bodies.
   - data related to current, future or potential users and uses of the different "goods and

services" (for example, volumes of surface or groundwater used for drinking water; number of hikers, bikers, anglers, ….; number of houses along river banks, etc…). Data may relate to the observed number of people or indicator number (for example, typical number of anglers per km river);

- reference data for valuation of these "goods or services": given the complexity of the analysis it is unlikely that for all the relevant benefit categories new empirical research on this step will be undertaken. There is a need to build on a set of reference values that are based on data from literature, and which have been adapted for use in a specific river basin. This adaptation called benefit transfer involves procedures to select the most relevant sources of information and include corrections for changes (for example, income, year, currency,…);
- rules for the aggregation of benefits over different categories, type of users, dealing with timing of benefits and discounting over time, etc.

Examples of this approach for the UK, France and the Netherlands are discussed in Section 5.3.

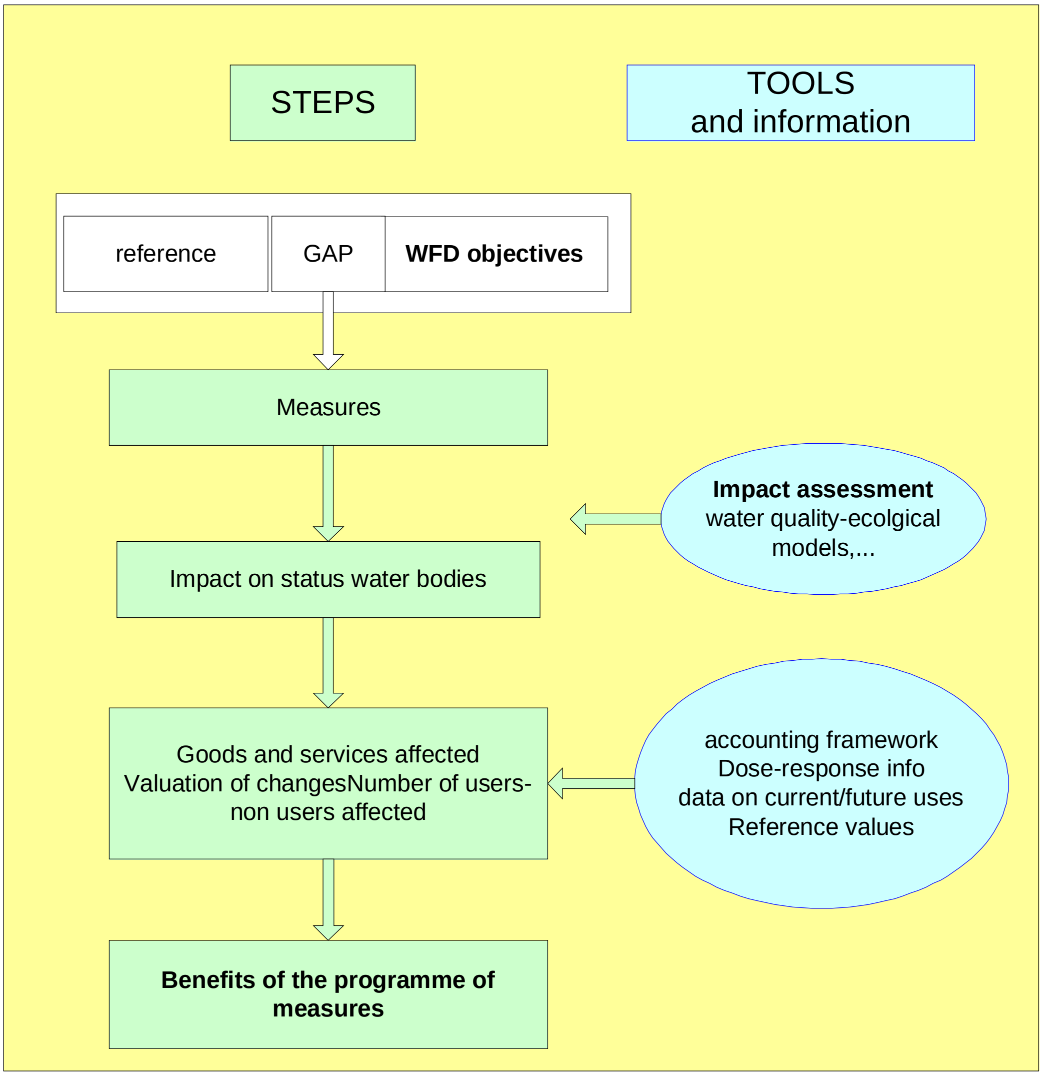


Figure 8: Benefit assessment of WFD using bottom-up impact assessment steps and tools

The result of this approach is the total benefits of a package of measures (a value per year or period for a water body, basin or country). These measures may reflect different accents or levels of ambition related to the good status of water bodies. These benefits can directly be compared with the costs associated with the same package of measures. It should be noted that this type of analysis is not required by the WFD itself: the Directive merely specifies that the most cost-effective selection of measures should be adopted to reach the good status objective, which suggests the use of a cost-effectiveness analysis. Yet, in contrast to a full-blown cost-benefit analysis, this does not require quantification of benefits in monetary terms.

A typical characteristic of this type of bottom-up approach is that it is difficult to make an assessment of the total economic value because it is likely that information for (important) impact categories will be lacking due to missing element in the analysis chain (info on impacts, dose-response, number of users, valuation,…). The number of potential benefits identified is always greater than the number quantified and monetized (Figure 9). This is further illustrated in Section 5.2. However, qualitative information and other indicators can be taken into account, especially at the level of an indicator CBA and when a limited number of types of measures or rough ambition levels need to be selected (see Section 5.4).

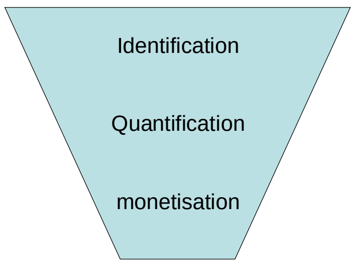


Figure 9: Reduction of scope in the bottom-up impact assessment.

Some of the benefit categories have close relationships with water quantity management and may also be seen as scarcity rents / resource benefits (depending on definitions used). For example, a better preservation of ground water resources will improve non-use values for groundwater (according to option, existence and bequest values). Better flow management may lead to improved fish migration and fish production (market), recreation amenities (angling, boating, swimming,..).

3.4.3.4 Benefits assessment of the WFD using top-down surveys.

Surveys are another way to assess the willingness to pay of European citizens to reach a good ecological status of a water body(ies). The approach looks simpler as it does not require the development of measures, nor their detailed impact assessment. In addition, it does not require an accounting framework to deal with potential overlapping and assumptions inherent to benefit transfer techniques. It requires an assessment and good description of both current situations (or reference situation) and the good status as envisaged by the WFD. This information is used to develop a questionnaire that asks people directly for their WTP to reach these objectives. The description of the good status and development of the questionnaire will however also require a GAP analysis and will have to make assumptions about WFD related measures and their impact. The survey is directed towards a representative sample of the inhabitants for which the benefit assessment is made.

The approach (Figure 10) suits the concept of the WFD, as it is a framework directive which specifies qualitative goals and provides procedures for further specifications. Of course, the approach assumes that the respondents have a good understanding of the current status of water bodies and the expected improvements due to the WFD. Experiences indicate that respondents need to be presented with questions and descriptions that are clear and easy to understand (Brouwer, 2004).

The approach is adopted by investigators estimating the benefits of nature development or conservation, especially for nature types where non-use values are likely to be dominant.[7] The approach has also been used to assess benefits from air pollution, but it is regarded as being less reliable as detailed assessments using air quality modeling and dose-response functions for health impacts are well established.

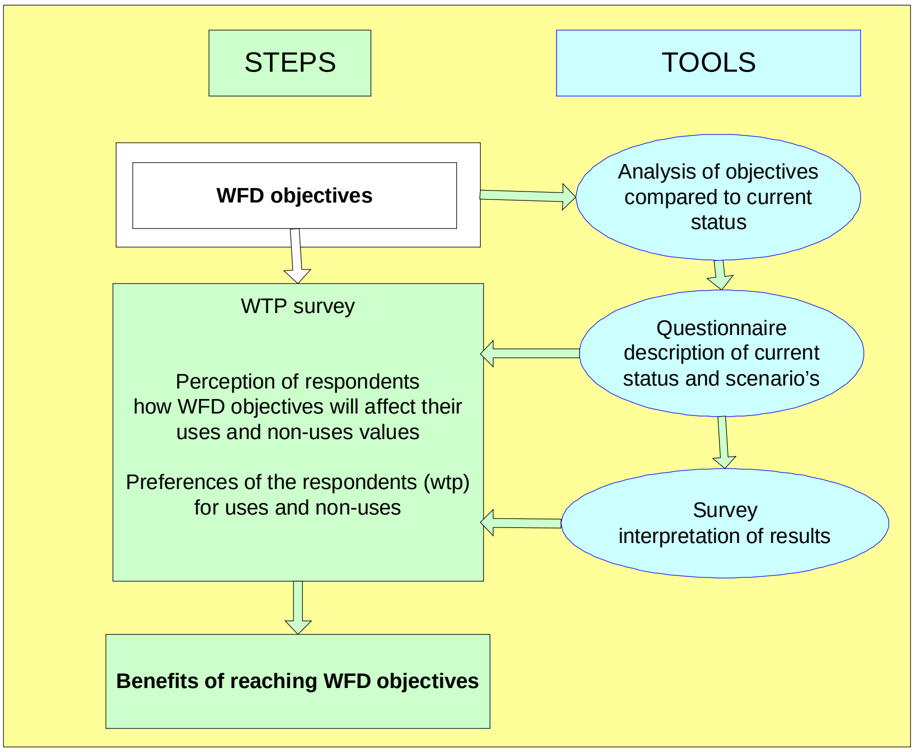


Figure 10: Benefit assessment of WFD using top-down surveys: steps and tools

3.4.4 Scarcity rents: main issues

3.4.4.1 What are scarcity rents?

Scarcity rents measure the value of a scarce resource over and above its opportunity cost, i.e. the next-best alternative use. They are a measure of economic benefits resulting from a more efficient use of water resources. One of the objectives of the WFD is to ensure resource efficiency, which is a vital concept of sustainable development. Resource efficiency means that water resources are directed towards uses with a relatively higher value added per volume used.

Resource efficiency is especially an issue in relation to situations where water sources are overexploited (WATECO) or where they are not allocated efficiently due to inefficient water rights or pricing mechanisms. Typical examples are the use of irrigation water in agriculture or flow management for fish migration (see Section 9). The European CIS Drafting Group Eco 2 uses a wider concept and refers to resource costs as the difference between the economic value of current water use and the optimal use of water.

[7] However, for wetlands, bottom up approaches are also frequently used (see further).

There are different levels of ambition or interpretation of what resource efficiency and integration of resource costs in water pricing can mean in practice (Heinz, 2005). The most ambitious interpretation is that WFD objectives include the achievement of an optimal water use and all water sources are allocated to these economic and/or environmental uses with the highest value added. A less ambitious interpretation is that water quantity is managed in a way to ensure the good status of surface and groundwaters, and that related measures may lead to improved water efficiency as water is allocated towards uses with higher added-value.

3.4.4.2 How to assess scarcity rents?

Scarcity rents are assessed by differences in added-value between reference and WFD scenarios on the basis of new measures. Water uses refer both to water use in different markets (agriculture, industry, drinking water,…) and the provision of environmental "goods and services". This assessment is closely linked and may show overlaps with the assessment of environmental benefits and costs.

- If WFD measures affect a sector, for example, agriculture, the differences in total output from the sector in the reference and the WFD scenarios will already be reflected in the cost assessment. A sector will adapt itself - some sectors will be reduced, others may further develop - as illustrated for measures related to limiting phosphorous emissions and improving irrigation management (see Section 9).
- Measures are also likely to affect the provision of environmental "goods and services" (shipping, recreation, water production) and there is a natural overlap with assessment of environmental benefits. These issues are already discussed above.
- If the measures lead to a further development of different sectors with higher value added per m³ water used, this is an additional benefit (for example, from low value uses in some agriculture sub-sectors to other uses in tourism or industry). It requires integrated modelling of water supply and demand under different scenarios to assess this benefit. As a matter of overall welfare, scarcity rents only play a role in cases that constitute a case of market failure / inefficient allocation. Resource benefits play a role when they are generally not incorporated into market prices, and it will therefore be necessary to rely on assessments of foregone demands and economic values.
- There are a number of issues which may deserve further attention:
  - it may be misleading to evaluate water efficiency for a whole sector or typical use (drinking water for households) on indicators based on average value added or prices paid, because within the sector or use there may be large differences. The provision of drinking water to households has a very high added- value for applications related to food production, drinking, bathing but this water source is also used for lower added-value including toilets, cleaning, etc…
  - In most cases, the reference scenario is likely to underestimate potential costs related to the unsustainable use of water resources.

It is more difficult to assess the scarcity rents that would result if water uses were allocated in the most efficient way, because it would require a model which is able to describe all the alternative options for demand and supply of water. Contrary to environmental benefits, one cannot rely on a description of the 'ideal state' and the use of survey methods.

3.5 Aggregation and comparison of costs and benefits

This section deals with the main methodological issues related to the aggregation of costs and benefits over time, spatial issues, and indicators to compare total costs and benefits.

3.5.1 Aggregation over time, time horizon

The PV or present value is an indicator for the total value of costs and benefits of a measure for the relevant time period. The relevant parameters are the pattern of costs and benefits over time, time horizons and discount rates used.

Cost-benefit analysis needs to look at the total costs and benefits of measures over a relevant period of time. On the cost side, the first years will require investments for all types of measures, which will be followed by a period with mainly operation and maintenance costs, until the replacement investments are required. The benefits will only start to take effect if the measures have been implemented, and in some cases there may be some delay before they take full effect. The time horizon should be long enough to account for all costs and benefits.

When we aggregate costs and benefits over time, we need to reflect that we value future costs and benefits less than immediate costs and benefits. To this purpose, discount rates are used. For a CBA of WFD implementation, a social discount rate is applied that reflects the social time preference rate, and which is different and usually lower than financial discount rates (HM Treasury, 2003). For long time horizons, a time declining discount rate may be required to better reflect the goal of sustainable development (HM Treasury, 2003, Turner 2007).

Most Member States have their own guidance or tradition on what time horizon or discount rate to apply. Odgaard (2005) has shown that both time horizons and discount rates used for Cost-benefit analysis related to transportation projects differ substantially between Member States (Odgaard 2005; Heatco, 2006). It is to be expected that for CBA in the water sector similar differences will occur. Studies discussed in Section 5 use indeed different long time horizons and discount rates. The time horizon ranges from 40 years for the UK (WRC, 1999) to a 100 year period for the Netherlands. Discount rates typically vary from between 3% to 6%. These differences need to be accounted for when comparing results.

As the PV over a specific period may be hard to interpret, this indicator is often expressed as annual costs or benefits (or annualised costs and benefits), which is based on the PV divided by the number of years.

3.5.2 Aggregation of benefits over water bodies.

Most literature on benefit assessment evaluates the impacts of improvements of a single water body (e.g. lake, river) or even a specific stretch of a river. The WFD will affect however a large number of water bodies within a river basin. This raises questions on how to use the information from literature for the assessment of benefits of the WFD. People living close to the water body are likely to use the river more and have a higher willingness to pay for improvements of water quality and river morphology, but people living further away however will still enjoy (lower) benefits (see section 5.3.8). The value of improvement of a river basin is likely to be smaller then the sum of the improvements of all individual water bodies. On the other hand, a larger improvement may generate benefits that a single project is unlikely to achieve. More natural river banks over a full stretch of a river and tributaries may create more opportunities for e.g. networks for recreation. Widespread opportunities for angling and bathing may change habits. These issues have been well identified and discussed (e.g. Chegrani (2005) but as there is little scientific evidence on how to improve aggregation, this is one of the issues dealt with in the ongoing EU FP6 research project AquaMoney (www.aquamoney.org).

3.5.3 Indicators to compare costs and benefits

There are several indicators that can be used to compare costs and benefits. In financial analysis and project appraisal a number of indicators are used such as internal rate of return (IRR) or NPV (net present value) that require a great accuracy of both costs and benefits. In the context of assessment of costs and benefits of WFD this type of indicators will be less useful. For policy appraisal it is more common and useful to discuss the total value of costs and benefits next to each other, taking into account omissions and uncertainties. In Section 5, this use is further illustrated. The use of the Benefit cost ratio (BCR) may be useful to compare different measures or projects. An example of this use is also given in Section 5.

As explained above, some of the benefits of WFD are cost savings, and may be either accounted for on the cost side or the benefit side of the equation. Examples may be:

- Costs savings due to more efficient water use that are reflected in lower total costs of WFD measures;
- Cost savings for emissions abatement measures thanks to improved purification functions due to wetland restoration or protection; and,
- Administrative benefits due to better planning and stakeholder involvement.

3.5.4 Definition of the spatial level of analysis

An economic appraisal is made for a certain target group, often the regional or national economy and society. As river basins are likely to crosscut administrative boundaries, it will require special attention to ensure that assessments at national and regional level are consistent with assessments at the level of (sub)basins. This issue is further discussed throughout the report, especially in the context of the need for economic appraisal to find a balance between information collection and guidance at national, regional and river basin level.

As indicated above, the definition of the gap scenarios is difficult, and the assumptions made for assessment and costs may be different. Such differences will make comparison of costs and benefits difficult.

3.5.5 Equity issues

One of the major issues to improve acceptability of CBA analysis is to account for equity issues and distributional effects, which can be dealt with in different ways (Turner, 2007) First, equity impacts can be dealt with by giving more detailed information on the division of costs and benefits for different target groups, which may be sectors, regions, income levels, etc. In addition, the numbers that relate to costs and benefits may be adapted for different income groups. It follows from economic theory that the utility or welfare of poorer people is more affected if they are confronted with the same level of for costs or benefits as richer people. To account for that effect, cost and benefits indicators can be equity-weighted, which means that costs (benefits) for lower income groups are given a higher weight, and some indicator-numbers are available for that purpose. National guidance documents for CBA assessment are likely to reflect different opinions and traditions related to equity weighting.

We are not aware of studies that apply these correction factors in the framework of studies for costs and benefits of WFD assessment. It is more likely to be an issue for the selection of specific measures and policies, for example, impacts on drinking water prices. It has to be noted that these equity considerations are different from adapting benefit indicators for differences in income and purchasing power, as part of a benefit transfer (see Section 6).

For the CBA of the WFD, three issues in relation to equity are relevant:

- distribution of costs and benefits between upstream and downstream regions;
- some sectors may be harder affected, which may be relevant for agriculture. Therefore, this study focuses in Section 9 on some of the impacts of the WFD on agriculture;
- the impact on poorer groups or regions affected

Equity issues are relevant for the discussion of the affordability of measures and disproportionality. This is an important issue for implementation of WFD but it is not the objective of this report to deal with this topic.

3.6 Summary of key points

The overall methodological framework for cost-benefit analysis of environmental policies is well established and it has been used successfully in many areas. The application of such a framework to the WFD requires further tools for estimation of costs and effectiveness of different measures, and tools for benefit assessment at the level of the river basin and/or national level. Such tools were not available at the start of the WFD, but have to be developed building on the existing guidelines, studies and reference data from other areas.

Some of the main issues and uncertainties are relevant for both costs and benefit assessment, (as well as for other types of assessment of the WFD):

- specifications of the baseline scenarios - and to what extent some measures are attributed to pre-WFD legislation or the WFD;
- the level of ambition for the specification of the objective of GES/GEP and the implementation timing;
- the cost effectiveness of new types of measures for which experience with large scale applications is limited;
- the CBA of WFD needs input from both specialised scientists such as environmental economists, ecologists, hydrologists and engineers, and local expertise at the river basin level; and,
- Comparing costs and benefits will have to take into account the uncertainties in both costs and benefits and their comparability.

Methods for the assessments of environmental benefits are well established although the valuation of non-market benefits adds additional uncertainties compared to market benefits. Experience and literature refers mostly to individual cases studies (for one service or water body) and is mostly done in the richer, northern EU Member States. For the benefits assessment of the WFD, two approaches have been used:

- a first approach is to identify and value all the different benefit categories for specific water bodies. These bottom-up approaches build further on the impact assessment of measures and on data on literature for valuation. For the WFD, guidelines and tools are needed to use these data to estimate the full economic value of improvement of all water bodies within a river basin and country. The UK, France and Netherlands have started to develop and use such tools, which highlight both the difficulties and usefulness of the results.
- a second approach is to assess benefits for a river basin or country in more generic terms using stated preference methods (surveys). These methods produce the overall range of benefits but provide little information to select individual measures or prioritise between locations.
- An improved allocation of water uses in the context of WFD may lead to in terms of higher added values per m³ water used. Methods to estimate these scarcity rents in the context of the WFD are less developed and there are no guidelines and indicator data.

Given the status of the GAP analysis, the complexities of the issues, and the lack of ready to use tools or indicator data, it is very difficult to make a full detailed cost-benefit analysis of WFD implementation today. Assessment of costs and benefits are more likely to be explorative, describing and assessing the relevant factors, and built on indicator numbers where available. This information may already be very useful to guide further work and analysis.

In this context, comparing costs and benefits should not rely on summary indicators used for financial or project appraisal, but should take account of omissions, uncertainties and qualitative information. This will also allow to discuss equity issues if information is available.

4 OVERVIEW OF STUDIES AND REPORTS ON COSTS AND BENEFITS OF WFD IMPLEMENTATION IN THE EUROPEAN UNION

4.1 Approach

A questionnaire survey of Member States was carried out to obtain an overview and produce an inventory of studies and reports on costs and benefits of WFD implementation in the European Union The questionnaire asked for studies already completed but also for studies in the pipe-line.

A workshop in November 2006, with representatives from the MS and stakeholders, was held in part to provide clarification on the objectives and context of the survey. Participants were given the opportunity to ask questions, provide comments on the work plan and suggest case studies to be included in this Report. The draft conclusions were discussed in a second workshop in April 2007. Further information was collected at and after the workshops. Stakeholders also provided information on specific issues.

Some limitations have to be taken into account.

- First, the major focus was on studies at the national level, or at the level of large river basins, and studies that deal with costs and benefits of multiple issues and sectors. The overview of studies and material has been further completed with other types of studies related to the specific measures of WFD, but this was not the focus of the questionnaire.
- The focus of the overview is the implementation of WFD, and not costs and benefits.
- The major focus is on completed studies that have produced results in terms of numbers. It does not intend to give a complete overview of studies that address single or pure methodological issues.
- Second, the overview of studies and reports is a snapshot in time of available information. We collected information on available studies until May 2007. It should be noted that information in this area is expected to grow and change rapidly, as a several Member States have launched studies.
- For our analysis, we mainly relied on published and public data, which are nearly always someway behind the latest numbers and insights. Especially for the Member States that have published numbers, it should be reminded that these data are in the process of being updated. Only for some selected issues, were we able to use more updated information.
- For a few Member States that did not participate to the workshops nor answered the questionnaire we had to rely on public information available. For these countries, we do not have a good idea to what extent economic analysis is or has been made.

4.2 Overview of past and planned studies and reports by type and Member State

The information provided by Member States or from the literature review indicates that the majority of the Member States have started the process of assessing costs and benefits of the WFD (Table 3). Most of these, however, are still at an early stage including the commission of first studies and/or the development of tools. The objectives of the planned or ongoing studies are broad, including the analysis of costs and benefits and cost-effectiveness.

Thirteen Member States, and one Bundesland from Germany answered the questionnaire and/or provided additional studies and reports to the inventory. From other Member States we received information through verbal communications at the two Workshops or through other means. In total there are about 180 studies in the inventory list, the largest part electronically available or provided as hard copies. The list is compiled on the basis of the questionnaire and an internet survey. According to the questionnaire survey there are also at least 25 studies ongoing or planned.

We have chosen to include only the studies about costs and benefits directly related to the WFD in the inventory. The types of policy orientated studies and reports related to the economic analysis of WFD implementation are the development of tools and instruments to perform cost-effectiveness analysis (CEA) and cost-benefit analysis (CBA). A large number of the studies and reports provide guidance on how to perform CEA, the valuation of measures etc. They also include a few practical examples, but are not always applied to river basins. Most of the studies in the inventory are about specific measures or specific regions/water bodies, and are generally not carried out at the national level.

The studies about costs of specific measures/regions concern mostly about methodologies for CEA for example, Germany, Latvia, cost-effectiveness of measures in a certain river basin for example, Belgium, and impacts of the WFD on a certain sector for example, WFD and Hydropower in Austria.

The studies on benefits include different valuation methods to monetize the (non-) market benefits from wetlands, cleaner water, recreational fisheries, flood protection measures…

The cost-benefit studies are either CBA studies of a specific measure, for example, dam removal, wetland restoration, fish migration and hydropower, or the valuation of different WFD measures in a certain basin, for example, Odense river basin, Cidacos river basin.

A large number of the studies on costs and benefits of specific measures, for example, wetland valuation studies, exist also but are not directly related to the WFD. Including these into the inventory is beyond the inventory scope, although they could be of some relevance to the WFD (see Section 8). As not all questionnaires were returned answered there may be studies in some Member States performed that are not aware of, although we believe that the most important studies are accounted for.

The Member States who answered the questionnaire survey all have a number of studies in the pipe-line (Table 4). The studies cover a wide range of issues concerned with WFD implementation, but at differing levels. Some MS need to start studies around methodology and data collection, whereas others are starting to develop cost-effectiveness analyses of different measures. There are also studies about costs and benefits of programs of measures planned. All Member States that answered the questionnaire indicate that they will do or try to do some kind of monetary estimation of the benefits, but most of them also have indicated that they will use other indicators as well.

For six member states that did not participate to the workshop nor answered the questionnaire (Bulgaria, Cyprus, Greece, Italy, Latvia and Romania) , we cannot judge to which extent they have also started economic analysis.

Table 3: Studies in the inventory already finished or ongoing

Member State°	Source of information	Nation-wide estimates WFD First exercises			Case studies/Specific measures		
		CBA	Costs	Benefits	CBA	Costs	Benefits
Austria	x*					X	X
Belgium	X				X	X	X
Bulgaria							
Cyprus	x**						X
Czech Rep.	x*						
Denmark	X						X
Estonia	x*						
Finland	X				X		
France	X		X	X	X	X	X
Germany	X				X	X	X
Greece	x**					X	X
Hungary	X				X	X	X
Ireland	x*					X	X
Italy	x**						
Latvia	x**					X	
Lithuania	x*						
Luxembourg	x**						
Netherlands	X	X	X	X	X	X	X
Malta	X					X	
Poland	x*						
Portugal	X					X	
Romania	x**					X	
Slovak Rep.	X						X
Slovenia	X						
Spain	X				X	X	X
Sweden	X				X	X	X
UK	X	X	X	X	X	X	X
Norway	x*						

° and Norway, that also participated to the workshop
INFORMATION PROVIDED: X = based on questionnaire, x* = information gathered via workshop or via other source (x**)

Table 4: Studies in the pipe-line in Member States who answered the questionnaire

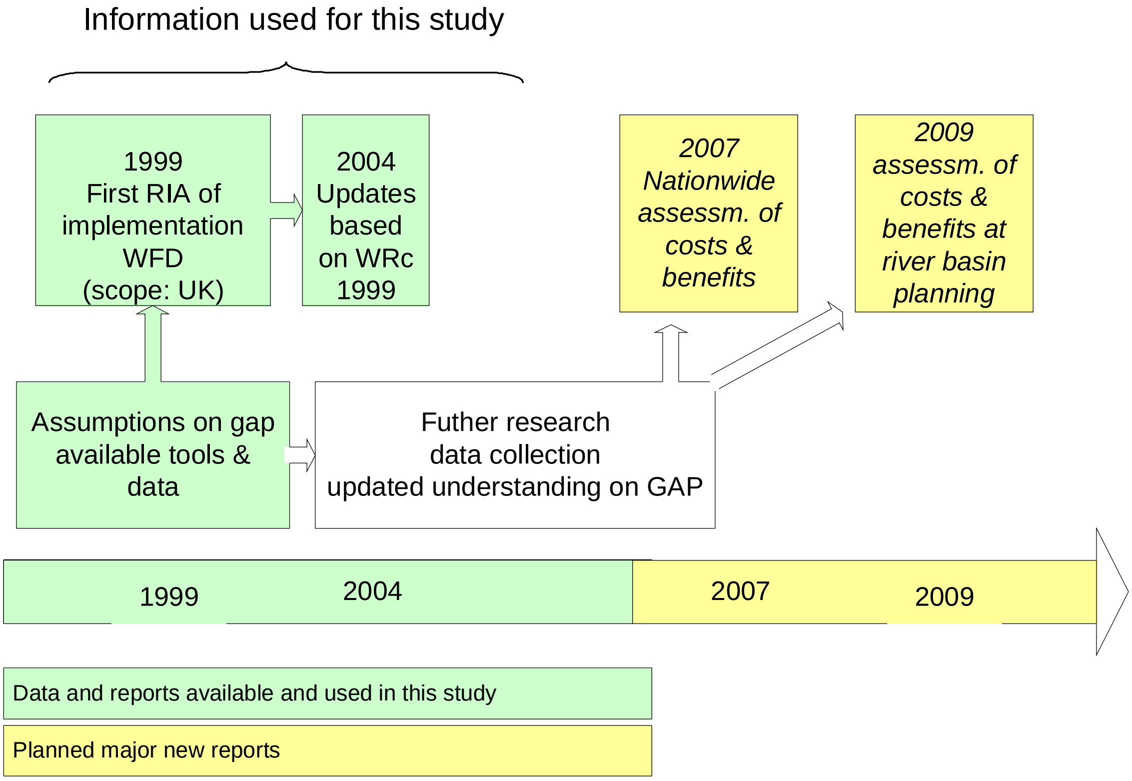
Member State	Costs	Benefits	CEA	CBA
Belgium	X	X	X	
Denmark	X	X	X	X
Finland				
France	X	X	X	X
Hungary	X	X	X	
Germany	X	X	X	
Luxemburg	x	x		x
Malta			X	X
Portugal				
Netherlands	X	X	X	X
Slovak Republic	X	X	X	X
Slovenia	X	X	X	X
Spain	X	X	X	X
Sweden	X	X		
UK	X	X	X	X

4.3 Available aggregated data are very first estimates

The first focus of our search for studies and data was related to aggregated studies at a national level, in order to have a more overall view. Only France, the Netherlands and the United Kingdom have taken the first steps towards a national assessment of costs and/or benefits of scenarios for implementation of the WFD. In addition, the UK and NL have compared costs against benefits in the context of their own requirements for cost-benefit assessment or regulatory impact assessment (Table 3). These studies and data are used in this report to illustrate approaches, identify factors and the orders of magnitude at a national level.

The data in the studies used reflect the understanding on costs and benefits at the moment of the study. They have to be considered as an input in the process of implementation of the WFD, rather than an estimate of the outcome of that process. These studies were and are the first steps in a longer process and they will be further developed in the coming years. A specific characteristic of this process is the interaction between information gathering and assessment and at local level (river basin, water boards, …) and nation wide assessment.

Especially the first studies that estimated costs and benefits for the UK are relatively old (1999-2004) and builds on assumptions that reflect the understanding and data availability of that time. Since then, assumptions have been updated and information and data has evolved, but no new nation-wide assessment of costs and benefits was published. In this report, we use the 'old series' of studies to get an insight of the factors driving costs and benefits. The data are rather illustrative, and do not reflect latest views and data. A new nation-wide assessment is planned later this year (2007) (Figure 11). The first study in the UK was the start for a long series of economic studies and debate. It involved a wide variety of different administrations and stakeholders and addressed a wide range of issues (methodology, data collection, consistency with existing guidelines and approaches, etc). The wide scope and need for collaboration is also illustrated in the fact that (part of) the research was organized through a Collaborative Research Programme for River Basin Planning Economics supported and steered by a range of relevant administrations and stakeholders. (see web address below for further information) These results will be input for an nation-wide assessments of costs and benefits later in 2007 [8]. The process aims at the development of tools and databases to facilitate the assessments of costs and benefits at the river basin level, as required in the river basin planning guidance by 2009 (Defra, 2006). In between, assessments of costs of specific issues have been made, e.g. in the context of the regulatory impact assessment of environmental quality standards (Defra, 2007).

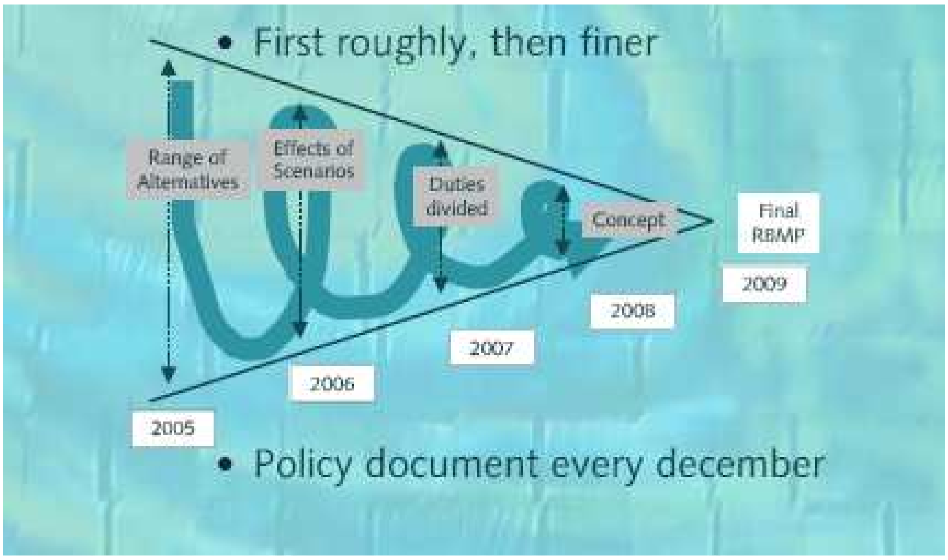


Source: Vito, based on information from Defra

Figure 11: Overview of major past and planned assessments of costs and benefits in the UK and information used in this study

The data on costs and benefits for the Netherlands are taken from the first strategic costs and benefits analysis for the WFD, and related documents, which is part of a longer term strategy with yearly reporting on progress in understanding of cost and benefits (see Figure 12).

[8] Defra, personal communications, 2007



Source: MVW, 2006

Figure 12: Illustration of the process and reporting periods for implementation of the WFD in the Netherlands.

During the surveying period for this report, there were no new aggregated data made available, but it was made clear at the consultative workshops that new information will become available throughout Europe from the ongoing studies. As we refer to aggregated sources for the UK, NL and France, the reader may check for updated information at the following places:

- new information on costs and benefits of implementation of the WFD in the UK: http://www.defra.gov.uk/environment/water/wfd/index.htm
- economic analysis for the support of WFD implementation in the UK: http://www.defra.gov.uk/environment/water/wfd/economics/index.htm
- overview and updated information for benefit assessment in France : http://www.economie.eaufrance.fr/rubrique.php3?id_rubrique=62 (in French)
- gives an overview of environmental and resource benefits in France and includes:
  - overview of different methods and guidelines
  - summary overview of results of studies for France
  - database with summary overview of each study
- overview of updated information on implementation of for the Netherlands, including updated 'Decembernotas' (in Dutch): www.kaderrichtlijnwater.nl.

Although it has to be recognized that the numbers themselves may be outdated, they will still provide useful insights in the factors that determine costs and benefits and the most important methodological issues. For the purposes of this report, we only use the numbers to give an idea about the order of magnitude of costs and benefits, and how they relate to the costs of current measures and measures in the pipeline.

4.4 Summary of key points

The overview of information illustrates that the WFD has given an incentive for economic analysis in the water sector, both for Member States with and without a tradition for this type of analysis in the water sector. However, this process of assessment of costs and benefits is still in the early phases, at least when it comes to results of studies that are both specific enough to be related to the WFD and generic enough to draw more overall conclusions at river basin or nation level. Only a few Member States have made first, nation wide assessments, as an input into an ongoing process of economic assessment.

Most Member States however have only recently started studies on assessment of costs and benefits of WFD implementation. The scope of these studies is wide, including cost-effectiveness analysis, assessment of benefits in monetary and other indicators and cost-benefit assessment. It is too early to evaluate to what extent all Member States will have the necessary tools and data to complete these ambitious objectives. The results from the first studies in UK, Netherlands or France illustrate the complexity of the issues and the need for further assessments.

The results of the early economic analysis studies carried out by France, the Netherlands, and the UK, are used to gain insights into the methods and tools used, the preliminary order of magnitude of costs and benefits estimates, the main underlying factors and the uncertainties that need to be accounted for at a particular time.

Published data need to be handled with care because they are only snapshots of the WFD process, based on assumptions or scenarios developed for specific purposes or objectives. These data and analyses are in the process of being updated and revisited in consultation with stakeholders. The information is therefore often very specific to the particular Member States (or regions), water bodies and issues.

5 FACTORS DETERMINING COSTS AND BENEFITS OF ACHIEVING “GOOD ECOLOGICAL STATUS”

5.1 Introduction

There is little specific and reliable information on the costs and benefits of the implementation of the WFD in Member States. Although Member States are obliged to draft river basin management plans by 2009, including an analysis of the cost-effectiveness of proposed measures to achieve the WFD targets, only very few Member States have drafted documentation on the costs and benefits of the implementation of the WFD. From this scarce information, still some conclusions may be drawn on which factors influence the costs and benefits of the implementation of the WFD.

5.2 Factors determining costs of achieving “good ecological status”

5.2.1 Introduction

In Section 3 an overview of the costs of environmental protection and the likely WFD costs is presented. A distinction is made between[9]:

- “business as usual” and/or “baseline costs”, which include already implemented measures as well as measures that should be implemented according to pre-WFD legislation; and,
- “additional costs”, which includes all costs on top of the baseline costs needed to comply with the objectives of the WFD.

In the following sections, the current information available on these costs and the underlying factors is assessed.

5.2.2 Current information

In most Member States of the EU, little is known on the current costs of water management. Many Member States still struggle to collect basic information on the costs of environmental protection, which is requested by the “Joint Questionnaire on Environmental Protection Expenditures” of Eurostat/OECD. In some of the EU Member States (Germany, France, Netherlands, the UK) detailed guidelines have been drafted on how to assess the cost-effectiveness of policy packages.

In the Netherlands, the entire United Kingdom and the region of Scotland, attempts have already been made to assess the full costs of the implementation of the WFD. In the UK , this assessment was already undertaken in 1999 (WRc, 1999), for Scotland a CBA was undertaken in 2002 (Andrews). As indicated above, these studies give some indications, but given that they are based on outdated assumptions, they provide information on factors rather than up-to-date information. For the Netherlands a first estimates of costs was published in 2005 (MVW, Decembernota 2005), with an update and assessment first assessment of benefits in 2006 (MVW, Decembernota 2006) (see also Section 4.3).

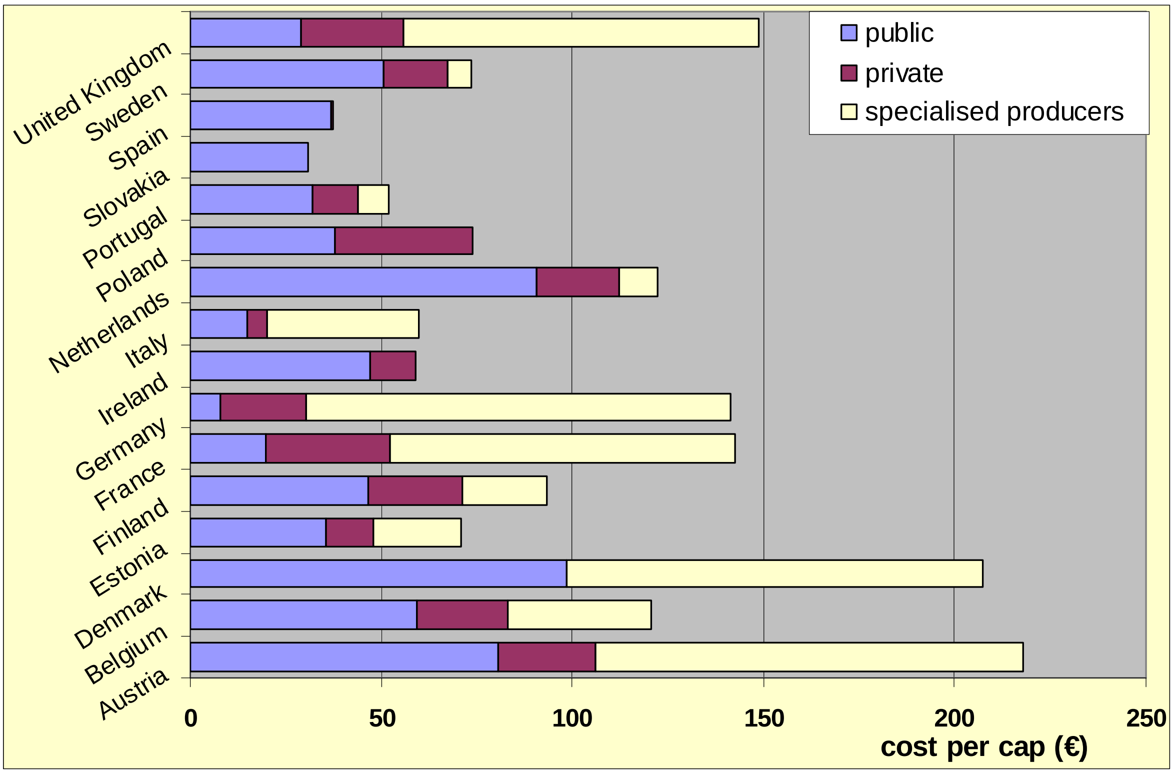
In addition, during the accession period for the new Member States, many studies were carried out on the costs of implementation of EU environmental directives. In some of these studies, some rough

[9] This is not necessary exactly the same distinction as is made in the legal text of the WFD, referring to “basic measures” and “supplementary measures” (see section 3.3)

assessments were made on the potential costs of the implementation of the WFD. However, as the methodologies used in these studies have a wide variation and basic data are often partial, no firm conclusions can be drawn.

5.2.3 Current efforts in water management

Incomplete information on water related environmental expenditures in various Member States can be derived from replies provided by the Member States on a voluntary basis to the Eurostat/OECD joint questionnaire (Figure 13). More recent is added for certain Member States to update or fill in gaps of at least some of the data.



source: based on Eurostat/OECD (replies provided by the Member States on a voluntary basis), with additional information from Metropolitan Consulting Group (2006), SCB (2004), Broniewicz (2006) and ESA (2006)

Figure 13: Annual per capita expenditure on water related environmental protection expenditures in selected Member States of the EU (mostly for 1999 and 2000)

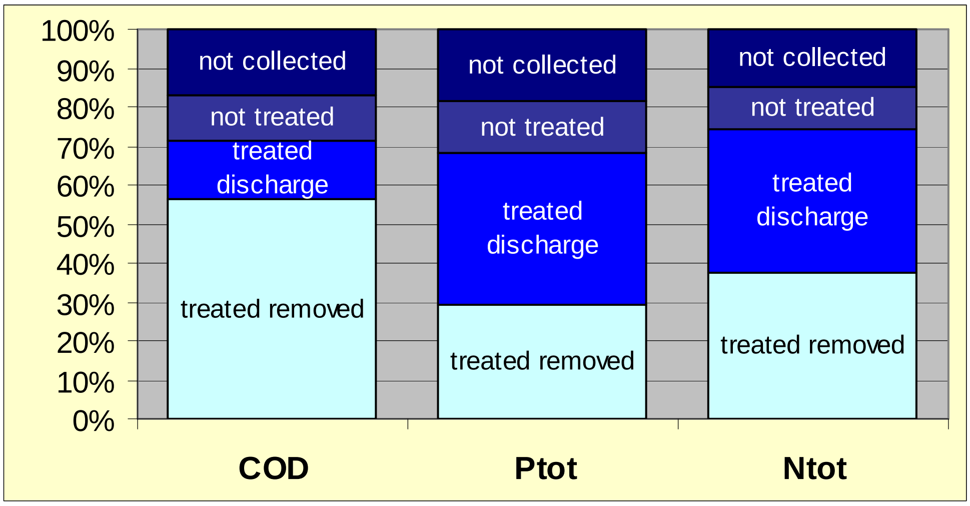
A subdivision is made between public expenditures (if, for example, sewerage and treatment are operated publicly), private (in case industry or agriculture have costs) and expenditures of so called "specialised producers" (these are (partly) privatised producers of (mainly) environmental services, for example, the exploitation of sewerage systems and waste water treatment plants). Figure 9 reveals large differences between Member States. Some of these differences are linked with differences in the level of implementation of water related policies. The recent Commission report on the implementation of the UWWTD indicates that there are large differences in the degree of implementation by Member States. The only Member States with high levels of compliance of close to 100% are Denmark, Germany and Austria (European Commission, 2007).

It seems logical that in Member States with a higher level of water services, more is spent on these services than for example the new Member States. But the large differences shown in Figure 13 may also point at differences in availability of statistical data (for example, the Eurostat/OECD data for UK reveal that only about € 15 per capita per year would be spent on (environmental) water management, other sources show much higher expenditures).

5.2.4 Costs of implementation of pre-WFD water directives in relation to the WFD

As explained earlier, the WFD implementation often goes side by side with the implementation of the pre-WFD water policies. Figure 14 gives a rough representation of these (existing) costs. The baseline or business as usual is important, as it gives the reference base for the comparison of additional costs of the WFD, and enables the delineation of costs. For example, for the new Member States it was estimated that compliance with the water directives of the EU (excluding WFD) a total investment of about € 16 billion was needed (by the mid 1990s) (Jantzen et al., 2000).

To illustrate the baseline situation, Figure 14 shows the situation regarding urban waste water in Poland during accession negotiations.

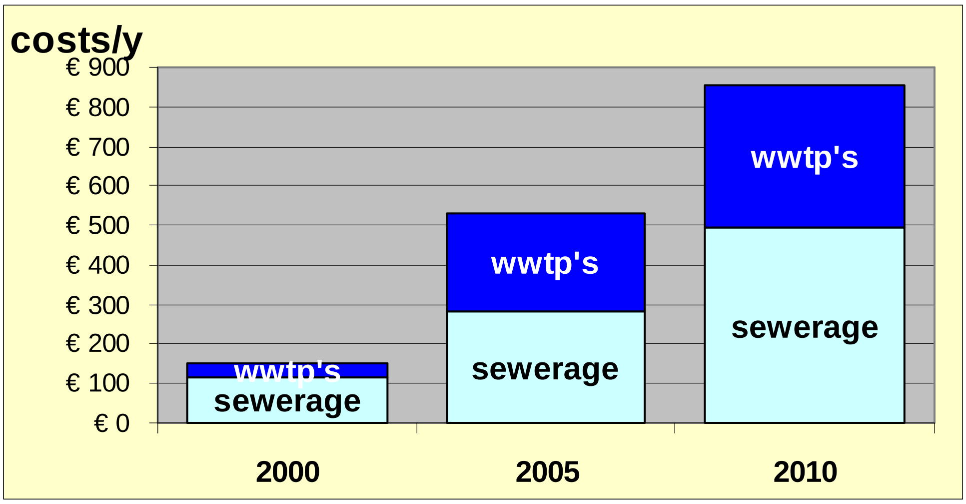


source: TME, 1998

Figure 14: Implementation of the urban waste water directive in Poland (1996), collection and treatment/removal of 3 substances in urban waste water (COD, P total and N total)

Figure 14 clearly shows that about 10 years ago, Poland had still a long way to go in the implementation of the UWWTD. Approximately 70% of urban waste water was treated, while 30% was not being treated (including direct discharges). It can also be seen that the treatment efficiency was low, at least for P-total and N-total. As a result, only for COD more than 50% of the total discharges were actually removed, for P and N much less. To achieve the standards of the UWWTD, additional infrastructure was needed.

Figure 15 shows that in the baseline scenario, due to the implementation of the UWWTD, additional annual costs will increase by almost € 900 million per year. Taking the additional costs into account, for a country like Poland the additional per capita costs of the full implementation of the UWWTD (which is included in the baseline) can be estimated to be € 23 (price level 2000).



source: TME, 1998

Figure 15: Estimated additional annual costs of the implementation of the urban waste water in Poland between 2000 and 2010, million €

As shown in the previous section and in "old Member States" such as France, Netherlands and Italy, there are still actions being implemented based on pre-WFD legislation.

5.2.5 Costs of the implementation of the WFD

Preliminary studies have been carried out on the costs of implementation of the WFD in a few Member States. Three examples will be discussed here[10]:

- an assessment for the UK (WRc, 1999), also referred to in the Third consultation paper on the implementation of the EC Water Framework Directive (2000/60/EC) (DEFRA/WAG (2003));
- an assessment for region of Scotland (Andrews (2002); and,
- assessments for the Netherlands (RIZA (2005), MVW 2005, 2006a; 2006b).

These studies have some common elements:

- costs as well as benefits are assessed;
- a top down approach is used, in which for the different sectors involved an assessment has been made on the actions to be taken and the expected costs; and,
- use of different scenarios to express uncertainty concerning the implementation gap (except in the Scottish study).

A major common element is that all the studies provide only preliminary results, indicating a possible direction in which costs may develop. For example, the UK study is already 8 years old and was conducted before the WFD came into force. In addition, the Scottish study is also dated but is in the process of being updated. So, although it is tempting to compare the results of these 3 studies, this would not be useful as the number of observations is small and the results are not comparable. Moreover. the way in which the results of the cost analyses are presented in the various studies, also poses some problems. In the study for the entire UK (1999) and the region of Scotland (2002), a PV is accounted, summing and discounting the costs over a period of 40 years with a 6% discount rate. In the RIZA 2005 study annual costs are estimated, whereas the MVW (2006b) study presents the

[10] Also a study for Zagyva-Tarna River Basin Management Plan in Hungary has been reviewed, but this interim report does not yet produce total cost estimates (DHV/Atkins (2006)).

PV for the summed and discounted costs over a 100 year period with a 4% discount rate. Even if a comparison is to be made, this is not made easy by the way the results are presented in the original studies. Therefore, the comparison of the studies is limited to the expression of the PV of the costs per inhabitant.

5.2.5.1 Case study: the entire United Kingdom

In 1999, in the UK a first assessment was made of the costs and benefits of the implementation of the WFD. The study addresses the so called "gap" between the implementation of the pre-WFD directives and the additional requirements of the WFD:

- administrative, planning and monitoring gap (to be discussed in the section on administrative costs and benefits);
- water status gap.

In the baseline scenario (business as usual) two approaches have been followed:

- a pessimistic approach concerning the further implementation of pre-WFD legislation on water status (no improvement);
- an optimistic approach, assuming improved water quality.

Also for the implementation of the WFD directive two options are assumed:

- minimal requirements concerning ecological and chemical status;
- maximal requirements.

Comparing the Baseline with the WFD implementation scenario, two assessments have been made:

- a minimal gap analysis (comparing optimistic baseline, with minimal EU requirements)
- a maximal gap analysis (comparing the pessimistic baseline with the maximal EU requirements).

The results of this top down cost assessment are shown in Table 5.

Table 5: Estimated costs of the implementation of the WFD in the United Kingdom carried out in 1999, in million £, Present Value at 6% (over 40 years)

Cost-benefit item	smallest gap	largest gap
Point source municipal	1,328	5,059
Point source industrial	403	1,522
Diffuse sources	1,198	3,463
Rivers Habitat	96	725
Low flows	27	273
Other	24	24
Water Status total	3,076	11,066

Note: these estimates reflects the understanding of costs of the WFD for the entire United Kingdom in 1999.
Source: based on WRc (1999), page 164

The results show, that the total discounted costs are considerable, but also differ largely in the two assessments, expressing the uncertainty of the assessment. Largest costs are linked with municipal point sources (43-46%), diffuse (agricultural) sources (31-39%)and industrial point sources (13-14%). Measures to improve the ecological quality of water cost less than 10% of total costs. Per inhabitant, the PV of all costs can be estimated at between £ 50 and £ 185 per capita (≈ € 75 - € 275).

5.2.5.2 Case study: the region of Scotland

In the study for the region of Scotland (Andrews, 2002), the costs have been assessed on basis of a top down gap analysis. The result of this analysis, which describes the difference between the Business as Usual case and the requirements of the WFD, is a list of quantified gaps (for example: "10 major hydro schemes requiring measures under the WFD but aiming at good ecological potential rather than good ecological status" or "625,000 (500,000 * 1.25) ha of land area requiring measures to reduce diffuse pollution of surface and groundwaters") and an assessment of costs, based on the gap analysis.

Table 6 summarises the total costs in Scotland for the implementation of the WFD (as Present Value, with a discount rate of 6% and over the period 2002 – 2042). It should be stated that after these estimates were published, "Scotland has since instituted new policy and regulatory regimes", and currently it is believed that the cost estimates are probably an overestimation (DEFRA, 2007[11]).

Table 6: Estimated costs of the implementation of the WFD in the Scotland carried out in 2002, in million`£, Present value at 6% (over 40 years)

Sectors	Subsectors	Additional costs WFD (PV)
Agriculture	Irrigators	17
	Arable and livestock	253
Industry	Food and drink	n.a.
	Pulp and Paper	9
	Mining	103
	Forestry	16
	Fisheries	15
	Power	115
	Water services	146
	Industry other (PHS/PS)	n.a.
Public	Modifications (flood defence)	76
	Contaminated land	17
	Urban drainage	33
Households	Rural sewage	21
Total		838

Note: these estimates reflects the understanding of costs of the WFD for the region of Scotland in 2002.
Source: Andrews (2002), Table 4.2

The results show that in the region of Scotland the costs of the implementation will also be considerable (almost ₤1 billion, or € 1.5 billion). Per capita, the discounted costs are ₤ 164 (≈ € 250). This figure is comparable with the "high" assessment for the entire UK.

5.2.5.3 The Netherlands

In the Netherlands, there is an ongoing effort in the framework of the preparation of a CBA for the WFD, which is still to be considered as very initial (see also Section 4.3). In 2005, the total costs of the implementation were assessed, distinguishing the following costs:

- costs of water policies as of today (current level of costs);
- additional costs due to policies in pipeline; and,
- minimal, average and maximal implementation of the WFD.

The costs have been assessed using a top-down approach, making rough estimates for various types

[11] Defra, personnal communication, 2007

of measures (more or less comparable with the approach in the UK).

Table 7: Estimated annualised costs of the implementation of current and policies in pipeline for water related directives, and estimated additional costs for minimal, average and maximal implementation of the WFD carried out for the Netherlands in 2005, in € million

			additional costs		
Types of measure	**current**	**PIP**	**minimal WFD**	**average WFD**	**maximal WFD**
Sewerage	1050	780	0	0	0
WTTP	780	0	75	200	275
Industry	380	0	75	80	125
Agriculture	520	220	180	190	200
Morphological measures	240	230	75	275	475
water soils	40	160	0	25	75
drying soils	40	60	0	0	0
Total	3050	1450	405	770	1150

Note: these estimates reflects the understanding of costs of the WFD for the Netherlands in 2005.
PIP = projects in the pipeline
Source: based on MVW, 2005.

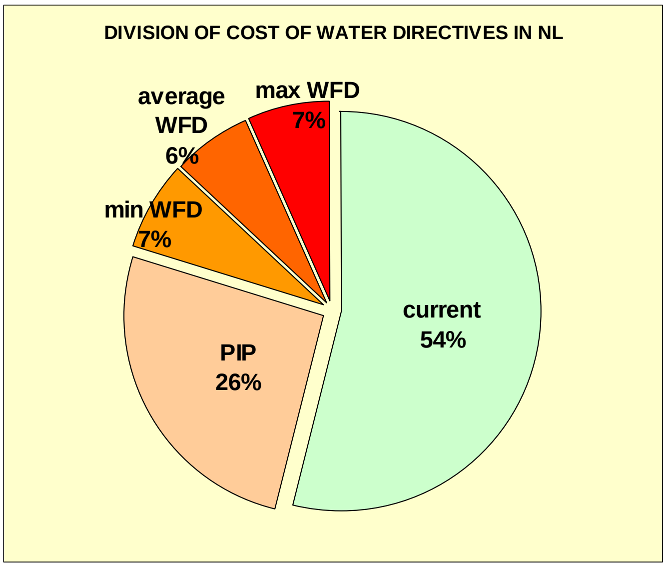
The results of the assessment show a few interesting issues:

- the current costs and costs of policies in pipeline dominate the picture;
- the costs of the WFD are relatively limited compared to the costs in the "baseline", which include both "current" and "policies in the pipeline" costs

As the figures in the table are annual costs, these cannot easily be compared with the results of the studies for the entire UK and the region of Scotland. If the same calculation rules as in the UK and Scottish studies would be applied on the above results, the PV of total costs over 40 years with 6% discounting), the PV can be estimated at between € 6.2 billion (minimal WFD) to € 17.6 billion (maximal WFD). This is between € 375 and € 1070 per capita. This is about 4 times higher than the preliminary assessment for the UK!

Baseline costs (current implementation of water polices, and "policy in pipeline") dominate the overall costs of water quality directives in the Netherlands (Figure 16)[12].

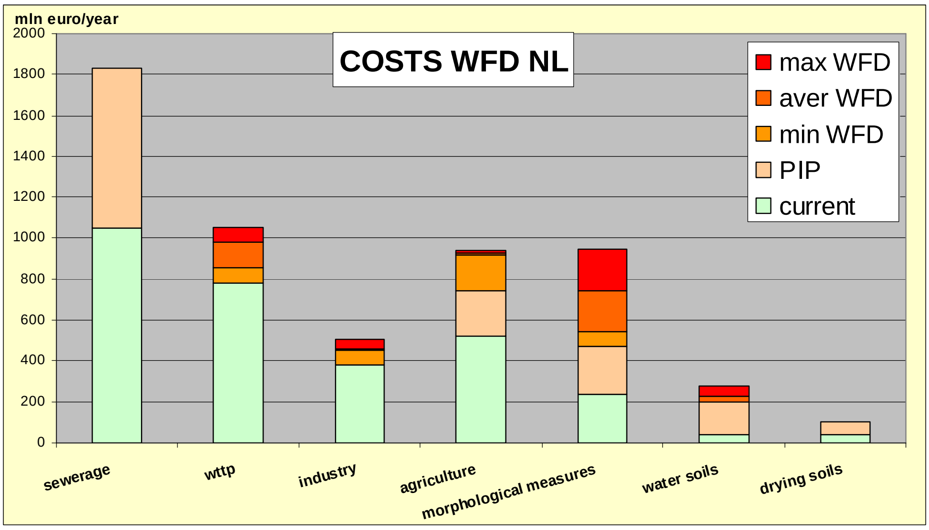
[12] It should be stressed that the assessment is initial, based on preliminary top down cost estimates and by no means the final assessment of costs of the implementation of the WFD in the Netherlands, which is an ongoing process.



Note: these estimates reflects the understanding of costs of the WFD in the Netherlands in 2005.
Source: based on MVW, 2005.

Figure 16: Division of estimated costs of water related issues in the Netherlands (Current costs, costs of policies in pipeline, Water Framework Directive)

Figure 16 shows a possible division of all (annual) costs of water related legislation. Of the potential 100% costs, currently slightly more than 50% is already implemented. The implementation of "Policies in Pipeline" would add some 50% to this, whereas on top of that the WFD may add almost the same annual amount (if implemented to the maximum). Costs are then subdivided over different sectors (Figure 17).



Note: these estimates reflects the understanding of costs of the WFD in the Netherlands in 2005.
Source: based on MVW, 2005

Figure 17: Division of annual costs of water related policies over different sectors in the Netherlands, 2005.

It can be seen in Figure 17 that most costs of the WFD implementation in the Netherlands would be linked with morphological measures, waste water treatment plants and agriculture.

Recently, an update has been published on the costs of the implementation of the WFD in the Netherlands (MVW, 2006b). This update is based on a “bottom up” approach. Each of the 7 water regions in the Netherlands has provided cost-estimates for their region (based however on a top-down approach). The total discounted costs[13] of the implementation of the WFD between 2009 and 2027 were estimated at being between € 7.3 billion (limited objectives, phasing of measures) and € 26.6 billion (maximal objectives, no phasing). If adjusted to 40 years and 6% discount rate, the PV of the costs can be estimated at roughly between € 4.5 billion and € 16.6 billion. This would be between € 275 to € 1000 per capita.

In comparison with the estimates for the UK Wales and Scotland, the Dutch estimates are high, but one should be aware of the differences in the way the PV has been calculated (in Netherlands a 4% discount rate over 100 years is applied, in UK/Wales and Scotland a 6% discount rate over 40 years). If similar discount rates are used, for example, the Scottish costs per capita would be somewhere in the range of € 400 per capita, quite close to the lowest estimate for the Netherlands.

Compared with the “top down” assessment of 2005, these estimates are somewhat (about 10%-30%) lower[14]. Although, the cost-estimates differ from the earlier “top down” assessment, the general picture has not changed much. For some sectors however, there are quite large differences, especially for the agricultural sector. Whereas the early estimate was in the range of € 180 - € 200 million per year additional costs for the agricultural sector, the new estimate of 2006 excludes additional costs for the agricultural sector. The main reason for this is that measures concerning phosphate are now assumed to be part of “pre WFD measures”[15]. In 2007 some pilot projects will be carried out to obtain more information on effectiveness and costs of additional measures for the agricultural sector.

5.2.6 Uncertainty

Cost assessments for the WFD are preliminary. There are various factors that make it difficult to assess costs of the implementation of the WFD. A recent study shows that estimated costs and realised costs often can differ by several factors (see IVM et al., 2006). On top of factors discussed in that study, for the WFD some additional factors make it even more difficult to correctly assess the costs of implementation:

- although the objectives of the WFD are relatively simple (good chemical and ecological quality of water), an operational approach towards achieving these objectives may be difficult as it is difficult to set objective targets;
- Current knowledge of the effectiveness (and the way to express effectiveness) of measures makes it difficult to make an integral assessment of cost-effective measures; and,
- Cost may also depend on the operational way of implementation: regulatory approach costs are in many cases assumed to be higher than market based approaches. For example, in the US some results have been achieved with a more cost-effective way of dealing with storm water by tradable permitting systems. In the context of the development of tools to improve the costing of measures, the UK collective research programme[16] has developed indicators to

[13] The NPV is calculated on basis of a 100 year period and a discount rate of 4%.
[14] An exact comparison is not possible as the 2005 figures are reported as annual costs, whereas in the assessment of 2006 the NPV has been calculated
[15] This was not the case in the 2005 assessment.
[16] Collaborative Research Programme for River Basin Planning Economics, http://www.defra.gov.uk/environment/water/wfd/economics/index.htm

account for cost differences from different implementation regimes or delivery mechanisms (Metroeconomica, 2006).

5.2.7 Analytical review

The data presented in this section on costs of the implementation of the WFD are preliminary and are by no means the final cost-estimate. The limited examples of cost estimates however show that the implementation of the WFD will most likely come at quite substantial costs to society. They also show, that apart from the implementation of the WFD, Member States most likely are also occupied with the implementation of the pre-WFD legislation, also leading to considerable costs. The additional costs of the WFD, compared to the business as usual scenario (which includes also the costs of policies in pipeline) can be roughly estimated at some 5 – 30% (this estimate is based on the example for the Netherlands).

The three studies reviewed have in common that an analysis has been made of possible measures that can be taken by different sectors. Assessments have been made of the magnitude of measures and the costs linked to the expected implementation. This analytical framework proves to be effective in identifying the major cost drivers for the WFD implementation. Additional efforts are however needed to improve the estimates of the costs linked with bridging the "WFD implementation gap".

The preliminary results show that the sectors that are likely to be affected by the WFD are agriculture (31-39% of total WFD costs in UK, 33% in Scotland, 25% in the Netherlands (2005 assessment)), the waste water sector (43-46% of total costs in UK, 18% in Scotland, 20-25% in the Netherlands), industry (13-14% of total costs in UK, 31% in Scotland, 10-20% in the Netherlands) and the public sector that implements measures to improve ecological status (4-9% of total costs in UK, up to 15% in Scotland and 19-41% in the Netherlands).

Based on data for the Netherlands, the additional costs of the WFD, compared to the business as usual scenario (which includes the current costs of water quality policies but also the costs of policies in pipeline) can be roughly estimated at some 5 – 30%[17]. As for other Member States such a comparison cannot be made, no conclusions can be drawn from this, other than that the WFD will in most cases add some costs to the baseline.

In case "pre WFD" measures in a Member State would also lead to full compliance with the WFD, the WFD would not add costs to the baseline. In case "pre WFD" measures would by far not be enough to achieve the objectives of the WFD, additional costs can be linked with the implementation of the WFD.

For all Member States, the costs may be 10s of billion euros (discounted costs) or € 100 or more per EU citizen[18]. A more precise figure cannot be estimated at this moment for several reasons:

- Current studies show preliminary results, in an ongoing process of policy definition and implementation. The cost estimates so far only give very rough indications of the actual costs of the WFD;
- even within consistent national study frameworks the range between low and high estimates is large (about a factor 3); and,
- comparing the results of the studies for the Netherlands and the UK, the results vary also by a factor 4 (possibly indicating either an underestimation for the UK or an overestimation for the Netherlands).

[17] Ideally, a better estimate would have been possible, if other member states (for example UK) also would provide reliable estimates on the costs of the costs of the "baseline" costs ("pre WFD costs").

[18] This is based on the observation for only 2 Member States (UK and NL), which represent about 15% of EU population, for these 2 countries total discounted costs are estimated between € 9 - € 30 billion, per capita between € 75 and € 1000.

5.2.8 Evaluation and lessons learned

The analysis shows that the main factors influencing the costs of the implementation of the WFD are:

- Baseline scenario for GAP analysis: In theory, the costs of current water policies, additional costs of policies in pipeline (which may be considerable), and the costs of the implementation of the WFD can be separated, and thus a “level playing field” for comparison purposes established. However, in practice, this will be hard. In each Member State, all the cost components of water policy, will overlap in the coming period of 10 – 20 years, and some costs that should be regarded as policies in the pipeline may be mixed up with actual WFD costs.
- GAP analysis and specification of WFD objectives: The way targets are defined and interpreted, especially for “ecological good status”, make it difficult to assess which set of measures is effective (due to complex ecological relations which are by far not yet fully understood). Targets may also be influenced by the results of assessing the Costs and Benefits of WFD related policies (for example, identification of excessive costs);
- The WFD requires a cost-effective implementation of policies. However, the way in which cost-effective approaches will be implemented is uncertain. Uncertainty of effectiveness and thus cost-effectiveness of (individual) measures makes it difficult or impossible to even give a rough estimate of the total costs of the implementation of the WFD. Case studies are too scarce to draw conclusions on.
- Policy instruments / delivery mechanisms: regulatory or market based. The instrumentation of the implementation is also a decisive factor on the costs that actually can be addressed to the implementation of the WFD.

5.3 Factors determining benefits of achieving “good ecological status”

5.3.1 Introduction

In Section 3 an overview of the benefits of environmental protection is presented. In the following sections the current information available on the benefits and the underlying factors are assessed.

5.3.2 Current information

The benefit categories and assessment methods are described in Section 3.3. The section identifies a bottom-up and a top-down approach to apply these methods for the benefits assessment of the WFD. In this section we describe and analyse further the factors determining the benefits, building on the results of available studies. In the first part, we will focus on the different benefits categories, using examples that are not necessarily linked to the WFD.

Table 8 gives an overview of the information used. It illustrates that information on nationwide studies of implementation of the WFD that has been identified or received is limited to three countries (Netherlands, the United Kingdom and France.) All these studies are first estimates, and were made in different contexts, serving different purposes.

Table 8: Overview of the main information sources used for benefit assessments of the WFD

Study	Relation with WFD	Approach	used as input for CBA
NL 1, 2003	GES	Top down	
NL 2, 2006	3 ambition levels	Bottom-up	X
UK 1, 1999/2003	Small-large GAP	Bottom-up	X
UK 2, 2003	Additional measures	Bottom-up	X
Fr; 2005	GES	Bottom-up	
EC, 2000	Pre-WFD	Bottom-up	
Literature	Specific measures	"Top-down"	

- The UK1 study (WRC 1999 and updates) provides information on the regulatory impact assessment (RIA) of the transposition of the WFD in 2003. It builds on a large body of specific valuation studies in the UK. In Section 4.3 it is explained that this study is an input to the WFD process and that the results will be revised later this year (2007). The results are further discussed in table 9 and the use in the context of the RIA is documented in Table 17.
- The UK2 study (Environment Agency, 2003) relates to the assessment of the benefits of additional measures considered by the water bodies for their investment programme (PRO4). The benefit estimates were used by the UK Environmental Agency to evaluate the benefit-cost ratio of these additional measures. Although not strictly related to the WFD, this information is useful because some of the measures are similar to the WFD requirements. In addition, it is one of the few occasions in which cost-benefit analysis of water related environmental policy has been used at the national scale so that it shows both the possibilities and the limitations of such exercises. The use of the results is further documented in Figure 20.
- The NL1 study (Brouwer, 2003) uses a top-down questionnaire approach to ask the inhabitants of the Netherlands how much they are willing to pay for the improvements to be expected from the WFD. Similar studies have been made for groundwater (Brouwer, 2006) and sedimentation issues. The results are discussed in Table 9 and the arguments in Table 13.
- The NL2 study (MVW, 2006b) discusses a bottom-up study of the benefits of three scenarios of the implementation of the WFD in the Netherlands, as an input into the nationwide cost-benefit analysis. It builds on guidelines and key numbers for assessment of environmental impacts in CBA. BOX C gives a more detailed description of steps and tools used in this study, as well as their results. The results are summarised in Table 9.
- In France, a rough estimate of potential benefits of the WFD was made in 2005, in order to set priorities for future studies on benefit assessment (Chegrani, 2005). The study builds on a literature review for France and the benefit assessment guidelines (BAG) from the Environment Agency of the UK (see study UK 2). The results are also discussed in Table 9.

Because these studies do not cover all the benefit categories and Member States, information from literature and other impact assessments will be used to complete the picture. There is a wealth of case studies that illustrate the environmental benefits of specific measures (wetlands, limiting eutrophication, more efficient water use and water quantity management). These benefits are described and discussed in Sections 8 and 9. Most of these studies have in common that they are specific points along a trajectory towards a better understanding of the benefits of the WFD, to be used for the selection of the Programme of Measures. They should be seen as inputs into this process, not as final products of it.

As the information is limited to a few of the old Member States in NW-Europe, the results of these studies are unlikely to be representative for the EU as a whole, but are very good illustrations of the type of benefits and the analysis of the factors that determine their magnitude. The analysis of these factors in the next paragraph will also illustrate which approaches and assumptions had to be chosen in order to make these first estimates.

Scarcity rents: The studies mentioned in Table 8 do not really address scarcity rents. In some of the cases, water quantity measures will improve environmental conditions, and these are accounted for in the environmental benefit studies. So far, scarcity rents have especially been discussed in the context of irrigation (see Section 9).

5.3.3 Generic overview of total benefits

5.3.3.1 Introduction

The first studies that are available indicate the order of magnitude of benefits to be expected, the most important factors and remaining difficulties. Table 9 gives an overview of studies and their results. All results are recalculated in order to present results on a common basis, euro per household per year, which is a common indicator to express benefits of environmental improvements. The details of the calculation are documented in annex. As discussed above, these studies are built on assumptions on both the status of water bodies in the reference scenarios and/or the standards which are needed to deliver good status. These assumption reflect the state of understanding of these issues at the time of the study, which may have been further developed since then. We therefore summarise the results to give the reader an idea about the order of magnitude. In the following sections, we will rather focus on the driving factors than on the scale of the benefits.

Top down studies: A first set of studies use a top-down approach in which European citizens are asked how much they are willing to pay to ensure water systems reach good ecological status or an important improvement of water status. Case studies for Northern Ireland, the Netherlands and France indicate that this willingness to pay varies from 15 to 100 € per year and per household for improvement of surface and ground waters. The main assumption underlying these studies is that the questionnaires can describe the impacts of WFD objectives and measures adequately and that people have a good understanding of the all the additional “goods and services” that could improve the ecological status of water systems. It may be difficult to single out the benefits from WFD compared to improvements of e.g. water quality and landscape from other policies or directives (pre-WFD, cross compliance under the CAP, nature developments under NATURA 2000,…) More studies are in the pipeline based on this approach (e.g. from the UK).

Bottom-up studies estimate the benefits of a specific set of measures building on impact assessment to analyse the physical effects and use monetary data from literature to monetise these effects. The impact assessment can be simply based on some assumptions (France) or can be more sophisticated (UK 2, NL 2). For France, a first estimate has been made of the order of magnitude of the likely benefits of reaching Good Ecological Status (GES) for the entire country. The environmental benefits are estimated to be 45 euro/household/year but uncertainties are large as the main purpose of the exercise was to identify priorities for further research. The result is dominated by the Willingness to pay (WTP) to protect groundwater (see further). In the UK, the studies for England and Wales result in benefits ranging from 37 to 90 €/household/year whereas the estimates for Scotland range from 90to 230 €/household/year.

In the Netherlands**,** a first study on the benefits of different ambition levels illustrates that benefits of a more ambitious plan will be much higher compared to the minimum ambition level (MVW, 2006b). Estimates vary from 1.6 billion to 6 billion euro[19] depending on the level of ambition (a factor three between the low and strong ambition level). In addition, minimum and maximum ranges are estimated for each GAP scenario, adding -20 % to + 20 % to each value (MVW, 2006) . These estimates correspond to a yearly benefit of around 10 to 30 euro per household for the three implementation scenarios (low, medium, high ambition levels).

Table 9: Overview of the range of benefit estimates from different studies

	Country, Scope	Results €/hh/year	Method	Source *
	UK			
12	Engl/Wales, Impl. WFD, GES	~ 37 *	bottom-up	UK 1 , 2003 (2)
	idem	~ 65 – 90	bottom-up	Env. Agency (2)
3	Scotland, Impl. WFD, GES	~90 – 160 - 230	bottom-up	Hanley, 2001(3)
	NL			
4	Benefit GES	~ 90 - 105	top-down	NL 1, 2004 (4)
5	CBA : 3 ambition levels GES	~ 10 - 30	Bottom-up	NL 2, 2006 (6)
6	Ground water protection	~ 35 - 72	top-down	Brouwer, 2006 (7)
	France			
7	ground water/water supply	~ 40	top-down	Fr. 2005 (5)
	GES surface waters	~ 5	bottom-up	Fr, 2005 (5)
	Subtotal all categories	~ 45	mixed	Fr, 2005 (5)

* Source refers to the list of studies mentioned in Table 8.
Note: Numbers have been recalculated from original data to current prices (2006) in € per household per year, taking into account exchange rate, inflation, number of households and estimating annualised benefits based on estimates of present value over a period of time. Sources and assumptions are documented in Annex 1.

5.3.4 Overview of the factors that determine benefits

To have a better understanding of the results mentioned above, it is necessary to understand the factors that affect the total value of the benefits, and how they are assessed in practice. We distinguish between six factors :

a) GAP analysis and magnitude of the improvement of the status;
b) scope : water bodies and their use
c) scope: study approaches number of benefit categories assessed
d) number of people affected;
e) preferences, willingness to pay, and income of the people affected;
f) avoided costs for water management or other sectors; and,
g) aggregation of the results over time and over different water bodies

A good understanding of the factors is important for both the interpretation of the results of available studies and for the design and priority setting for new studies.

5.3.5 GAP analysis and magnitude of the improvement of the status

The total benefit will reflect the magnitude of the improvement between the reference situation and

[19] Present value of benefits over a 100 year period, for measures introduced between 2009 an 2027. see box A for details

the envisaged status. The scope of the GAP closed is likely to differ a great deal between Member States.

Table 10 summarises the indicators, definitions and assumptions to define GAP closure and estimate the related benefits. For France, as a first approximation, it is estimated that WFD will affect 30 to 60 % of the water bodies that aim to reach the ambition level of GES . The study for the UK uses a small and a large GAP that starts from different reference levels (based on different assumptions about yearly improvements), reaching different end points (ecosystem class 2 or 3). Consequently, in the large GAP, a longer length of rivers will be improved, for both water quality and morphology. The study in the Netherlands assumed that all surface waters would benefit from the WFD implementation and makes a distinction between the three ambition levels (moderate, high, maximum).

Table 10: Factors that describe the GAP and ambition levels

MS	**Indicators**	**GAP definition**		
		small		***large***
France	number of water bodies	30%		60%
	end status	GES		GES
UK	km length improved			
	chemical	11%		39%
	morphology	17%		38%
	end status	RE 2		RE3
NL		Moderate	high	maximum
	number of water bodies	100%	100%	100%
	end status	Moderate	high	maximum

GES = good ecological status.

RE2, RE3: River ecosystem class based on a classification system in 5 steps.

5.3.6 Will benefits continue to increase as water status improves?

Literature suggest that benefits will increase if environmental status improves from fair to good or to very good. The differences in benefits between the small and large GAP in the UK study are a factor 4 and relate to both differences in quality and km river length. It is to be expected that benefits will be larger for river basins or water bodies that have at current a poor or very poor status (this is illustrated in Table 11). But also river basins with already a fair or good status are likely to gain benefits from further improvement.

It is nevertheless true that in many cases the high health benefits from the construction of sewage and waste water treatment infrastructures have already been reaped. If the large amounts for replacement investments are accounted for on the cost side, one would also need to account for these types of benefits, which may be huge but difficult to estimate.

Table 11: Value to householders for improvements in water quality for three scenarios

from very poor to	Description of scenario	WTP per household per year (€)
Poor	Small improvement - a few species of fish, such as roach would begin to be seen in the river, and more plants such as reeds and rushes would grow in the water and along the river edge. Water suitable for boating.	5,4
Medium:	Medium improvement - water quality is now improved such that some game fish species such as perch would migrate up the river and the number and types of insects such as mayflies and dragonflies, which live in and around the river would increase. These would attract greater numbers of birds and other wildlife. Water good enough for fishing as well as boating.	8,1
Good:	Large improvement – the water quality in the river is restored to what is was before the industrial revolution. i.e. with trout and even salmon. Water suitable to paddle and swim in.	13

Source: Georgiou et al., 2002

The bottom up study for the Netherlands concludes that the benefits between a low and high ambition level are substantial, but that the marginal benefits of further improvement (a maximum scenario) are minimal (whereas the costs double). This suggest that the law of declining marginal returns may apply for higher ambition levels. Of course, this depends very much on the definition of the "high" and "maximum" scenarios and which assumptions are made for the impact assessment. The lower benefits from the maximum scenario are to be explained by the low impacts of these measures, not on the valuation of the impacts. In addition, it has to be noted that in the maximum scenario there is an important negative impact on commercial fishing due to lower concentrations of nutrients in the river. Furthermore, the study was a first attempt to identify, assess and value the benefits and both the impact assessment and the valuation part of the benefit study are under review. Consequently, one cannot draw definitive conclusions from the current results.

5.3.7 Water bodies affected and relevant benefit categories.

The relevant benefit categories of improving water status will be very context specific and relate to:

- the natural characteristics of the river, that will determine the type of goods and services it can delivers: the relevant recreational benefit categories will be different for a river with wild water that attracts sport fishing from a calm river that runs through the city or from a lake suited for swimming. The same reasoning goes for other benefits like regulation functions, importance for biodiversity preservation, etc. The benefits may be already different for upstream and downstream area's for the same river.
- how the river interacts with the people living nearby and further away: the relevant benefit categories may be different for a similar type of water body if is located in a densely populated area or a more remote one. It will also depend on the proximity of other water bodies that deliver similar goods and services.

This variety and the a wide range of potential benefit categories makes it difficult to draw general conclusions from the existing literature on the relative importance of different categories. In addition, the comparison of relative importance of benefit categories is hampered as studies differ in the number of benefit categories assessed and assumptions used. A comparison of the scope of three bottom-up studies for the UK, NL and France illustrates that studies are seldom complete in the sense that they address all the potential benefit categories for all water bodies, and that they suggest that different categories may dominate.

This variety leads to three important conclusions:
1. The first is that benefits are context specific and one has to consider the broad range of potential benefit categories. This conclusion is explained using quantitative and qualitative data from different available studies.
2. A second conclusion is that available studies are likely to be incomplete, which leads to an underestimation of the total benefits (unless the categories assessed are overestimated). This limitation needs to be accounted for in the use of the results.
3. Third, one can not use data or results from context specific studies and use them in other contexts. The use of these data will require benefit transfer adjustments, whereas there are currently no practical guidelines available to do this in the context of benefit estimation for the WFD.

5.3.7.1 Overview of benefit categories in available bottom up studies.

Table 12 gives an overview of the benefit categories considered in the three bottom-up studies, and their relative importance. It suggest that all of them are incomplete, in the sense that for some benefit categories no data are available. As these types of studies typically build on available data, it is logical that they are incomplete. As an example, the first nationwide studies for the UK was rather detailed for rivers (km river length affected), but did not include – or was incomplete – for other water bodies, either because there were not enough studies to build on (estuaries and especially lakes) [20], or it was unclear to which extent the WFD measures would affect these water bodies (groundwater, coastal waters). Nevertheless, in the process of benefit assessment, it may be very useful to start from the full list of potential impacts, and try to give an indication of the relative importance, even if this requires other methods etc. It is better to give some indication of potential importance. A benefit category may not have been assessed because it is thought not to be important or because the data or tools for impact assessment and monetisation are not available. It is as important to illustrate the level of completeness when presenting the data on benefits. Table 17 gives an illustration taken from the UK RIA (regulatory impact assessment) whereas the Section BOX C (p. 68) gives an illustration taken from the strategic cost-benefit assessment of the Netherlands.

5.3.7.2 Discussion of different benefit categories.

U*se benefits:* Table 12 shows the relative importance of user benefits, and the different categories. . We listed the protection of groundwater bodies in France as a separate category as it reflects both use values (drinking water) and non-use values (option value for water production). shows that it is more likely that user benefits will dominate, rather the non use values. The importance of use values indicates that it is crucial for water managers to identify the users and potential beneficiaries of protection measures. It is remarkable that in most countries very little data are available related to the use of water bodies, which illustrates that water managers can hardly have a good understanding of who the potential beneficiaries of their projects are. Improving on this understanding will create opportunities to optimise protection measures in order to maximise benefits. This may require additional investments, for example, to improve accessibility for recreation. Although it may be a large effort for water managers to instigate a benefit assessment, it is likely that they will profit from this in the stakeholder process, and find support for the implementation of measures more readily.

It is recommended to include a wider range of potential uses, rather than just building on the current uses of water systems, because the WFD may create opportunities for new functions. Typical examples are the opening up of covered rivers in cities or new opportunities for bathing in surface

[20] appendix, page 33

waters that are now considered unsafe for bathing.

Table 12: Overview of benefit categories assessed and their relative importance in a few nationwide studies on benefits of the WFD

Benefit categories	**UK(1)**	**NL(2)**	**FR(3)**
Environmental: Use values			
Avoided costs water supply	NA	NA	28 %
Fish (commercial)		-6 %	
Formal recreation Informal recreation Angling In-stream/water sports	 6 % 13 %	16 %	3%
Health (bathing, indirect)		NA	NA
Amenity	24 %	42 %	NA
Improved regulation functions: Efficiency gains in water management (flooding, droughts) CO_2 storage, air quality Improvements of flow management	 NA 35 %	 NA 33 %	NA
Non-use values Conservation-biodiversity/bequest	 21 %	 17 %	 9 %
Protection groundwater sources			60 %
Subtotal	100 %	100 %	100 %
TOTAL	NA	NA	NA

NA: not available

References: based on : UK (1): Environment Agency, NL(2): Ruigrock et al., 2006, FR(3): Chegrani 2005.

Avoided costs: Most of the benefits will be related to non-market welfare increases for users and non-users, not reflected in market prices. In addition, the WFD is likely to lead to large amounts of avoided costs related to water supply, flooding, and for the treatment of contaminated river sludge. It is surprising to note that these avoided costs have been less quantified in most studies. It is not clear why these avoided costs have been less quantified in most studies and whether that is due to lack of information or whether it reflects a feeling that these may be less relevant.

Some explanations of the differences: The differences in the studies indicated in Table 12 reflect both differences in the availability of information, the focus of the study, and real differences between river basin characteristics. As an example of differences in approach, the bottom up studies for the NL and UK do not include groundwater, as it is unclear to what extent groundwater will be affected by WFD measures. On the other hand, the study for France indicates that it is potentially an important benefit category, building both on studies based on willingness to pay for improved groundwater protection as based on avoided costs for water supply. Additional studies for the NL confirm similar high benefits from a better protection of groundwater in the NL.

On the other hand, the differences in scope and results may reflect real differences between Member States related to the physical characteristics of the water system, socio-economic environment and uses of water bodies, such as accessibility of water bodies for recreation and local habits. It is logical that numbers are lower for the UK and France, as not all water bodies are affected, or at least not over their full length. The relatively high benefits for the NL, especially for the high and maximum ambition level, reflects that the NL is basically a large river delta, with high population density and where most people live close to the water.

Negative benefits: As Table 12 shows, the environmental impacts of WFD measures may be negative. The negative estimate for commercial fishing in the Netherlands reflects that some valuable commercial species now profit from the high level of nutrients in surface waters. A drop in nutrient levels will especially benefit species that are commercially less valuable. Other examples are impacts of measures affecting hydropower on air emissions, etc. (see Section 8).

Benefit categories in questionnaire studies : This overview has shown that it is challenging to be complete if a detailed bottom-up assessment is chosen. A top-down questionnaire approach is likely to be more complete for the assessment of use and non-use values, provided the description of the potential benefits is adequate and complete, and that people interviewed can paint themselves a picture of a future of water bodies with good status. From this perspective, one would expect that top-down studies result in higher values, but there are not enough case studies to test this hypothesis. In many cases top-down questionnaire studies are also incomplete because people are likely to be unaware of the potential benefits of improved regulation functions such as flood protection, CO_2 storage, etc.

On the other hand, these top down studies can point to the potential importance of benefit categories that get less attention in bottom up approaches. The participants of the Dutch questionnaire study ranked health impacts as their top concern, whereas health benefits for bathing were estimated to be very small in the bottom-up study (see Table 13). However, the bottom up study only accounted for the improvement of the small amount of lost swimming days in open air swimming locations, whereas the participants to the questionnaire may have a much broader concept in mind of opportunities for a safe dip into surface waters.

Table 13: Arguments for the willingness to pay to improve water quality, as indicated by participants of the WFD Benefit estimate for the Netherlands

Source: Brouwer, 2003

5.3.8 The number of people affected

As discussed above, it is important to identify the beneficiaries of WFD measures, both for user values/non-use values. Studies show that the improvement of the status of water bodies is especially relevant for people living relatively close to the water body. The estimation of the number of beneficiaries for the specific benefit types, especially non-use benefits, turned out to be one of the major problems in using the BAG for benefit estimation in the UK (Fischer, 2004). The relevant distances depend on the type of benefit categories, water body and the vicinity of other water bodies offering similar "goods and services":

- improvement of amenity and living quality is only relevant for people along or very close to the river banks or lakes. In some cases, rivers that were covered for public health reasons or to hinder undesirable odours may be opened again, so that the number of people affected may be higher than data on the current number of houses along rivers may be an underestimation of the potential effect.
- improved conditions informal and in-water recreation are especially relevant for people living in the vicinity of that water body. Water bodies that are suited for water recreation (boating, surfing, sailing) will recruit users from a greater area.
- distance is also relevant for non-use values because we attach more value to natural environments nearby and feel more responsible to protect nearby nature for future generations. The relevant range will depend on the type of ecosystem: it may be limited to a few km for more natural riverbanks whereas unique wetlands will have a nationwide or even European interest. Relevant distances from the UK BAG are given in Table 14.

Table 14: Maximum distances for the assessment of the number of people affected by non-use values

Importance of the river	Improvements	Relevant distances (km)
Local	Minor	30
	Moderate	40
	High	60
Regional	minor to moderate	60
	High	120
National/International	minor to high	60 to 150

Source: UK Environment Agency, 2003

- The relevant range will also depend on the vicinity of other water bodies offering similar "goods and services", both use and non-use. This is especially relevant for benefit assessment of the WFD because it affects all water bodies and river basins. Literature, on the contrary, often focuses on more isolated measures improving one or a limited number of water bodies. If benefit assessments of the WFD builds on theses studies, there is a potential overlap and risk for double counting.
- In the end, all households within a river basin may benefit from the improvement of water bodies, either as a user, or as a non-user. Table 15 gives an example of how households in the Loire Valley in France are making use of the river. (Some of the specific user groups (for example, kayak) are likely to be small but with a high willingness to pay. For other groups, for example, informal recreation, the WTP may be low but because the group is large the total benefits may be important.
- These issues are well identified, but needs further research to solve it. The issues and experiences in UK and France are discussed in-depth by Chegrani (2005).
- For specific uses like angling, surfing, canoeing, one is more likely to find data on actual use. If the benefit estimate uses data of present uses, it is likely to underestimate the total benefit because improved conditions are likely to attract more users.

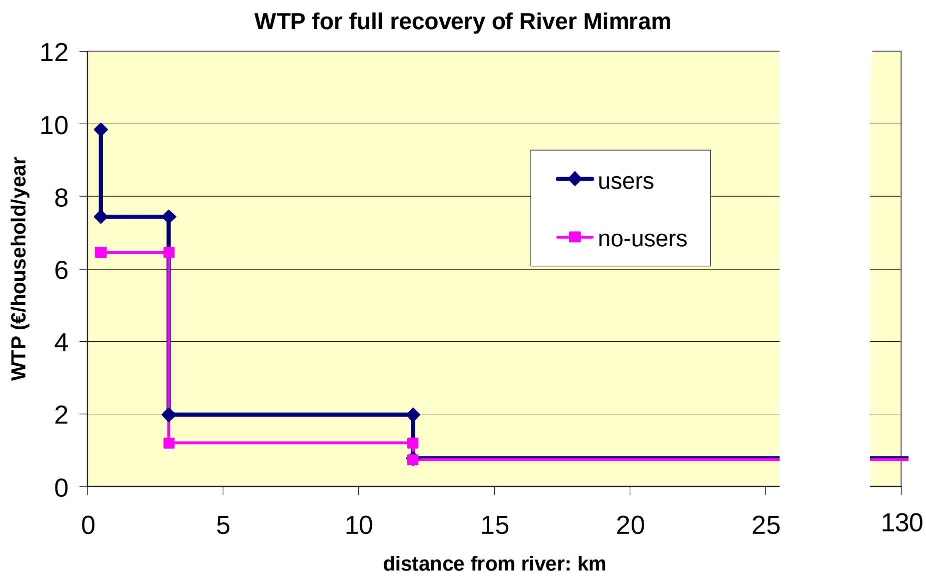
Table 15: Users and non-users of the Loire Valley

Beneficiaries in the Loire	**% of households**
Use	66
Walking	45
Angling	9
VTT (mountain bike)	7
Kayak	5
Non-use	34
TOTAL	100

source: Chegrani, 2005

- The empirical evidence to estimate the relevant range or distance is limited and there are two approaches to deal with it. The first relies on distance decay functions that describe the number of potential users as a % of total population and in function of the distance to the water body. This is used in the UK guidelines for benefit estimations (Environment Agency, 2003). As an example, Figure 18 shows a distance decay function for the benefits of the River Mimram in the UK. It illustrates how both use and non use values decrease with distance.

Figure 18: Distance decay functions of WTP for the full recovery of River Mimram



Source: Gibbs, 2002, cited in Cascade, 2006

- The second approach relies on fixed distances, in which one value is used for all the people or properties within a certain boundary. This one is recommended if the original studies do not result in distance decay functions but just single values, as is the case for France. Second, it is less data intensive to implement.
- As different studies use different assumptions, comparison is hindered. If studies at the river basin are to be aggregated towards national studies, the establishment of guidelines is required to facilitate both the benefit assessment and the aggregation and interpretation of results.

5.3.9 Preferences, willingness to pay and income of the people affected

Today, there are a large number of case studies that have estimated the willingness to pay (WTP) for different use and non-use values. Overviews of the results of these studies are given in the guidelines for the UK, France and the Netherlands and in literature. The ongoing EU FP6 project AquaMoney will deliver an overview and analysis of the best and most relevant studies (www.aquamoney.org).

These studies confirm that people are willing to pay for an improvement of the status of different water bodies and the associated improvements of goods (drinking water, fish), services (recreation, amenity,..) or preservation of related ecosystems. The valuation builds on different approaches, using market prices to value avoided costs (for example, cleaning of drinking water), estimates of how good water quality affects housing prices, willingness to pay for specified services like walking or angling, etc. (see Section 3). These studies allow to account for the number of people affected, depending on the type of water, service and population density. The amount of the WTP will depend on different factors:

- the willingness to pay for a good or service depends on the quality-quantity of that good, the preferences of the people, the costs for alternative services and disposable income. It requires further research steps and specific approaches to estimate to what extent people are prepared for a financial engagement to improve the situation (see Section 3.3). The available indicators for this willingness to pay may either relate to a specific service (angling, living nearby water, protection of biodiversity, …) or to the full range of services and the total economic value.
- As discussed above, the willingness to pay will also depend on the distance to the river or water body. If benefit estimates relates to data from literature, the procedures and data used to estimate the number of people affected for the case study and the WTP data used should be consistent.
- Figure 17 illustrates how WTP declines with distance to the river, for both users and non-users. The figure shows that there is WTP up to a distance of 130 km from the water body.
- The WTP will be higher for more important improvements (for example, from very poor to very good) compared to smaller improvements (from good to very good) (see Table 11 for an example). Typically, WTP study estimates refer to a status or improvement, which is described in qualitative terms. There may be a difficulty to match the results of impact assessments (for example, in terms of pollution concentrations or indicator classes for biological quality or fish indexes) with the description of the improvements used in WTP studies (example is given in Table 11 for 3 different improvements).
- Compared to market data, valuation based on states preferences will be more uncertain and controversial due to the hypothetical nature of the methods.
- For non-use benefits uncertainty may be even higher as it is related to a more abstract good or service, compared to e.g. recreational benefits. Typical ranges in the case studies for France, NL and UK are 5 to 10 €/hh/year for households affected.
- Although there is a large literature, it is incomplete (i.e. not all water bodies and categories are studied). Therefore, it may be needed to make rough assumptions to avoid too many benefit categories not being accounted for. The amenity benefits for the Netherlands are mainly based on assumptions related to the impact of WFD improvements on house prices and how many houses are affected (5 % increase, for 8 % of the house stock). One can discuss the assumptions, but at least these rough estimates show that it is a potentially important benefit category and may deserve further attention for the selection of measures or priority setting for further studies.
- An important shortcoming of water related WTP date in Europe is that so far most data are available for NW Europe and much less for Southern or Eastern member states. Some studies are available for new Member States, and they conclude that the methods to value e.g. water quality improvement, work as well in those countries as it does in the US or NW

Europe (Ready 2002). So, this unbalance in information is likely to improve in the coming years, as our inventory in chapter 4 has identified that most Member States have launched new studies. In addition, EU wide research initiatives like Aquamoney (see above) will enlarge both the number of studies to draw on and will gain insight in how to use these data in other countries or contexts.

- Compared to most Member States, it was more easy to establish guidelines and indicator data for the UK, France or the Netherlands because they had studies in their country to build on. It is logical that using these data in other parts of the EU will increase uncertainties, but it is unavoidable to build on this literature if benefit assessment is to have a momentum in the EU. Furthermore, it is to be expected that the AquaMoney project will provide insight on how these data can be adapted for benefit estimation in other river basins and socio-economic contexts (benefit transfer).
- The results of the Eurobarometer inquiry among European citizens indicate that in all Member States water related issues rank very high among environmental concerns. This suggests that European citizens share a common concern, even if they may live in very different environments and socio-economic conditions. Although this does not mean, however, that they will share an identical willingness to pay, it does offer perspectives that benefits transfer may well work (within certain boundaries).
- Today, there is little information on how environmental valuation data may differ between NW-Europe and other parts of Europe, and especially in the new Member States. There is some information in studies related to WTP to limit eutrophication in the Baltic (see Section 9). This study confirmed lower WTP values in Poland compared to Sweden, but the results are too specific to use that ratio as a general guideline. Malzubris, Senkane and Ready found much lower values for WTP for water quality in Lativa than one would expect to find in old Member States, reflecting the lower incomes and – in this specific case - share of pensioners (Malzubris 1997, Ready 2002).
- Willingness To Pay depends on preferences and disposable income. One of the issues benefit transfer will have to deal with is the correction for differences within Europe related to disposable income and price levels. This remark is important for the interpretation of the data for NW Europe. The correction for differences is however rather straightforward and has been used before for example the estimation of the benefits of the environmental acquis.
- This also suggests that WTP will increase as Europeans get richer thanks to economic growth. This should be accounted for (see further).
- In many cases, the uncertainty added by using benefit transfer for monetary valuation is likely to be small compared to the overall uncertainties of the benefit estimations and is unlikely to be larger than the benefit transfer used in other environmental policy domains.

5.3.10 Avoided costs for water management

Improvement of status of water systems in Europe will enable the avoidance of a range of costs for water supply, flood risk protection, treatment of sludge, etc. This may be of special importance in the context of looking for win-win situations with adaptation measures for global warming, which will create greater pressures for water management (for example, floods and droughts).

- The measurement and valuation of these market related costs is rather straightforward. As measures will often serve different purposes, there may however be an issue of attribution of these benefits to WFD or not. This is not a problem for the evaluation of individual measures, but it needs to be avoided to mix costs and benefits of measures related to flood protection that are taken both for WFD and other reasons.
- The impact of cleaner surface or groundwater on costs for production of drinking water depend on the cost of cleaning contaminated ground- or surface waters used for production of groundwater.SVW (Samenwerking Vlaams Water, a federation grouping all drinking water companies in Flanders) recently estimated the total costs of removing nitrates, sulphates and pesticides from drinking water, which are summarized in Table 16. These cost

reductions will lead to lower consumer prices for tap water. Also other direct abstractors of groundwater benefit from an improved groundwater quality through reduced costs in treating the abstracted groundwater.

Table 16: Overview of the costs to purify groundwater from some selected pollutants in Flanders

Substance	**Avoided cost (investment + operational cost)**
Nitrates	0,40 € / m³
Sulphates	0,30 € / m³
Pesticides - big production units	0,005 € / m³
Pesticides - small production units	0,10 à 0,15 € / m³

Source: SVW, federation of drinking water companies of Flanders ,
cited in Manuel Dierickx Visschers , 2003.

- WFD measures will improve the regulation functions of water systems to retain rainwater, store and drain water, which will avoid damages of flooding and droughts, or will avoid costs for other measures related to flood or drought protection.

  Hydro morphological measures can contribute to flood protection, which may lead to important economic benefits in terms of either avoided damages from flooding or avoided flood protection measures. These benefits will become more important because of climate change. This is illustrated by a cost-benefit study that compared a base line (current situation) with different options for flood protection for the tidal area in the Scheldt river basin in Belgium. An example are the flood protection benefits from a strategy combining controlled inundation areas and the creation of wetlands. A strategy that combines dykes, flood protection walls and controlled inundation areas will deliver the same flood protection benefits as a more technical solution, a storm surge barrier near Antwerp, at one third of the total costs. Total benefits will further increase if the controlled inundation areas are combined with the creation of wetlands, as further discussed in next paragraph and Section 8.
- Wetlands and more natural river banks will capture CO_2 and air pollutants. These benefits are quantified based on either in terms of avoided damages or avoided control cost. The study for the Netherlands suggests that in particular the capture of air pollutants may be an important benefit. It has to be noted that although the contribution of wetlands and reeds to nutrient recycling can be important, these cannot be accounted for because improvements in water quality and related effects are already accounted for via the other impact categories.
- Better water quality will lower costs of water management as costs of treatment of contaminated sludge are very important.
- The beneficiaries will be the water sector, administrations, insurance companies, and the transportation sector. Households will benefit indirectly through cheaper prices for water supply or water services, lower insurance premiums for flooding and lower taxes.

The examples listed above are generic ones. It will depend on the context to what the extent these costs can be avoided, and whether the avoided costs can be attributed to WFD related measures. The analysis should also look into both potentially avoidable and additional costs.

The WFD measures may however also lead to additional costs in other policy areas. This is especially the case for measures that result in lower production from hydro-electric plants.

- The value of marginal losses in hydropower production depends on the market for electricity, and if 1 kWh of hydro is lost, it will have to be produced using different sources. For this loss, both internal and external environmental costs are relevant, especially since hydro has low external costs for CO_2 and air pollution per kWh. The marginal production costs are different for peak and non peak conditions which in turn depend on season and time of day. Guide values for France indicate differences of a factor 3 for replacement costs per kWh[21]. Similar guide values have been developed for the costs of CO_2. It has to be noted that depending on the context, the avoided costs related to CO_2 and other pollutants may already be reflected in prices for 'green' or renewable energies through permits or certificates.

5.3.11 Need for guidelines and indicator data to facilitate benefit assessment

The description of the different factors illustrate the complexity of estimating benefits. The factors illustrate that the exercise not only needs a multidisciplinary approach linking impact assessment with economic analysis, but also requires input of data and information that is only available at river basin level. On the other hand, one cannot do a lot of original valuation studies for all basins and uses involved. Therefore, guidelines are required to help the multidisciplinary teams to build on data from literature and similar studies.

The studies in the UK (2) and NL(2) and France build on national guidelines and indicator data that have been established to facilitate these types of studies. These guidelines include a general accounting framework, a set of rules of thumb, and indicator data to facilitate the benefit assessment and to ease comparability of results. The guidelines developed for France serve a similar purpose. In Box B the procedure of the UK guidelines is described. These guidelines and indicator values need to steer the benefit transfer because all of these studies will have to rely on data adapted from literature to value the impacts. In this context, results needs to be adapted to account for differences in impacts, setting, income etc. between the context of the original study and the impact valued.

Today, clear scientific guidance is missing on how to get the best reliable data based on benefit transfer, and how big the added uncertainty is. As the EU AquaMoney project aims to develop such guidelines in view of application in the context of the WFD, the scope to use benefit transfer is likely to improve in the near future. Nevertheless, the experiences in the UK, the Netherlands and France indicates that some rough approaches are likely to be unavoidable to get a first idea of the benefits and the beneficiaries.

In both the UK and Netherlands, the results of the benefit estimation are first steps on a longer road to improve decision making by taking account information concerning benefits. The results are not final outcomes of the process, but rather a first input into that process.

5.3.12 Evaluation and lessons learned

The information on benefits of the WFD in Europe is limited. Only three countries that have a longer and extensive tradition in benefit assessment have made first studies. The review of these studies show that for even these countries it remains difficult to get a complete picture of the full benefits. As these studies will be further used in the WFD process in these countries, it is expected that the overview will become more complete and more accurate in the coming years.

These first raw and incomplete data show that benefits are very diverse and include avoided costs for water supply and management, benefits for water related recreation (angling, kayak) and informal recreation (walking or cycling), amenity benefits for populations close to rivers, non-use benefit related to improved protection of biodiversity, water resources and water systems. The available data

[21] Directive cadre d'eau, calcult du coût des pertes ou des deplacements de productible hydroelectrique, guide des bonnes pratique en phase valeurs guide.

does not suggest that one of these single categories dominates the total benefits.

The factors that determine benefits include definition of GAP and ambition levels, the relevant benefit categories for the affected water bodies, the number of people affected and their willingness to pay, and the scope for win-win measures with water supply and management. The order of magnitude of the benefits quantified is 10-100 €/household/year.

This variety in benefits is good news for water managers because a wide range of people is likely to benefit from the WFD measures, especially through non-market benefits. The other side of the coin is that it makes benefit estimation a complex and challenging task, especially in Member States that have no tradition in economic benefit assessment and less studies and expertise to build on. As a lot of studies have recently started, it is expected that the data and guidelines will improve.

BOX B: Guidelines for benefit assessment.

UK Environment Agency:
The guidance documents for benefit assessment (BAG) were developed by the EA (Environment Agency, 2003) to provide guidance for assessment of social costs and benefits of water quality and water resources schemes that are assessed in the framework of business plans of the UK water industries for 2004 (PRO4). This document builds on a wide set of previous guidelines, both related to benefit and economic assessment in general and application to water related issues. Although these guidelines were not developed for WFD implementation as such, they address the relevant issues and are further developed in view of application at river basin level for development of measures for the WFD and current planning phases. The guidelines follow a step by step approach building on benefit transfer for monetary valuation because of the large number of schemes (more than 450) to be evaluated (Figure 19). An evaluation of the guidelines and their use is described in (Horton 2004).

France:
Following a seminar between the ministry and environmental economists in 2001, France has developed a similar strategy for benefit assessment in the framework of the WFD. Guidelines for benefit assessment were developed and a database with reference material was developed. A great deal of attention was paid to the issues of aggregation. A first overall estimate was made, especially to identify priorities for further research.

The Netherlands:
A guidance document for CBA and strategic CBA for infrastructure and policy assessment (Eigenraam et al, 2002) has been completed with guidelines (Ruijgrok et al, 2004) and indicator data (Ruijgrok et al, 2006) to take into account environmental issues. The latter includes indicator data for water related issues, which have been use for the strategic CBA of implementation of WFD scenarios. More recent initiatives aim to help water managers at the local level with economic analysis and cost-benefit assessment (Helpdeskwater, 2007).

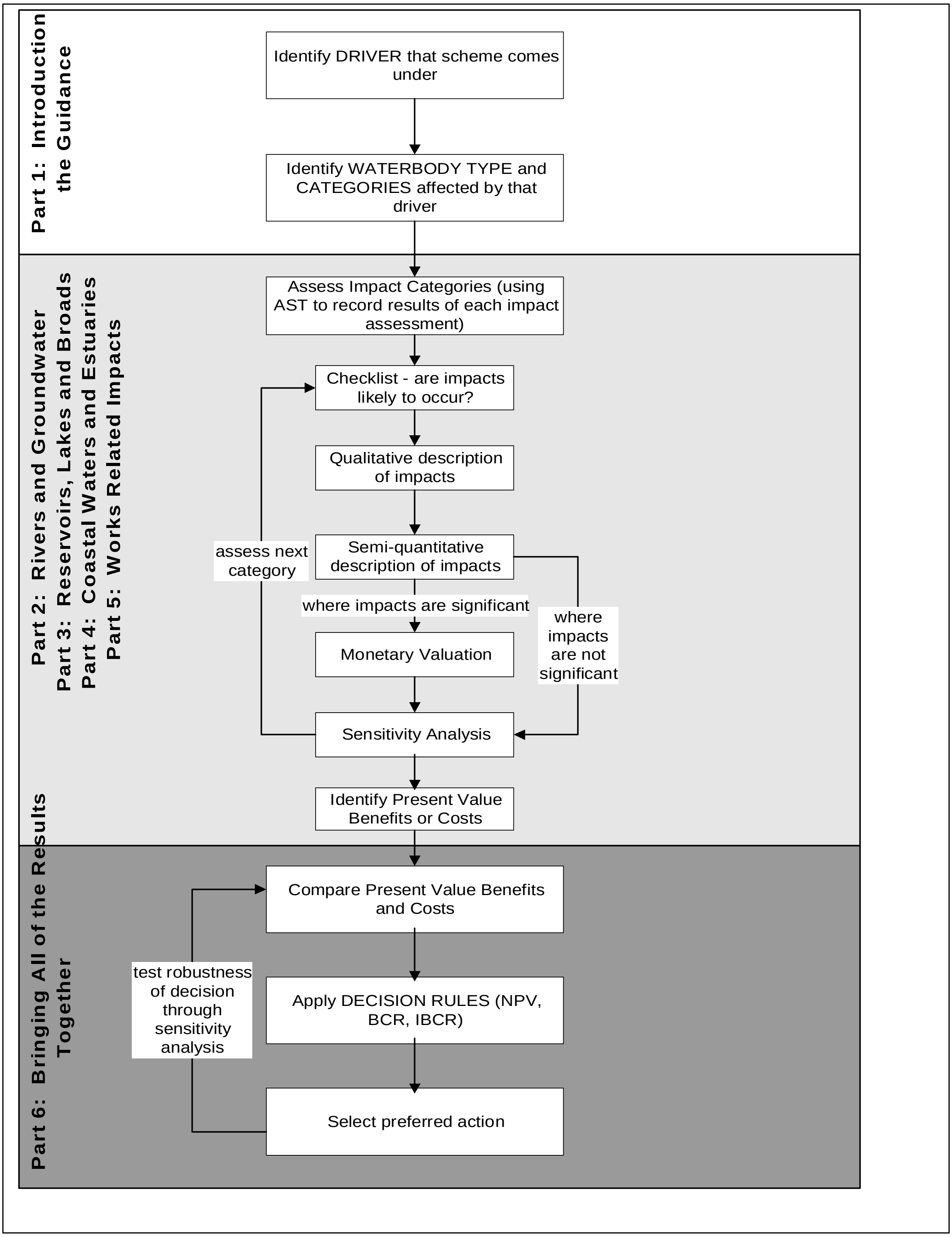


Figure 19: Steps in the assessment of benefits used by the UK Environment Agency

BOX C: Netherlands: benefits as part of the strategic CBA, Dec. 2006 Objectives

Objective: To make a first overall inventory and assessment of benefits of improved water quality related to the implementation of the WFD in the Netherlands (MVW(2006b), and annex; Ruijgrok et. al. (2006) , Ruijgrok et. al. (2007)). It aims to:

- identify and describe the types of benefits;
- indicate the order of magnitude of the monetary benefits; and,
- identify action plans for further research.

The study reflects the understanding and data availability in 2006 (MVW(2006b))

Context: Part of the strategic cost-benefit analysis of implementation of the WFD, version December 2006. Annex to the “Decembernota 2006”, a policy document to discuss the major orientations and choices to be made related to implementation of WFD, taking into account other objectives, especially related to water quantity management.

Approach

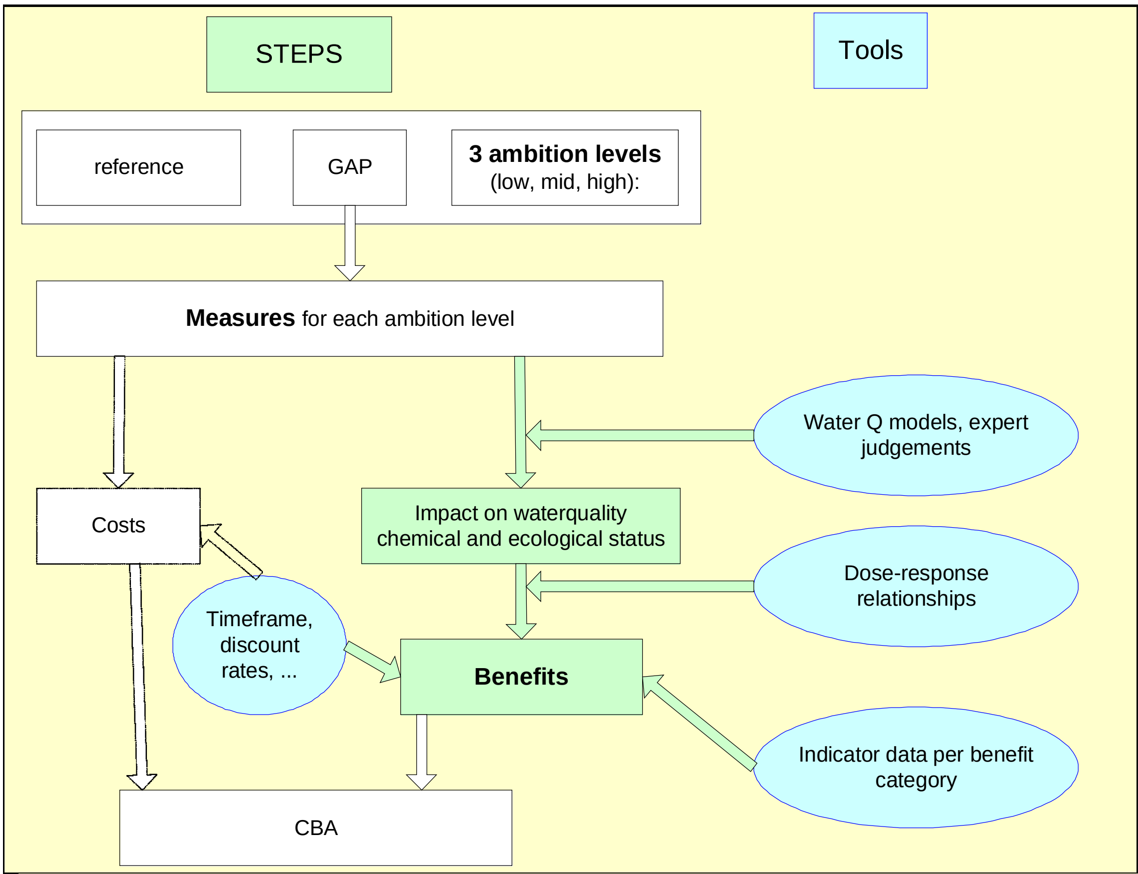
The study follows in general lines the approach for Strategic costs benefits analysis as described in Section 3. Box C1 illustrates how the study on benefits fits within the overall CBA framework and indicates the main steps of the approach. It aims to assess benefits of different packages of measures reflecting three different ambition levels.

The approach uses 5 main tools or elements of information, which build on the overall analysis of cost and benefits for the CBA (a, b) and is closely linked to the assessment of impacts and effectiveness of measures (c) and on guidelines and indicator-data to account for environmental impacts in CBA in general. The tools are:

a) definition of ambition levels and related measures;
b) definition of scope of the analysis, time frame, discount rates, etc.;
c) tools for impact assessment (water quality models, expert judgements) to assess the impact of the measures on the chemical and ecological status ;
d) dose-response functions used to estimate how the status of water bodies affects “goods and services” delivered by the different water bodies. The dose-effect relationships are expressed in terms of a % attainment of a maximum benefit for 17 categories, depending on physical-chemical, hydro-morphologic and biologic characteristics of each water body;
e) indicator data for (the maximum) welfare gains for each good or service affected (for example, average costs for treatment of drinking water (€/m³); indicator for change in amenity values related to prices of houses and number of houses affected, ….)

The maximum scenario refers to a 100 % achievement of good status (or potential for heavily modified bodies), except for eutrophication the measures are insufficient to reach good status.

Ambition	**Contribution to reaching good status**			
	Surface waters			**Groundwater**
	ecologic	**eutrophication**	**chemical**	
limited	++	+	++	++
substantial	+++	++	++	+++
maximal	++++	++	++++	++++



based on MVW 2006
Units: Present value in 2006 of the total net benefits for a period 2009-2027, discounted at 4 %. As benefit will only start once the improved status is reached, they start in 2015 (to be checked).

Results

- Table Box C 1 (below) shows the benefits of implementation scenarios for the WFD in the Netherlands.
- The benefits accounted for relate to commercial fishing and improved non-market services from water bodies. A number of benefits could not be quantified, especially because the impacts of the measures on the status of the water body could not be assessed.
- The benefits quantified vary from 1.7 to 5 billion € for the limited, substantial and maximum ambition level. The benefits increase substantially between a limited and substantial implementation (three times higher), whereas the maximum implementation only adds another 10 %. It suggest that the economic law of diminishing returns is applicable to these measures.
- The uncertainties in the impact assessment are around 20 %. The uncertainty related to dose-response functions is estimated to be less important. Of course, the overall uncertainties, including issues not accounted for or uncertainties on the indicator values are much higher but not specified.
- The net impact on fish production is negative, because some species profit from the higher nutrient levels in the reference and lower ambition scenarios. This effect is especially important in the maximum scenario (- 20 % of total benefits).
- Improved status of water bodies will improve amenities for nearby residents, which will be reflected in increased housing prices (estimated at 5 % for houses along the banks).
- More natural banks (15 m width) contribute to capture of CO_2 and pollutants (PM, NO_x, SO_2), are estimated to generate substantial benefits for all inhabitants.
- The non-use values for biodiversity are based on a indicator figure for WTP of 11 € per household/year (for maintenance of the biodiversity of river banks covered with reed, applied to all households within a 10 km range).

- The impact on health benefits from bathing is limited, as current number of health problems is already limited.
- The contribution of the bequest or inherence value for 'clean' waters has only a limited share in total benefits (valued at 5 € per household/year within 10 km of water bodies).

The information related to the total benefits from the 3 programmes of measures. The benefit of individual (packages) of measures is not discussed or documented.

These figures are present values (PV) for a 100 year period, discounted at 4 %. Taking into account the number of households for the Netherlands, these benefits correspond between 7 and 32 euro/household/year, which is lower than the results of the top-down CVM study. It has however to be noted that these data are first estimates which are both incomplete and uncertain as the assessment was based on indicator numbers and often rough assumptions had to be made.

Table Box C 1: 2006 estimation of the Benefits of implementation of WFD in the Netherlands, PV over a 100 year period at 4 % for measures taken between 2009-2027, in million euro.

Benefit categories	**limited**		**substantial**		**maximum**	
	Ambition level					
Benefit categories accounted for	**limited**		**substantial**		**maximum**	
fishing	-86	*-5%*	-282	*-6%*	-948	*-19%*
health for bathers	2	*0%*	6	*0%*	17	*0%*
recreation	254	*15%*	711	*16%*	873	*17%*
Amenity	704	*42%*	1900	*42%*	2309	*46%*
regulation functions (climate, air)	554	*33%*	1496	*33%*	1818	*36%*
non-use values biodiversity	265	*16%*	715	*16%*	869	*17%*
Bequest values	0	*0%*	29	*1%*	78	*2%*
Subtotal	**1693**	***100%***	**4575**	***100%***	**5016**	***100%***
% of max value	34%		91%		100%	
benefit categories not accounted for						
Cleaning drinking water	pm		pm		pm	
Agriculture	pm		pm		pm	
flood protection	pm		pm		pm	
Shipping	pm		pm		pm	
food safety	pm		pm		pm	
TOTAL	**P.M.**		**P.M.**		**P.M.**	

P.M. = pro memory (not accounted for)

Note: these estimates reflects the understanding anno 2006 of benefits of WFD implementation.

Source: MVW, 2006, main report; Ruijgrok (2007)

5.4 Diverse contexts to compare costs and benefits

Cost-benefit analysis can have two roles in the decision making process (Turner, 2007). It can have the role of a decision rule to select projects or policies that contribute most to welfare. Alternatively, it may be part of a comprehensive policy analysis and offer insight in impacts from an economic perspective. In the context of economic appraisal of the WFD, the second type is most important. Economic analysis helps to improve decision making by identification, quantification and analysis of the costs and benefits. This economic information can serve as different building blocks and information can be used as inputs for different types of policy questions. The level of detail and accuracy required will depend on the context and decisions to be taken. In Section 3 we have already indicated that current studies are rather at the level of indicator assessments, which will help to identify directions for further research and debate to select the most important problems, candidate measures, etc.

In this section we illustrate this type of uses of results of economic analysis with two cases of comparison of the costs and benefits, that we discussed in Sections 5.2 and 5.3:

a. discussion of the overall costs and benefits of WFD implementation in the UK (UK, RIA, 2003);
b. discussion of costs and benefits of different ambition levels (NL, CBA, 2006); and,
c. In contrast, we illustrate the use of cost-benefit analysis in a context of evaluation of a wide range of schemes (UK, PRO4).

5.4.1 Discussion of overall costs and benefits in context of RIA, UK

The context: The regulatory impact assessment of the transposition of the WFD in England and Wales (UK) used quantitative and qualitative information on costs and benefits. In the regulatory impact assessment, this information is completed with other information such as the impact of the costs (and benefits) on small firms and their competitiveness.

Methods: The RIA builds on the study by WRc (1999) and a study on the costs for measures in agriculture (RPA, 2003). The WRc study was an initial assessment of the potential impacts of the WFD in the UK and can be considered as a typical indicator number CBA. The most relevant methodological issues and factors were discussed in Sections 6.1 and 6.2. In the context of the RIA the results of the 1999 study were updated for England and Wales. These updates are more accurate as more was known about the final contents of the WFD and the evolution of water quality legislation. It is however still mentioned that it is impossible to accurately estimate costs and benefits of the programmes of measures as costs and benefits depend on the iterative technical and economic work the Directive requires. Also, the extent to which derogations are used is also very uncertain. It is noted that the RIA no longer uses the small and large GAP assessment.

Results: The summary table of costs and benefits of the updated Regulatory Impact Assessment for England and Wales is summarized in Table 17. This table illustrates that costs and benefits quantified are of a similar order of magnitude, but that the RIA paid attention to both the quantified and non-quantified costs and benefits. The summary table illustrates that the objective of the RIA is to be informative about the potential range of costs and benefits, and to put them in perspective. There are no judgements to be made on what type of measures to be taken or what ambition levels are appropriate.

Interpretation: This economic analysis helped to identify areas for further research, and the UK developed a long time strategy to improve tools and data for economic assessment. As indicated in chapter 4, in 2007, that new information will be used for a new nation wide evaluation of costs and benefits of the implementation of the WFD will be made. The economic information in that study will be more important for the further selection of measures.

Table 17: Indicative costs and benefits of the programmes of measures necessary to achieve planned targets of the WFD

Benefits	**Costs**
Overall assessment : The WFD will tackle a substantial proportion, but by no means all, of the remaining damages to the water environment. • Not all potential benefits can be quantified. The level of quantified benefits is considered to **underestimate** the actual level of benefits. • Benefits are based on early estimates of the status gap which is known to have declined considerably in some areas and this would reduce benefits. • Where benefits can be quantified and valued these appear to be in the region of **£560m million per annum** and therefore represent only a proportion of the potential benefits. Note: Overall estimate of the TOTAL potential benefits from removing the remaining damages to the water environment is £1,000 to £1,400 million per annum	**Overall assessment :** The costs of compliance with the WFD that can be quantified at this stage amount to between **£450 and £630 million per annum.** • These costs may be **under or overestimates.** • Costs are based on early estimates of the status gap which is known to have declined considerably and this would reduce costs. • Costs are based on measures which may not necessarily be the most cost effective and do not take account of derogations which will allow disproportionate costs to be avoided. • However, it has not been possible to value all costs, and some omitted costs may be significant. Note: Ball park estimates of the TOTAL current water related environmental protection expenditure is £3,600 million per year(3).

Benefits		M £/year	Costs	M £/year
Quantified benefits PoM			Quantified costs PoM	
rivers	angling	70	Removal of BOD, NH_3 and P	420
	non use	120	(rivers), N (transitional and	
	informal recreation	34	Coastal waters) and river	
	amenity	134	habitat and flow improvements	
	flow	198	Diffuse pollution agriculture	30 - 210
	Sub-total	560	Subtotal	450- 630
Benefits not quantified *lakes, wetlands, flood risks*			*Costs not quantified* *rivers: other factors than chemical and physical factors, lakes, artificial and heavily modified water bodies*	

Note: these estimates reflects the understanding in 2003 of costs and benefits of WFD implementation in the UK
Source: Defra, 2003, 2005

5.4.2 Assessment of different ambition levels for WFD (NL, CBA, 2006)

Context: The Netherlands announced in 2005 that it would use a strategic cost-benefit analysis as one of the tools to further define the objectives and measures to be taken in the context of WFD implementation. A strategic CBA uses very rough and often qualitative information to identify costs and benefits and derive estimates of orders of magnitude of costs and benefits. It does not address issues related to equity and burden sharing nor impacts on competitiveness. In Section 4.3 we have already discussed and illustrated that the reports available today are part of a longer, stepwise process to improve understanding of the impacts of the WFD.

To that purpose, three ambition levels for implementation of WFD were defined (limited, substantial, and maximum) (Table 18). This information on costs and benefits has been used in the Decembernota 2006 to select the ‘high’ ambition level as the beacon for the further developments of packages of measures.

The maximum scenario refers to a 100% achievement of good status (or potential for heavily modified bodies), except for eutrophication the measures are insufficient to reach good status.

Table 18. Overview of goals for different ambition levels

ambition level	contribution to the achievement of good status			
	Surface waters			groundwater
	ecologic	eutrophication	chemical	
limited	++	+	++	++
substantial	+++	++	++	+++
maximal	++++	++	++++	++++

source, MVW, Strategic CBA WFD, 2006

Methods and data for assessment of costs and benefits: The objectives and measures related to these ambition levels were identified using information from water boards, provinces and national administration. The costs and benefits of these packages were assessed in indicative terms in 2006. These estimates have been discussed in more detail in sections 6.1 and 6.2 of this report.

Results of comparing costs and benefits: The comparison of costs and benefits in the strategic CBA focused especially on the differences in the evolution of costs and benefits between the different scenarios (Table 19). The costs continue to double between the limited, substantial and maximum scenarios. The benefits on the contrary increase sharply between the limited and substantial scenarios but the additional benefits of the maximum scenario are minimal. Consequently, the substantial scenario has the best benefit-cost ratio. Current understanding and data on the costs and benefits is too uncertain to draw any conclusion from a comparison of cost and benefits. In conclusion, the strategic CBA contributed to the selection of the substantial ambition level as the beacon for further elaboration of measures.

Table 19: Overview of costs and benefits (in billions of euros) for different ambition levels

Ambition level	Costs	Benefits
Limited	7.3	1.7
substantial	13.3	4.6
Maximal	22.4	5

Source: MVW, 2006
Note: these estimates reflects the understanding in 2006 of costs and benefits of WFD implementation in the Netherlands

Interpretation: this study illustrates how a stepwise approach for economic assessment works. On the one hand, this study builds on previous work to build guidelines and indicator data. On the other hand, this study is input for a new set of further actions to improve insight in economic affects of water policies.

5.4.3 Assessment of specific measures (UK, EA 2003)

Context: The economic analyses that the Environment Agency carried out for the National Environment Programme (NEP) for the 4th Periodic Review of the Water Industry (PR04). Every five years, the UK regulatory Office of Water Services (Ofwat) carries out a review of the expenditures of water and sewerage companies in England and Wales to set their prices for the following five years. In this context, the Environment Agency, the main environmental regulator for England and Wales, conducted an in-depth cost-benefit analysis of 437 environmental water quality and water resource improvement schemes that were not required by legislation. In addition, cost-effectiveness analysis was applied to all schemes. This exercise is recognized as the largest such appraisal of its kind undertaken in the UK to date.

Methods: The CE and CBA builds on the expertise and information in different administrations and regulatory bodies to assess costs and their effectiveness. For benefit assessment, a set of guidelines were developed (BAG, benefit assessment guidelines) and applied using local expertise. The use of BAG, systematic reporting schemes and input from 'central' administrations ensure consistency and comparability between the different schemes.

Results:

- Cost-effectiveness analysis was applied to identify the least cost solutions to reach the stated objectives, which resulted in a reduction of the number of schemes by about 48% and trimmed their costs by more than 50%.
- Cost-benefit analysis was used to rank schemes in 6 categories according to their cost-benefit ratio or regional importance Table 20 and Source: UK *Environment Agency, 2004*
- Figure 20 show the results.
- These data confirm that there are still net benefits to be reaped from the implementation of measures that go beyond "pre-WFD" obligations, but that not all potential measures will produce net benefits.
- The analysis allowed to identify schemes with good benefit-cost ratio's, that together would be able to deliver 80 % of the total benefits of all schemes at 37 % of the total costs. These 60% best schemes have an overall benefit cost ratio of 1.8 whereas the benefit cost ratio of the 40 % worst schemes is only 0.3.
- Although the efforts for economic assessment were big, it allowed to save £750 million.

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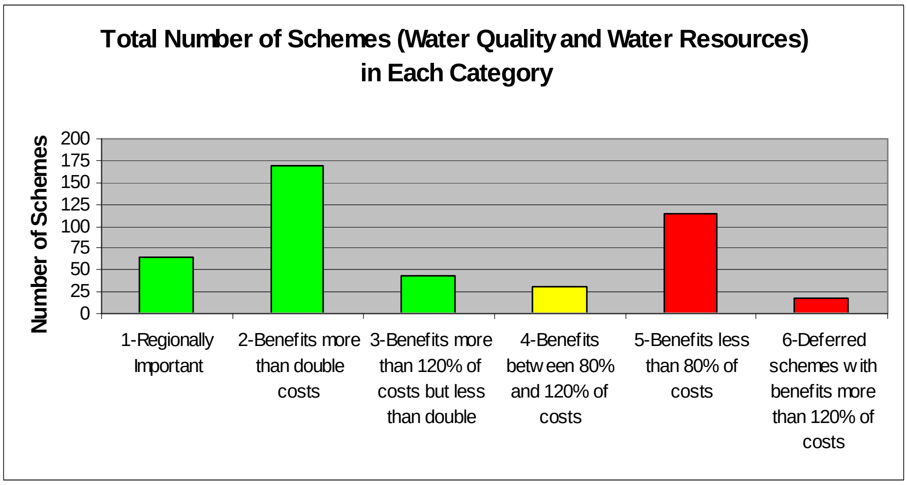
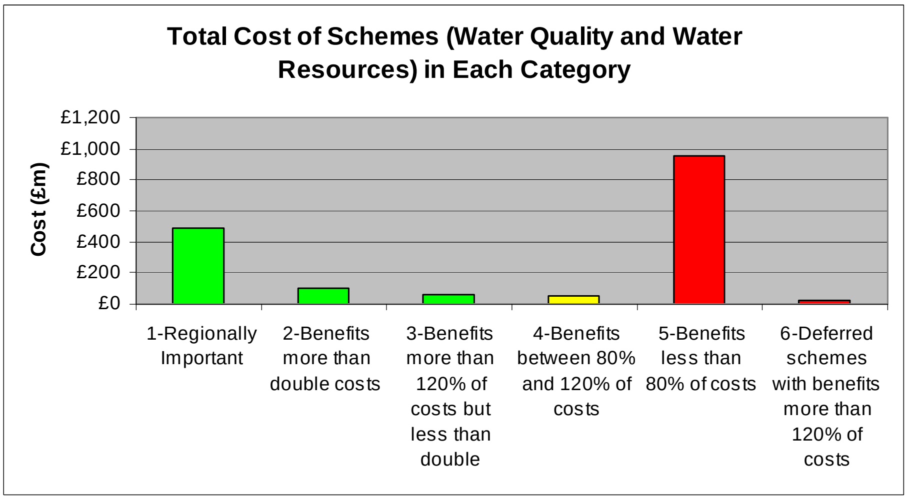
Table 20: Total costs and benefits of schemes indifferent classes: (PV, in £ million)

	Categories 1 to 3 Proposed schemes (% of total)	**Categories 4 to 6 Deferred schemes (% of total)**	**All categories**
Total number of schemes	274 (63%)	163 (37%)	437
Total costs (PV)	£ 649m (37%)	£ 1035m (63%)	£ 1684m
Total benefits (PV)	£ 1160m (80%)	£ 286m (20%)	£ 1446m
Benefit cost ratio	1.8	1.3	





Source: UK Environment Agency, 2004

Figure 20: Cost benefit ratios of water quality and resources schemes

5.4.4 Conclusions and lessons learned.

- The three case studies illustrate that similar economic information can be used in different contexts and to support different types of decision making. The level of detail and accuracy needs to be adapted to the decisions to be taken. Depending on the context, it may possible to account for qualitative information and uncertainties.

- These different applications show that Member States need to develop a strategy for assessment of costs and benefits. The development of guidelines and indicator data are an essential part of that strategy.
- Part of the process is also the input from and feed-back to more local authorities and stakeholders.
- At the start of the process, decision making may rely on more qualitative and rough information. This is especially the case for information used as in input to the WFD process when this information is mainly informative or is to select the major orientations for a further development of programs.
- However, information on total costs or benefits of a program of measures does not ensure that all measures are efficient. A more fine tuned assessment procedure is required to identify the packages of measures with the best benefit-cost ratio.
- Towards the end of the selection of measures, it is likely that many different measures or schemes have to be compared. In this case, a wide range of comparable information is required, and their assessment is likely to rely more on quantitative information.
- The practical examples illustrate that society can reap large benefits if it invests in methods, data and capacity building to identify packages of measures with the best benefit-cost ratio.

5.5 Summary of key points

The information on the nationwide studies of costs and benefits of the WFD is limited to a few countries that have a long tradition of economic assessments in the water sector. The review of these studies shows that these countries are far enough in their process of economic assessment to have produced first rough estimates, but not far enough to paint a complete and definitive picture of costs and benefits. In the years to come, these member states will complete their analysis, while others are likely to release the first estimates.

This section builds on early information from especially the Netherlands and the UK to identify the main categories and driving factors for costs and benefits. Table 21 illustrates that most of these factors are common for costs and benefits.

Table 21 : Overview of factors determining costs and benefits

Determining Factors	**Costs**	**Benefits**
GAP analysis: reference situation and ambition level	**x**	**x**
selected measures	**x**	**x**
(assumed) effectiveness of measures	**x**	**(x)**
efficiency of policy instruments and of implementation	**x**	
number of people affected, and their preferences		**x**
income and price level	**x**	**x**
scope for win-win measures with other sectors	**(x)**	**x**
timing of measures	**x**	**x**
assumptions about time frame and discounting	**x**	**x**

A main factor is the GAP analysis, which includes both differences in the status of water bodies in the reference scenario, and the level of ambition for the WFD scenario. The available information on costs and benefits illustrate that the WFD is not a single, well defined objective or set of measures. The data suggest that there may be large differences for both costs and benefits between small and big gap scenario's or between low to high ambition levels. This offers the opportunity to member states to define ambition levels and select measures taking economic analysis into account.

Important factors for costs are the extent to which selected measures and policies will be cost-effective. The way targets are defined and interpreted, especially for “good ecological status”, makes it difficult to assess which set of measures is effective (due to complex ecological relations which are still not fully understood). The current available data for the Netherlands indicates a cost increase by 5 to 30 %, compared to baseline situation. However there are large uncertainties. The level of ambition can effect costs by a factor of 3 to 5. Although uncertainties are very large, the information available today indicates that costs of WFD implementation are likely to be substantial but unlikely to be bigger than costs for current measures and measures in the pipeline.

These first raw and incomplete studies show that benefits are very diverse and include avoided costs for water supply and management, benefits for water related recreation (angling, kayak) and informal recreation, amenity benefits for residents non-use benefit related to improved environments for plants and animals and better protection of water resources. None of these single categories dominates the total benefits, but overall the use benefits and avoided costs seem to be very important. The order of magnitude of the benefits quantified is 10-100 €/household/year.

The required level of detail and accuracy will depend on the decisions to be taken. At the start of the WFD process for selection of measures, decision making may rely on more qualitative and rough information to select the big orientations for a further development of programs.

Towards the end of the selection of measures, it is likely that a lot of different measures or schemes have to be compared. In this case, a wide range of comparable information is required, and their assessment is likely to rely more on aggregated, quantitative information.

The practical examples illustrate that society can reap large benefits if it invests in methods, data and capacity building to identify measures with the best benefit-cost ratio. Taking into account the difficulties encountered in Member States with experiences to build upon, this will be a challenging task in most Member States.

6 PROSPECTS FOR WIDER USE OF ECONOMIC ASSESSMENTS IN THE WATER SECTOR

6.1 Lessons from success stories

The overview of current state of information in Section 4 shows that only a few Member States have already made first estimates on costs and benefits. However, about half of the Member States have indicated that they have or will start studies related to economic assessment, for both costs and benefits. The evaluation of the costs is in line with the WFD requirement for Cost-effectiveness analysis. Most of the Member States have indicated that they will also study the benefits, looking for both monetary and non-monetary indicators. This illustrates that these Member States are in the early stages of the process to develop economic information.

The analysis of the information on costs and benefits for UK, NL and Fr. in Section 5 has illustrated that although this information may be incomplete and surrounded with large uncertainties, it may still be very useful and appropriate to answer the specific questions. The example of the Netherlands shows that economic information to be used at the start of the selection of the measures may be rough and qualitative and will nevertheless allow to inform and improve policy decisions. The experience with the use of information on costs and benefits for the PRO4 in the UK illustrates that it is possible to assess a large number of measures in a comparable way so that measures with good or bad benefit-costs ratios can be identified.

There are some lessons to be learned from these successes:

- These successful studies were the result of a well defined research strategy and planning, that took into account the needs of the decisions to be taken, available resources, time and studies to build on. The PRO4 assessment in the UK started with the development and discussion of a strategy to assess costs and benefits of a large number of schemes in a short time framework.
- Second, these studies use some kind of guidelines and assessment tools. The strategic CBA in the NL builds on expertise and tradition in the NL to use this type of economic assessment tool for policy making. It could also profit from generic indicator data developed to account for environmental impacts for this type of studies. The PRO4 assessment in the UK developed guidelines and indicator data to be used at local level to do the assessment of specific schemes.
- The studies combine sophisticated analysis where tools and information is available with very simple, pragmatic approaches in area’s where information is missing.

Economic assessment in the water sector looks complex in the sense that a broad range of water bodies, potential measures, benefit categories need to be assessed that require inputs from different disciplines, and need to combine local expertise at river basin level with more specialised horizontal inputs. The problems may not be that different for the economic analysis related to air and energy, but in these sectors the research communities and administrations have been successful to create frameworks and procedures to combine dispersed information in an efficient and effective way:

- It could build on a longer tradition of using more standardized technical-economic models at national and international level;
- These offer a framework for dialogue between different policy levels and stakeholders to improve data and assumptions and ensure that the learning is embedded in the models;
- The benefit estimation could build on a series of EU funded research projects and related software. It especially offered a framework to combine different disciplines which could easily be updated as new information on specific issues becomes available; and,

- Probably, intrinsic uncertainties are not smaller compared to the water sector, but there is more agreement on how to deal with these uncertainties.

6.2 An accounting framework with individual components

These examples illustrate that it is important to develop a strong accounting framework that ensures consistency between different components of economic analysis while allowing flexibility to improve the individual components (building blocks). Economic analysis in the context of the WFD should be considered as a process, in which information which is gathered in different building blocks are gradually further developed. If the building blocks are well defined, they can be used and combined in different ways to answer multiple questions at different levels (water body, river basin, national and/or inter national analysis, cost-effectiveness analysis and cost-benefit analysis,…).

It is expected that the first inputs from economic analysis will be rough, but this may be sufficient to guide first steps for the selection of measures. It is essential that the information can be improved and updated along the process. This requires a good overall framework to define research tasks and store results:

- As it is likely that many administrations, water managers, research institutes and stakeholders will be part of this process, a fixed accounting framework that ensures consistency between different building blocks and over time will be required;
- The accounting framework should give guidance to the wide variety of people involved in the economic assessment and facilitate their work. It should ensure that results for, for example, different river basins are comparable;
- The accounting framework should be able to store the results of that work, both quantitative and qualitative information;
- It is to be expected that assessment of costs and benefits will follow their own trajectories, but the factors that affect both costs and benefits, as identified in Section 5 should be part of a common analysis and common assumptions. This is the case for the definition of the GAP, the identification of potential measures and the assessment of their effectiveness; and
- Another set of factors relate to assumptions on time frame, discounting,.. Here, it may be necessary to take national guidelines into account (for example, for discount rates).

Some building blocks can already be defined:

- For costs assessments, many Member States have started a systematic process of producing guidelines for assessment of costs and cost-effectiveness.
- For benefit assessments, guidelines have been developed and used for the UK, and have been developed for France and – in a wider context – for the NL. The EU project AquaMoney will both contribute to such guidelines, will develop a new range of data, and provide guidance to improve the use benefit transfer in benefit assessment.
- Impact assessment of measures is an essential input for the assessment of cost-effectiveness and benefits. This will require inputs from water quality and ecologic models.

6.3 Share results and experiences

As most Member States will go through a similar process of improving economic assessment, there is a wide scope to learn from each others' successes and failures, share and improve models, and exchange information and data.

One particular goal would be to identify measures and situations with good CBA ratios, and to pin-point measures and situations that require further study.

An important additional issue is how to integrate the efforts by different Member States to estimate costs and benefits for international river basins, to ensure that comparisons are feasible.

6.4 Conclusions

The further development of the CBA of the WFD requires more detailed, stepwise analysis that feeds in with cost-effectiveness analysis and river basin planning. The development of standard tools will help to realise this goal. An important step is to rationalise the lessons from the first experiences. These examples and those in other areas (energy and air) illustrate that it is important to develop a strong accounting framework that ensures consistency between different components of economic analysis while allowing flexibility to improve the individual components (building blocks):

- Such a framework should give guidance to all those people that can provide inputs to improve the information;
- The framework should ensure that improved components do not undermine consistency between parts and over time;
- These components can provide the basic inputs to answer a wide variety of different policy questions at different scales, ranging from local to international analysis;
- Such a framework can build on the existing guidelines and handbooks related to the assessment of costs and cost-effectiveness and the available guidelines for benefit assessment (and under development); and,
- Impact assessment of individual measures in another component to be used for both cost and benefit assessment.

7 ADMINISTRATIVE COSTS AND BENEFITS OF THE WATER FRAMEWORK DIRECTIVE

7.1 Introduction

Environmental policy in general needs, as is the case with other public policies, to be supported by administrative measures. Legislation has to be drafted, discussed and passed through the democratic process, by-laws need to be made, and procedures outlined on how to implement legislation by public authorities and the business community. Environmental standards are required, often after carrying out research and consultation with interest groups and stakeholders. In some cases permits are allowed for individual cases, that require follow up and inspection. All these actions however, are administrative and in general will not reduce pollution or improve the environment.

It is not always easy in practice to draw the line between administrative actions and actions that really lead to the reduction of pollution and improvements in the environment. Especially for technical research, it will be difficult to draw this line, as the research as such will not lead to pollution reduction, but it may led to technologies or techniques that actually can reduce pollution and make improvements to the environment.

Little is known about the current administrative costs of environmental policy. The results of the joint Eurostat/OECD inquiry on expenditures on pollution abatement and control (PAC) do not reveal how much is actually spent on administrative actions (OECD (2003)). So it is hard to set a sort of benchmark for such expenditures in case of the WFD.

The implementation of the WFD will certainly lead to additional administrative costs, as it requires:

(a) more and better monitoring of water quality and discharges;
(b) planning by means of River Basin Management Plans;
(c) modelling of water systems in GIS; and,
(d) consistency with Main Ecological Structure reporting.

These requirements lead to additional tasks, and thus – at least initially – to an increase in administrative costs. On the other hand, it can be that already considerable administrative costs are linked with issues covered by the WFD. This implies that probably at least some of the additional costs can be “absorbed” in current expenditures. In addition, benefits may also be obtained from lower costs due to better administration management or procedures.

At the same time, the WFD will replace several existing EU water Directives (such as the 1875 Surface Water Directive or the 1976 Dangerous Substances Directive). With other Directives, including the Nitrates and Urban Waste Water Directives, some synergies may be expected (for example, in relation to monitoring and reporting). This should reduce the administrative burden in the medium to long term. Thus, a fair proportion of the administrative costs that Member States experience now are indeed one-off costs for conversion and adaptation of the existing water management structures.

In this section, therefore, we use a wide definition of administrative costs, namely all costs that do not directly lead to reduction of pollution or improvement of the environment (as far as measurable).

7.2 Current information

7.2.1 General

As mentioned in the introduction, little information is available on administrative costs of environmental policy in general. An example can be drawn though, from the Dutch Environmental Cost model (MONNIE) (RIVM (2000)). In this model, all environmental measures that lead to costs for public authorities, the business sector and consumers are modelled, providing information on the development of environmental expenditures in the Netherlands. From the latest version of this model, it can be concluded that in the Netherlands the administrative costs of environmental policy to society are in the range of about 10% - 15% of total environmental expenditures (TME (2006)). About 8% of total expenditures relate to coordination, permitting, enforcement etc. (most of these cost relate to the public sector, but also part of it is borne by the business sector), some 5% relate to what is called "instrumentation", which mainly relates to research and informing the public(also partly public and partly private costs).

Some information on the Netherlands and UK is used to illustrate the costs of implementation of the WFD.

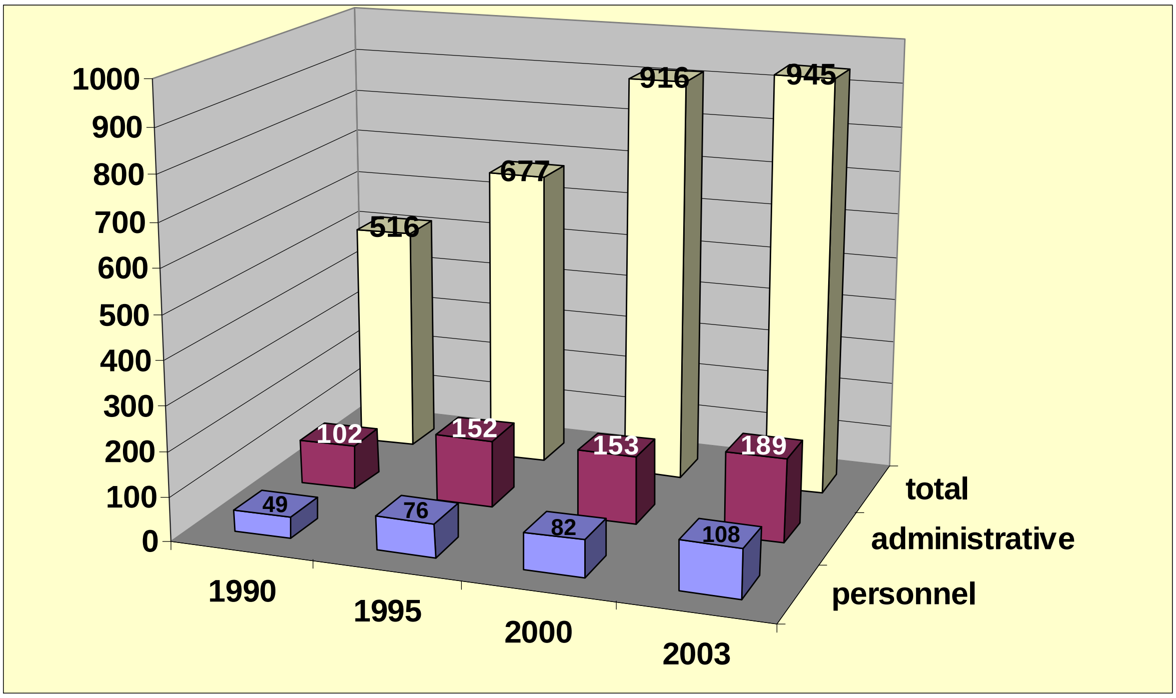
7.2.2 Administrative costs of the WFD in the Netherlands

For the Netherlands quite detailed statistics on the administrative costs for water quality are available over a longer period. This enables to place the possible additional administrative costs of the implementation into a broader perspective. It may also reveal some trends to consider.

In addition, a rough estimate of the administrative costs linked with the WFD has been made, based on interviews with some key actors in the implementation of. the WFD (see Box D below).

7.2.2.1 Current administrative costs

Administrative costs of water quality management in the Netherlands have been monitored since the 1970s. Water Boards perform the main tasks in the field of water management in the Netherlands, they are the main public service providers for waste water treatment and also in monitoring, enforcement and permitting. Figure 21 gives an overview of the development of their expenditures in the period 1990 – 2003 (latest year with available statistical information).



source: CBS (2006)

Figure 21: Development of expenditures on water quality management by Water Boards in the Netherlands, total, administrative costs and personnel costs (included in administrative costs) (1990-2003, in million Euro)

Figure 21 shows that administrative costs more or less keep pace with total expenditures, at a level in 2003 of 20%. The total administrative costs can be subdivided into (CBS (2007)):

- office costs 27%
- fee collection 19% (water boards also operate waste water treatment plants, for which they collect cost-covering user fees);
- plan development 8% (these costs have almost tripled between 1999 and 2003);
- water quality management 22% (mainly costs of monitoring);
- water discharge management 24% (mainly costs of permitting and control of permits).

Based on this, a rough estimate of administrative costs can be made for the implementation of the WFD: the assumption would be that for every million of additional costs for the implementation of the WFD, about 20% administrative costs should be anticipated. Of course this assumption can be challenged, but the empirical evidence over a period of 13 years shows that ongoing development of water related legislation and implementation also requires more administration in absolute terms. Applying this to the estimated annual costs of the implementation of the WFD in the Netherlands the additional costs can be estimated at between € 80 M and € 230 M.

In comparison with a specific estimate that has been made on basis of information of experts working for the water boards in the Netherlands (see Box below), these estimates are at the high end. According to the specific estimate (explained in the box) the additional annual administrative costs of the WFD would be closer to € 50 M per year. But even if the lower cost estimate is taken, it is clear that in the Netherlands, it is believed that the implementation of the WFD will lead to considerable additional administrative costs.

BOX D Assessment of additional administrative costs for the WFD

The additional administrative costs linked with the WFD have been estimated by interviewing several individuals that are involved in the implementation of the WFD. In total 3 cost categories were mentioned:

- Monitoring;
- Planning; and,
- Modelling (GIS).

A. Monitoring

The WFD gives some additional administrative obligations, of which the most important one is, that - with respect to the past - the WFD expects more frequent and more structured reports. Gains can be achieved by taking a larger integrated overview by river basin and by a better harmonisation and streamlining of data, which also allow for data comparisons between river basins. In the Netherlands, monitoring of substances and suppression resources is (and remains) frequently outsourced. Other monitoring is examined ad hoc (own service or outsourced). The monitoring (recording data) of surface water is generally not automated as is the case for groundwater.

Costs of monitoring

It has been agreed that in the Netherlands in total 40 water bodies will be monitored within the framework of the WFD: 20 water bodies (mainly large state waters) will be monitored completely (situation and developments) at 2 or 3 locations per water body (total 50) and 20 (smaller) water bodies will be monitored operationally (parameter parcel is considerably smaller) at 1 location per water body. Per location parameters will be measured once or up to 12 times a year. It is estimated that complete monitoring costs (all-in, but labour costs excluded) are about € 200,000 per location for rivers and lakes and approximately € 260,000 for coastal waters. Operational monitoring costs are estimated at € 50,000 per location. Total monitoring costs for the 70 locations are estimated at € 11 million.

According to the WFD, a complete monitoring is obligatorily only once per planning period of 6 years. In the Netherlands it is agreed that a complete monitoring will take place once every 3 years. For the other 2 years it is agreed that operational monitoring will be sufficient for these (50) locations. The smaller water bodies (20) will be monitored operationally every year. Therefore, per sequence of 3 years, total monitoring costs (labour costs excluded) can be calculated as shown in the following Table 22.

Table 22: Estimated costs of monitoring for the WFD in the Netherlands

	No. of locations	**Costs (€)**
Year 1		
Complete monitoring	50	10.000.000
Operational monitoring	20	1.000.000
Year 2		
Operational monitoring	70	3.500.000
Year 3		
Operational monitoring	70	3.500.000
Total for 3 years		18.000.000
Average per year		**6.000.000**

Source: RIZA, 2003, Monitoring surface waters according to the WFD, annex 4.

Of the (on average) € 6 million per year, 75% is additional with regard to existing monitoring programs. Therefore, each year € 4.5 million can be attributed to administrative costs of the WFD. No information is available on labour costs of analysing and reporting, but if (in total for the Netherlands) 5 full-time equivalent (fte) is required, total annual monitoring costs can be estimated at € 5 million.

B. Planning
In the Netherlands there are 27 water boards (2005) with total personnel of about 10,000 (source: www.cbs.nl and www.vemw.nl). Annual reports of the water boards show that at least 1% of their personnel (5 fte per water board) is fully employed on drafting plans for implementing the WFD. Also national ministries and provinces have personnel employed on drafting WFD plans.

There are specific plan developments (management plans) for the WFD. For the Meuse, Rijn-Oost and Rijn-West separate project offices have been set up as a new type of co-ordinating and decision making structure. The project offices are in charge of plan development, establishes agendas for other agencies and will carry out some tasks themselves. The Meuse office consists of representatives of the state, provinces and water boards (total 4.5 fte), each contributing one third of the office costs. Municipalities are indirectly involved, by means of 7 water ambassadors. In the Rijn-West office only water boards are represented.

By region several plans are co-ordinated and incorporated into one plan. This will certainly lead to a more efficient and effective policy implementation. From the WFD there is an obligation to realise goals in 2015 for the River Basin Management plans. Associated budgets and time schedules to facilitate the realisation of the goals can be set if all Area Management plans (that interfere with River basin Management plans) are ready (in charge at national ministries).

Costs of plan development
Currently little is known on administrative costs in EU Member States related to environment and water, but statistical evidence from the Netherlands shows that administrative costs of the water boards (which perform the main water management tasks in the Netherlands) are on average 20% of total costs (20% of 1 billion Euro). Most of the administrative costs relate to plan development and preparation, and dissemination of legislation.
As mentioned earlier, taking all the water boards together there are currently about 100 full-time equivalent (fte) additional staff employed to address WFD issues. This costs about € 10 million per year. This is in line with a very rough estimate (based on one province in the Netherlands), that for all Dutch provinces together about 150 fte additional staff is employed to deal with WFD issues.

About € 35 million per year is needed for external advice (GIS, reports, etc.). This applies especially for the stage that the implementation of the WFD is currently in. One may assume that these expenses will diminish (updating a GIS system is less costly than making one).

C. Modelling (GIS)
The river basins are not currently being modelled within the context of the WFD. It is expected that this will be the case at a later stage (for now it is only part of discussions). Costs are covered in Section B.

Total
From the description above it can be estimated that plan development requirements of the WFD could lead to an increase of yearly administrative costs of approximately € 50 million. This can be subdivided as follows:
- costs of monitoring: € 5 million per year;
- costs of planning (100 fte´s): € 10 million per year; and,
- costs of external advice: € 35 million per year (may be less after first planning cycle).

This is about 25% (maximum estimate) of the present total administrative costs of € 200 million per year. Part of this increase is already realised (and incorporated in budgets), part of the additional costs will have to be made in the near future.

As the observed existing and additional administrative costs are considerable, it is an interesting question how these costs will develop in the future. As shown earlier, administrative costs are quite constant in relative terms (20% in the Netherlands). If this trend continues, in absolute terms these costs may be expected to increase in the coming years due to:
- the additional implementation of policies in pipeline; and,
- the implementation of the WFD.

As shown earlier, these additional expenditures may lead to almost a doubling of the current total costs, implying also almost a doubling of administrative costs. Following this approach, it can be assumed that the additional administrative costs of the WFD will be absorbed in the general increase that will probably occur.

7.2.2.2 United Kingdom

In the UK an indicative assessment of the costs (and benefits) of the implementation WFD is made (WRc, 1999). This assessment includes an overview of possible additional administrative costs of the WFD. In the study, three types of administrative costs have been distinguished:
- administrative arrangements (setting up of committees, costs of staff and meetings);
- planning process according to a 6-year cycle;
- monitoring according to a six year cycle.

Making assumptions on the administrative arrangements needed, the following costs have been estimated (Table 23).

Table 23: Administrative costs related to the implementation of the WFD in the UK, discounted total (at 6%) and annual average (in million £ and €)

	total costs (discounted)		annual costs	
cost item	Pounds Sterling	Euros	Pounds Sterling	Euros
administrative arrangements	3	5	0.2	0.3
Planning	20	30	1.2	1.8
monitoring and assessment	94	141	5.8	8.6
Total administrative costs	117	176	7.2	10.7

Source: based on WRc, 1999

As the report on costs and benefits of the implementation of the WFD does not reveal the current administrative costs, it is difficult to interpret these results. But in comparison with the totally estimated costs for the implementation of the WFD (of between £ 3 - 11 billion), the estimated additional administrative costs could be between 1% and 3% of total costs.

Benefits of administrative requirements/arrangements

The additional administrative requirements of the WFD may also lead to some benefits:
- participation of stakeholders (for example farmers, industries, communities) may lead to cost savings, which easily can be between 1 and 10% of incremental costs (this is at least the assessment of a British study);
- a clever preparation of a cost effective implementation of River Basin management Plans can only be achieved at certain costs, but may also save considerable amounts of incremental costs to achieve good water status; and,

- for all involved, administrative arrangements should guarantee a “level playing field” (which should be a general feature of good administration).

Participation of stakeholders in the implementation of the WFD, by involving them in the process of the implementation of the WFD can save considerable costs, to the opinion of the WWF (WWF (2005). An example is the restoration of straightened rivers to a more natural meandering type of flow. If this is done without involving for example landowners, it can be anticipated that high costs will be involved due to legal procedures. It is believed that at least some of these costs could be saved by the active participation and involvement of stakeholders in the process.

In addition, the involvement of different stakeholders may lead to an exchange of key information needed in the decision-making process, thus leading to better decisions. Due to the complexity of the relation between actions that need to be taken to achieve good ecological status a large amount of information is needed, which will be costly. By involving stakeholders, the collection of such information may become considerably cheaper.

Involvement of stakeholders can also reduce conflicts, as potential conflicts of interests will be flagged up early in the planning process, thus creating more opportunities to solve conflicts at the start.

For the UK, WWF estimates annual costs of partnerships at ₤ 2.2 M per year, whereas they expect at least a saving on implementation costs of 1%, leading to an annual saving of already ₤ 4.5 M. So even a relatively marginal saving would already justify the additional costs of stakeholder involvement.

Another approach is to assess the potential savings of a clever implementation of the WFD. It has been shown, that a top down regulatory approach, which is often followed in the implementation of environmental policies, can turn out very costly for stakeholders. At least, it does not at all guarantee a cost-effective approach. For example, a benchmark study on public (waste) water services in the Netherlands has shown, that the costs of the provision of the same level of service, is considerably cheaper in some regions than in others. Unexplained cost-differences and thus possibilities for saving of up to 30% have been found (Ocƒeb (1997)). Another study (Veeren van der (2002)) shows that an integrated and cost-effective approach of reducing nutrient discharges in the Rhine Basin, may generate considerable cost-savings. But again, to achieve these savings, additional research needs to be carried out, and knowledge on the costs and effectiveness of measures needs to be collected.

The general conclusion may be, that a cost-effective and integrated approach will generate considerable financial benefits, but that it will also need considerable attention and thus funding (especially for independent research).

Although the WFD requires an assessment of the cost-effectiveness of River Basin Plans, there is no guarantee that this will actually be the case in the short term. First of all, because environmental and water authorities have little to no experience with the concept of cost-effectiveness. Secondly, because up to now, no concrete bottom-up information on the cost-effectiveness of measures is available, which is a basic requirement for a decent cost-effectiveness analysis. Thirdly, because the guidelines on cost-effectiveness (which exist for example for the Netherlands, Germany and the UK, but also the WATECO guidelines) are in no sense conclusive and leave much room for (mis)interpretation.

So the question remains, whether cost-effectiveness analysis, in the way it will be carried out under the WFD, will really lead to the considerable cost-savings that in theory are possible.

7.3 Analytical review

From the little evidence available on administrative costs linked with the implementation of the WFD, two quite opposite conclusions could be drawn:

- the estimates for the Netherlands reveal that there will be considerable additional costs, but that in relative terms administrative costs will not increase;
- for the UK one may argue that although considerable additional costs for the implementation of the WFD are predicted, the additional administrative burden will be only a few percent of the total costs. Assuming that in the UK, current relative administrative costs would be in the same range as in the Netherlands (20%), the implementation of the WFD would hardly lead to an absolute increase in administrative costs and a decrease in relative costs.

The administrative costs will further depend on:

- the efficiency of measures; and,
- the available manpower and budgets.

Additional administrative requirements may both improve overall administrative efficiency or push aside other tasks. There is currently insufficient information available to evaluate the relative importance of these issues.

7.4 Summary of key points

- There are certainly some extra administrative costs that can be attributed to the setting-up of plans for, and implementation of, the WFD. Estimating these additional administrative costs is not easy, for the Netherlands a rough estimate indicates additional administrative costs of € 50 million per year or about 25% additional to the current administrative costs of managing water bodies.
- Although in absolute terms the administrative costs of water management may be assumed to increase (in line with the additional expenditures due to the implementation of policies in pipeline and the WFD), it is reasonable to assume that administrative costs in relation to total costs will remain constant. An indication of the share of administrative costs as part of total water management costs is 20% (both from data from the Netherlands and the management of wetlands around the Baltic Sea);
- Benefits of administrative requirements that attribute to the setting up of plans for the WFD will result from integration with other water/nature related policies/planning and more effective decision making (obligation to achieve results). Here too, estimates (in Euros) are now difficult to make. If sound administration really supports cost-effective implementation, the savings may be much larger than the additional costs.

8 COSTS AND BENEFITS OF SPECIFIC WFD MEASURES

8.1 Introduction

The Good Ecological Status (GES) in the Water Framework Directive goes beyond quality standards set by earlier European water directives and national policies. In addition to traditional biological and chemical parameters, it also identifies some new parameters such as the composition, abundance and age structure of fish fauna and hydromorphological issues. Fish populations will benefit directly from the achievement of improved water quality, but additional measures are needed to promote fish movements to feeding/breeding grounds to fully reach a GES.

Currently the number of barriers in European rivers is of concern and the quality of design and construction of fish by-pass facilities does not necessarily mitigate the impact adequately, meaning that additional measures may be needed to achieve GES for this issues. In addition, it is argued that the impact of the WFD on hydropower may have some consequences for the achievement of the climate protection changes.

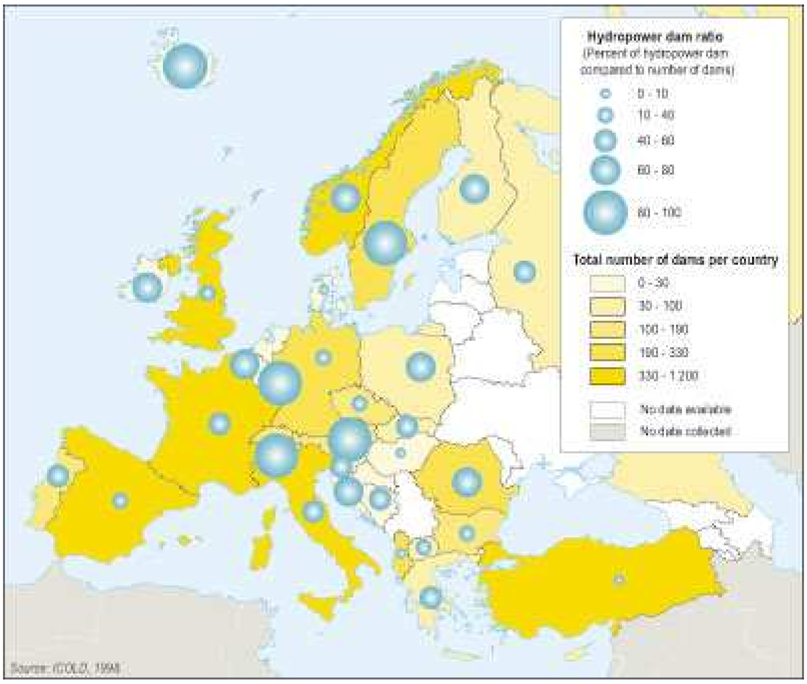
Hydromorphological issues include measures related to sediment management, the chanalisation/straightening of rivers and the return to natural rivers, and alterations of surface water profiles. The conservation and restoration of wetlands may have an important role in stopping or reversing hydromorphological changes – taking on the role as a flooding area, regulating erosion, sedimentation and pollution from agricultural lands. Wetlands are therefore included in this study to reiterate their importance to the WFD and the Programme of Measures.

8.2 Fish migration

8.2.1 Introduction

Most large European rivers are modified and contain hydropower stations, weirs, small dams and a range of other migratory obstructions. In some of the larger river systems the total number of obstacles can exceed a thousand, several of which may be complete obstructions to fish passage, but many of which might only be partial barriers but still preventing fish to reach their feeding and/or spawning grounds. All these infrastructures could also have an impact on the fish population by changing water flows and habitats, and so causing fish mortality. The rate of fish mortality depends on the species, the fish size, the type of turbine/obstacle and the river flow. Solutions for preventing fish migration disturbances are very location specific. It is not only the design of the infrastructure that leads to the choice of a certain measure, but also the characteristics of the fish species and the hydraulic circumstances (for example, the rate of river flow).

Figure 22 provides an overview of the concentration of hydro-power stations across Europe. Hydropower stations are generally located in regions with high rainfall and mountains.



(source UNEP)

Figure 22: Distribution of hydropower stations within Europe

In different Member States, studies have been carried out on fish migration and possible measures. Some results have even been incorporated in national or regional legislation. Several Water Boards in the Netherlands have formulated targets regarding fish migration. The Flemish region of Belgium uses a map of priority waters where all problems with regard to fish migration should be solved by January 2010. It categorised approximately 800 bottlenecks on 3000 km of priority waters for fish migration. In England and Wales, obstructions to the migration of salmon are targeted for action within the Salmon Action Plan. The river basin plans, as part of the WFD, are a framework to seek the restoration of fish migration in river systems.

The following measures are identified to solve fish migration problems:

- removing obsolete obstacles (small dams and water infrastructures not in use);
- fish friendly types of turbines, water intakes;
- adapted work regimes in peak migration periods;
- assisting up flow migration: ladders, lifts, transportation and minimum flow requirements; and,
- assisting down flow migration: fish guidance systems or mechanical barriers, and hydraulic by-passes.

Ovidio and Phillippart (2002) propose the following scheme for the solution of fish migration bottlenecks: “Before choosing a measure one should know why fish can not by-pass the obstacle and what the effects are on the fish living upstream and downstream of this obstacle. An important question is also the usefulness of the obstacle. If it has no function anymore it can simply be removed. A second step is to see if the obstacle can not be adapted to make more fish by-pass it without the construction of a fish by-pass for example, fish friendly water intakes and the restoration of former meanders. A last option is to build a technical fish by-pass. This must be adapted to the chosen species and hydraulic variables of the location.”

8.2.2 Overview of costs and benefits of fish migration measures

8.2.2.1 Overview

Although there is a great deal of information available on the types of fish migration measures and some information is available on their efficiency, there are few cost and benefit assessments published. Some information on investment costs is available in case specific studies on fish migration and dams. But there is little literature is currently available on the opportunity costs and the benefits of fish migration measures.

The European Interreg IIIC programme “From Sea to Source” provides information on the problems surrounding fish migration bottlenecks and how to prevent or solve those problems. It lists a number of case studies, but no quantitative values for costs and benefits are given.

Hakansson et al. (2004) presents a cost-benefit framework for use in Sweden to analyse the interaction between hydropower operations and salmon populations. In the available article no comparison between the costs and the benefits is given.

The Austrian Eurelectric Member has provided some cost-studies concerning fish migration measures on different types of hydropower installations (see Box E in Section 8.4). In the U.S. numerous studies exist about local costs and benefits of dam re-licensing and dam removal.

8.2.2.2 Costs

Due to the site specific solutions, upstream as well as downstream mitigations exhibit significant ranges in costs.

Investment costs of dam removal

Although modernising and upgrading existing infrastructures is an option, it is better to first investigate if the obstacle is still of use as proposed by Ovidio and Phillippart (2002). An American study on small dam removal (Trout Unlimited, 2001) showed that it is more cost-effective to remove the infrastructure when its economical benefits are small than to invest in modernising structures.

Table 24: Costs of removing small dams in the United States of America

State	River	Name of Dam (Year Removed)	Estimated Repair Cost ($)*	Estimated Removal Cost ($)*	Actual Removal Cost ($)*
CA	Butte Creek	Four dams (1998)	N/A	9.500.000	9.130.000
CA	Cold Creek	Lake Christopher (1994)	160,0000 - 180,000	N/A	60,000 - 100,000
FL	Chipola	Dead Lakes (1987)	N/A	32,000	32,000
ME	Kennebec	Edwards (1999)	9,000,000**	N/A	2,100,000
ME	Pleasant	Columbia Falls Hydro (1998)	80,000***	N/A	20,000 - 30,000
ME	Souadabscook	Grist Mill (1998)	150,000	N/A	56,000
MN	Cannon	Welch (1994)	N/A	120.000	46.000
MN	Kettle	Sandstone (1995)	1.000.000	300.000	208.000
NM	Santa Fe	Two-Mile (1994)	4,100,000	N/A	3,200,000
WA	Whitestone	Rat Lake (1989)	261,000	N/A	52,000
WI	Baraboo	Waterworks (1998)	694,600 - 1,091,500	N/A	213,770
WI	Willow	Mounds (1998)	3.300.000 - 6.000.000	1.100.000	500.000
WI	Willow	Willow Falls (1992)	5.000.000 - 6.000.000	622.000	450.000
WI	Yahara	Fulton (1993)	900,000- 1,000,000	N/A	375,000
WI	Black	Greenwood (1994)	500,000	N/A	80,000
WI	Embarrass	Hayman Falls (1995)	455,000 - 800,000	N/A	180,000
WI	Lemonweir	Lemonweir (1992)	700,000	N/A	190,000
WI	Manitowoc	Manitowoc Rapids (1984)	30,000 - 250,000	N/A	45,000
WI	Kickapoo	Ontario (1992)	100,000 - 200,000	N/A	47,000
WI	Prairie	Prairie Dells (1991)	725,000	N/A	200,000
WI	Apple	Somerset (1965)	30,000	N/A	75,000
WI	Milwaukee	Young America (1992)	313,000	N/A	74,000
VT	Clyde	Newport No.11 (1996)	783,000	N/A	550,000

* Dollars are assumed to be in the year the dam was removed.
** Cost of installing fish passage.
*** Cost to repair fish ladder.

Source: Trout Unlimited 2001

Investment costs for the adaptation of a fish obstruction

The Common Implementation Strategy workshop concerning the WFD and Hydromorphology (CIS WFD, 2005) suggested that the development of hydropower capacities could be supported first by the modernisation and the upgrading of existing infrastructures. If this is combined with fish friendly adaptations of the turbines, down stream fish migration will especially benefit without huge extra costs and without (or with a small) loss of energy production (Peltier 2003; Fischer, 2001). In Europe research has been done to develop fish-friendly Pelton- and Francis-turbines for dam heights larger than 20 m (Couston, 2003).

Investment cost of constructing a fish by-pass

The main problems in constructing upstream fish by-pass facilities are largely economical, although in some cases, for example in highly populated areas or at high-head hydro-electric dams the problems are also technical (Kroes, 2006). Solutions must first be found in the adaptation of obstructions before embarking on construction measures The costs may be lower if fish migration measures are taken into account from the start of the design of the infrastructure/hydropower installation. A Waterschap Hunze and AA study (2003) in the Netherlands provides some cost estimates for fish migration measures (Table 25).

Table 25: Cost estimates for fish migration measures in the Netherlands (in euros)

Priority	Name	Total costs
1	Fish-f riendly venturi pump	134.000
2	Fish by-passes	50.000-100.000
3	Adapting fish by-passes	100.000-200.000
4.	Test case fish migration Polders	20.000
Total		**320.000-475.000**

Source: Waterschap Hunze en Aa's (2003).

Another study in the Netherlands estimates the cost for fish by-passes to range between €50 000 and €5 000 000, depending on the type of water body and the purpose of the fish by-pass (Ruijgrok, 2006).

Elvira (1995) quotes the following cost ranges for different technologies or measures: € 22 000 to €149 000 for pool type; €14 900 to €119 300 for sloping channel; €14 900 to €119 200 for lifts; and, €222 400 to € 372 800 for automatic lifts.

In Finland a cost-benefit analysis assesses the impact of installing fish ladders to assist salmon to migrate upstream of two hydropower plants – the sensitivity analysis indicates that the efficiency of the ladder and the initial smolt survival rates the most critical issues in the assessment (Laine, 2006).

In Scotland the vast majority of the fish by-passes were built more than 50 years ago. They have not retro-fitted any fish by-pass facility and only one small dam has been built with a fish by-pass in recent years. The authorities are currently investing around 750k euro per year to refurbish these facilities. It should be noted that these are targeted specifically at salmon and sea trout. Other species can use them with varying degrees of success.

In general, therefore, investment costs in fish migration measures can range from between €50 000 to €5 000 000.

Opportunity costs

Physical fish guidance systems influence the output of the power installation by causing a loss of energy levels. Behaviour changing systems have no influence on the hydrodynamic return of the power installation. By-passes take a part of the usable flow of an installation. Little information on these losses is available in literature.

Hakansson et al. (2004) assume a yearly loss of 1,5 MSEK (approx. 13 600 000€) at the Stornorrfors plant (Sweden), with an assumed value of 1 MSEK (approx. 9000 000€) per day generated by the daily production of electricity. These numbers are based on rudimentary calculations.

Depending on the type of fish by-pass the cost of water losses can differ strongly. Due to the fact that for example, the Scottish dams are associated with storage hydro hence the power station is not located at the dam, the cost of the water losses is relatively small. The fish by-passes at the dams are utilised to pass compensation water into the rivers hence the flow through them, although a loss to generation, cannot solely be attributed to fish passage. i.e. the river down stream would be dry if water was not allowed to be discharged. The Scottish electricity company mentioned a few stations where additional water is passed down a fish by-pass and therefore loss to electricity generation occurs. However these examples are at low head/high flow sites so that the volume discharges down the pass is relatively small.

The Austrian electricity sector also calculated the losses on 3 different types of fish by-passes (See Box E).

Box E Example of Austrian cost-studies for fish by-passes for hydro-power dams

Austrian hydropower plants with fish by-passes for their dams provided the following information on investment costs and costs of water losses for electricity generation.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
vertical slot fish ladder	200 000	3.8				
vertical slot fish ladder	170 000	1.3				
lower section: vertical-slot; middle section: capped, gently inclined (gedeckelte Flachpassage); higher section: natural-like-rivulet (naturnahes Gerinne)	334 600	6.33	13	250	110000	
vertical slot fish ladder	70 000		5.3	250	42000	40 000
combination of natural-like-rivulet and vertical-slot-fish-ladder	380 000		15.8	300	163000	158 000

(1) investment cost fish by-pass
(2) height fish by-pass [m]
(3) energy production of the power plant (GWh/a]
(4) allocation of water to the by-pass [l/s]
(5) costs of losses [kWh/a]
(6) cash value of losses (€) (50 years, 6,9% WACC)

A study carried out to assess the impact of providing fish passage facilities at hydropower plants in Austria, using different scenario models, estimated that the costs could reach € 90 m (Stigler, 2005). The study concluded that the economic impacts were strongly dependent on the type, size and utilization strategy of the respective hydropower plant.

An American *ex-post* cost benefit analysis (Kotchen et al., 2006) found the extra producer costs of changing flow rates from peaking to run-of-river flow, in order to improve habitat conditions downstream, ranged from \$219 132 to \$402 0941 per year. These costs are due to less hydroelectricity generated during peak demand, and more during the off-peak period. This means that the electricity company had to adjust the timing of its thermal electricity generation in order to maintain the same levels of combined peak and off-peak production.

The production losses at the hydropower plants must be set off in some cases by other power plants to meet the electricity demand. If this is done by thermal power plants, it is argued that the requirements of the WFD will jeopardize reaching the goals of climate change mitigation set for the Kyoto Protocol. Parts of the energy loss could be overcome by measures such as energy efficiency measures or other renewable sources than hydropower, but these may result in higher costs. Furthermore, reductions in hydropower production would also have negative impacts on grid regulation and back-up for intermittent resources, such as wind power. [22]

8.2.2.3 Benefits

The efficiency of fish by-passes is measured through monitoring the number of fish by-passing the obstacle. Fish migration measures are effective if during their design not only the hydropower installation type but also the target species and hydraulic conditions are taken into account.

For the moment little information exists on the effect on fish population levels. The assumption is that increased fish populations will results in increased benefits for commercial and recreational fishing.

Use-values

An example from the Manistee river (Kotchen et al., 2006) reports on the adult fish population of Chinook Salmon increasing from 28 % to 82% on return to a run-off-river flow. This was translated into a higher catch rate. Recreational fishing benefits were then estimated through a travel cost method to be between \$301 900 and \$1 068 600 a year.

In a study by FERC, US, fishing values for anadromous species ranged from \$5 to \$40 per day (1999). Values associated with marginal changes in fishery quality ranged between \$2 to \$153 per fish caught.

Non-use values

A number of case studies show that people have a certain Willingness to Pay (WTP) for improving fish population (Hakansson et al., 2004).

These reports indicate that people are willing to pay extra for their electric bills just to know that there is a fish population out there, even though they may never even go fishing or eat the fish. That is a non-use value, one that should be included to get a representative set of monetary values for costs and benefits. More research still needs to be done to arrive at an acceptable set of procedures

[22] Personal Communication EURELECTRIC (2007)

for placing resource values on the environmental resources of hydro-electricity dam projects. For example, the values for each salmon in the Pacific Northwest may range from $10 to $500 to $900 per fish, depending on how the values are derived. There is still a great deal of controversy concerning these assessments because, if the value is low, installing a fish-ladder may not be justifiable; if it's high, then a fish-ladder can be justified. (in Hydropower licensed to protect the environment, interview with Mike Sale and Chuck Coutant, both of ORNL's Environmental Sciences Division, US).

Economic benefits of removing small dams

Case studies from the United States illustrate some of the economic benefits to be gained by the removal of small dams. The removal of Ontario Dam from the Kickapoo River in southwestern Wisconsin in 1992 increased the number of canoeists in the river. In 1999 alone they spent $1.2 million on lodging, canoe rentals, groceries, gas and other items. This revenue helped support 36 jobs in the area. This is of course a very local cost-benefit analysis. The Ontario dam removal also resulted in cooler, less silty water, conditions much better for trout. Fishing is a popular activity in the watershed and non-local angler expenditures are more than $1 million annually. Removing small dams can be the most cost-effective and biologically effective approach to restoring fish habitat and increasing fish populations (Trout Unlimited, 2001). On the Consetoga River in Pennsylvania, ten small dams were removed, improving river habitat at a cost of less than $12,000 per mile. For comparison, in stream restoration efforts of fish habitats – including measures such as bank stabilisation and installation of fish habitat structures – can cost $30,000 to $50,000 per mile.

In summary we can expect:

- Significant cost savings for repairing and maintaining dams (see section on costs);
- Potential for local recreation and growth in tourism (river walks, swimming, fishing); and,
- Decreased costs related to water quality improvements and fisheries management.

It will need case-specific analyses to evaluate how big these potential benefits will be.

8.2.3 Analytical review

There are few cost-benefit analyses of fish migration measures. Most of the studies concerned are qualitative studies or cost-effectiveness studies. So a comparison of costs and benefits is currently not possible.

Fish migration measures can go from ‘cheap’ to ‘expensive’, but they may also bring many economical benefits to society if it is seen in the context of water quality, recreation, fisheries and biodiversity, and not only in the context of energy production by hydropower. American studies on small dam removal show that the most cost-effective measure could be to remove the obsolete (i.e. not in use) obstacles (effective for fish migration and water quality, and involving low costs).

One may ask four questions about the costs of fish migration measures:
- Is the infrastructure necessary, still in use?
- Are the costs of the measure in balance with the environmental benefits?
- Are the costs bearable by the owner of the hydropower installation or other infrastructures?
- Are the costs reasonable in comparison with the profits of the installation?

By answering those questions one may come to a cost-effective solution for restoring fish migration routes. Prioritising waters and measures is very important because full restoration of migration routes in river systems may be a very difficult and expensive goal. In most cases it is simply not possible to resolve all of the problems at once and for this reason a phased approach is often required. Prioritisation for action should be on the basis of criteria agreed at the outset and the timescales should be in line with those of the WFD. It may be the case that more than one solution might be identified to resolve an obstruction and, subject to an assessment of the costs and benefits of each, it is preferable to select the most natural solution (Kroes et al., 2006).

8.2.4 Evaluation and lessons learned

We can conclude from this overview that there is a great deal of information on different fish by-passes, but little information on actual costs and benefits. This is due to the fact that the building of a fish by-pass is very species and location specific. Furthermore, due to the lack of knowledge between the measures and their effect on the total fish population in a water body, it is very difficult to calculate the benefits. Therefore, to measure how fish migration measures can contribute to the overall WFD objectives, a focus on the effect of measures on the total fish population is needed.

There are no published assessments of the costs and benefits of fish migration measures in Europe. A couple of North American studies, however, provided evidence that the removal of unused dams or weirs brought benefits to local communities in the form of improved recreational fishing facilities.

A good cost-effectiveness analysis is needed to compare different measures:

- removal of obsolete (i.e. not in use) obstacles could be cost-effective;
- upgrading the older installations with fish-friendly turbines could be more cost-effective than building fish by-passes/ new installations (lower fish mortality, higher productivity) – but cannot not accommodate fish that migrate upstream; and,
- an integrated approach is necessary for the design of new fish by-pass installations and creation of suitable habitats.

To obtain the objectives of the WFD, measures concerning fish populations need to be taken into account in different sectors (for example, hydropower, commercial fishing, recreational fishing).

The economical costs in relation to Climate Change Policy targets could increase due to the loss of electricity production in hydropower. The loss in electricity production with hydropower could make it more expensive (for example, other renewables, more investments in prevention, …) to reach the Kyoto Protocol objectives for some Member States.

8.3 Wetlands

8.3.1 Introduction

The WFD stresses the importance of wetlands as an integral component of river basin management. The deterioration of wetlands is for some water bodies one of the reasons for the degradation of water quality (due to higher rates of erosion, less nutrient retention), decline in coastal and riverine flora and fauna populations, decline in groundwater levels and an increase in flood risks. So wetlands are on the one hand the subject of protection, whereby measures are taken to prevent deterioration (i.e. a maintenance measure). On the other hand, wetlands can be newly created for water treatment, flood protection and other functions (i.e. an investment measure).

The importance of wetlands is also stressed in other legislation and agreements. Member States have reported on the wetland areas protected under the RAMSAR Convention (Figure 23). In addition, there are more than 5000 constructed 'treatment wetlands' across Europe (US-EPA, 2004).

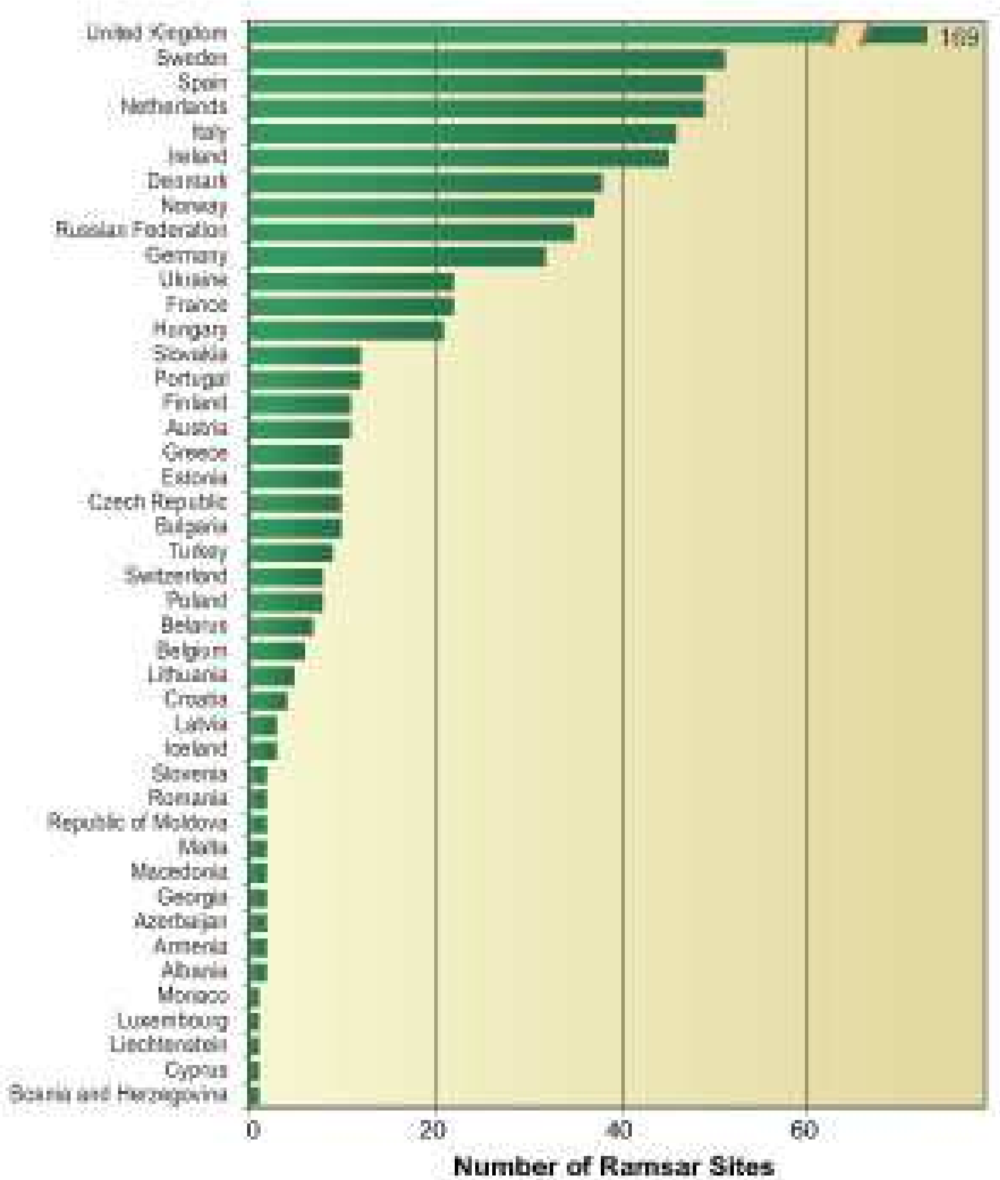


Figure 23: Number of RAMSAR sites reported in Europe (Source: EEA 2006)

8.3.2 Overview of costs and benefits of wetlands

8.3.2.1 Overview

There are several individual studies on wetland valuation and wetland restoration. It is not the purpose of this study to sum up all the individual studies on wetland valuation, but to review the information on costs and benefits of wetlands in relation to the Water Framework Directive.

According to the Horizontal Guidance on the role of wetlands in the WFD(2003): “The protection and enhancement of surface water and groundwater will be achieved through the application of the Directive’s environmental objectives, and where appropriate through the use of wetland protection and restoration to help fulfil these objectives in a cost effective and sustainable manner.” As wetlands are a crosscutting issue, the purpose of this Guidance is to elaborate a common understanding of the WFD requirements regarding wetlands and identify their role in its implementation.

EUROWET (2005) is a specific support action on the thematic priority "consolidating knowledge on the role of wetlands in the water cycle.". The study stresses the evidence of wetland functions playing an important role in River Basin management. The use of wetlands to achieve pollution control, alleviate the impacts of floods and droughts, achieve sustainable coastal management, and to enhance groundwater recharge could help in achieving the WFD objectives. The Technical Guidelines of EUROWET attempt to address the majority of the topics to be revisited or further developed, that were mentioned in the CIS Horizontal Guidance document. Also socio-economic values are taken in consideration.

EVALUET + WEDSS (Wetland Evaluation Decision Support System) links a functional assessment knowledge base with methods of socio-economic valuation within a GIS environment. The knowledge base carries out assessments of hydrological, biogeochemical and ecological wetland functions using data which can be rapidly gathered in desk studies or field visits. By integrating functional and valuation information within a single tool, decision makers can consider all of the relevant information within wetland management and can fully consider wetlands within integrated catchment management. This is done by multi-criteria analysis.

In the Netherlands (Decembernota 2006) a study on cost-benefit analysis for different ambition levels of complying with the WFD also takes hydromorphological measures into account. It estimates the costs and benefits of a package of these measures combined with other more technical measures. In the context of the development of a long term vision for the Scheldt-estuary [23]the Dutch and Flemish governments used cost-benefit analysis and strategic environmental impact assessment to evaluate the use of floodplains and wetlands for flood protection and nature development (De Nocker et al., 2004).

8.3.2.2 Costs

Investment costs

Costs to restore or to develop wetlands are very location specific and depend on the type of wetland. Restoration of floodplains may need expensive infrastructure works, whereas other wetlands may need only small interventions to restore or optimise wetland functions.

A cost-benefit study for creation of floodplains and wetlands in the Scheldt Estuary showed a range between k€ 30 and 400/ha. Creation of natural floodplains and semi-natural inundation areas for flood protection are among the more expensive ones and costs were estimated to cost k€ 150 – k€400/ha. The upper part of the range is due to relocation of levees and sluices behind the flood area to protect against more extensive flooding. Creation of minor inland wetlands in Flanders (for example, wet meadows) are much cheaper and were estimated to cost approximately €30 /ha.

Opportunity costs

In addition to the restoration or creation cost of the wetland itself, there are also costs concerning the

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[23] see The Scheldt Estuary Development Outline 2010**:** www.proses.be

loss of land for the previous user. The value for society of the loss of agriculture land depends on the suitability of the land for agriculture (which is reflected in the type of crops grown) and how important it is for the farms affected. In the study for Scheldt, this is estimated to be on average €30K/ha, but with a wide range depending on the crops grown. (De Nocker et al., 2004). Pasture, or meadows close to the river is likely to have a lower value for agriculture than farm land used for more valuable crops.

In general, restoring wetlands is cheaper than developing new wetlands with costs ranging between $9 000 to $200 000 per hectare. These costs increase with the planting of trees and shrubs. Initial construction costs of treatment wetlands are relatively low compared with traditional water treatment systems, because wetlands require little maintenance, so that long-term costs are also quite low. The cost of a constructed wetland is proportional to the number and sizes of treatment cells required. In general cost estimates range from $86 500 to $370 000 per hectare (USEPA).

8.3.2.3 Benefits

As part of the Programme of Measures, wetland creation, restoration and management, may prove a cost-effective and socially acceptable mechanism for helping to achieve the environmental objectives of the Directive [Article 11.4; Annex VI, Part B(vii)]. Wetlands have the potential to offer benefits in terms of different “goods and services” they provide - flood prevention, nutrient and pollutant load abatement, wildlife protection, tourism and recreation (De Groot (1992), Costanza et al. (1997), Gilbert and Jansen (1998), Brouwer et al. (1999), Barbier (2000), Turner et al. (2000)):

- Wetlands can be valued using the ecosystem function approach, as explained in Section 3. The first step is the identification of the relevant functions that link wetland ecosystem structures and processes to their various uses, referred to as “goods and services”. The valuation involves four stages: an assessment of the potential provision of the goods and services by the wetland;
- Determination of the extent to which the wetland actually provides the goods and services, and what the effect would be if the wetland were removed;
- Identification of the actual impact on human welfare of the goods and services; and
- Estimating the economic value of the goods and services.

The relevant benefits categories are:

- Wetlands improve water quality in nearby rivers and streams (nutrient retention, sedimentation, reducing erosion). The natural filtration process can remove excess nutrients, making it healthier for drinking water, bathing and supporting plants ad animals. The Morava floodplain (1727 ha) in Slovakia removes a quantity of nitrogen from the watershed equivalent to a removal by a treatment plant with an investment cost of €7 million. The estimated monetary value (on the basis of replacement costs) of the nitrogen sink of the wetland is around € 682K per year.
- Wetlands can play an important role in water quantity issues for example, recharge of groundwater bodies, flood protection. They have the ability to store flood waters. After peak flood flows have passed, wetlands slowly release the stored waters, reducing the risk of property damage downstream or inland. A cost benefit analysis of flood protection measures to prevent the flooding of the river Scheldt, Belgium, estimated that the creation/restoration of 1800 ha of controlled inundation area would have a total flood protection benefit of €648 million until 2100 (Vito-RA-IMDC, 2004).

- Wetlands offer a number of commercial goods such as materials (wood, reed…) and food (fish, shellfish, plants). Two thirds of all fish consumed worldwide are dependent on coastal wetlands at some stage of their life cycle (source: Ramsar website). Wetlands provide a consistent food supply, shelter and nursery grounds for both marine and freshwater species. In the River Rhine Basin the fish production function due to wetlands was estimated to be $ 1.7 million per year.
- Wetlands offer recreational benefits for hiking, bird watching, fishing...
- In addition to the use-values, wetlands offer an important non-use value. A large number of contingent valuation (CV) studies focus on the use and non-use values of wetlands (see Crowards and Turner, 1996 and Brouwer et al., 2003 for a review). Pate and Loomis (1997) found that WTP for a wetlands improvement program in California, USA, is about €183 per household and that this value decreases as the distance from the site increases. Oglethorp and Miliadou (2000) for example found the that mean per capita WTP per year for use and non-use values of Lake Kerkini in Greece was €22.5. Finally, Brouwer et al. (2003) used 30 wetland CV studies to conduct a meta-analysis of wetland valuation studies. They found that use values (such as flood control, water storage and water quality attributes) had a stronger influence on the WTP than non-use elements such as the biodiversity function of wetlands.

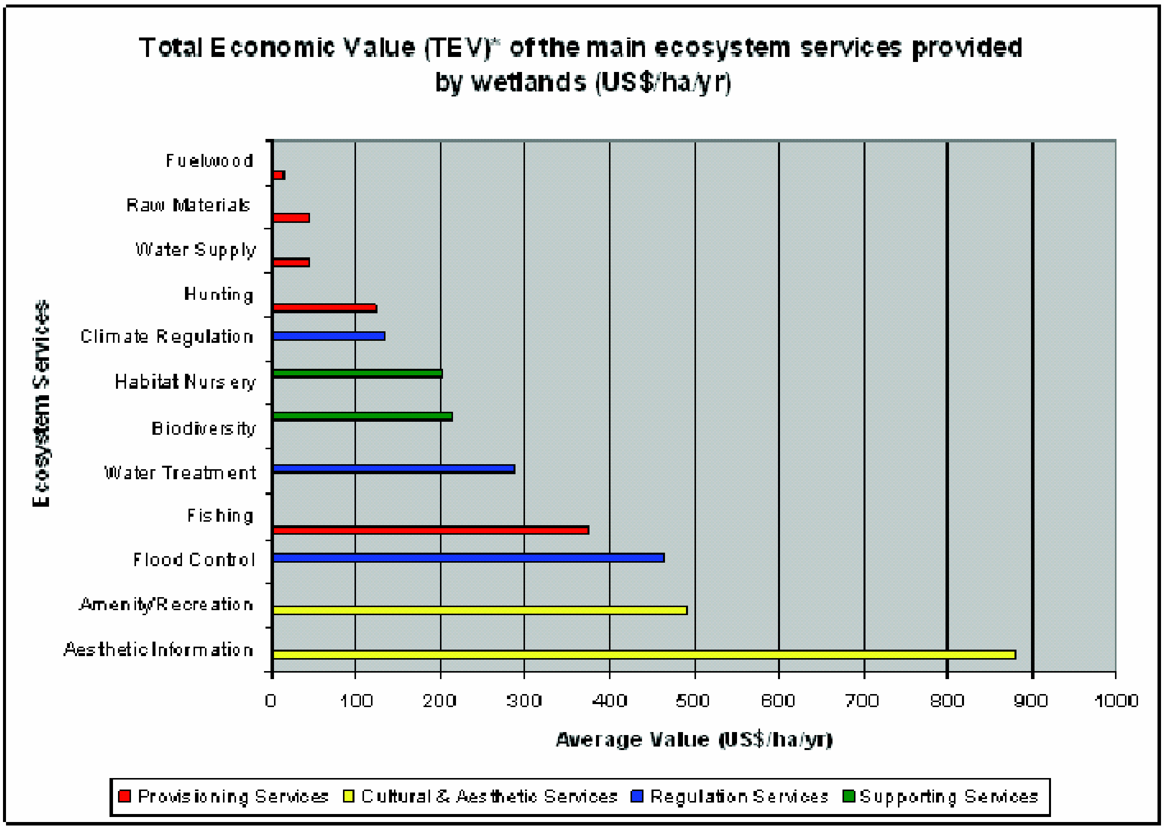
The societal value of wetlands is also determined by the actual level of provision of goods and services, the availability of substitute sources (for example, other natural areas, recreation areas), and society's preferences (EUROWET Technical Guidance).

8.3.3 Analytical review

There are many on-going studies on the valuation of wetlands in Member States and at the European level (for example, WEDSS, EUROWET). A large number of examples are given on the valuation of functions of existing wetlands, and a smaller number on the future benefits of restored/created wetlands. They all provide evidence of societal value for specific wetlands. Protection from external threats for example, housing development, irrigation, industry and mass tourism requires a different strategy than restoration or enhancement.

The total costs of wetland construction are between €9000 to €400 000/ha depending on the location and the need to replace flood protecting infrastructures needed to protect people living close by the rivers.

Total benefits may differ from wetland to wetland depending on which goods and services are provided. In Figure 24 average global values are given based on sustainable levels taken from two synthesis studies: Schuijt and Brander (2004) (calibrated for 2000) and Costanza et al. (1997) (calibrated for 1994), together covering over 200 case studies. Most figures are from Schuijt and Brander (2004), except the aesthetic information service and climate regulation. The overall total for the services assessed is 3 274 US$/ha/year, but this total includes not all possible goods and services so it is certainly an underestimation (De Groot et al., 2006). In a Dutch policy study the mean value for Natura 2000- projects is about €4000/ha/year (Kuik, 2006).



Source: De Groot et al. 2006

Figure 24: Total Economic Value (TEV) of the main ecosystem services provided by wetlands (US$/ha/year)

This type of indicator data need to be handled with care:

- First, the results of these show that wetlands may offer a potential for a wide range of benefits, but it needs to be examined in each case to which extent these benefits are relevant.
- Second, most of these benefits are marginal benefits, and may no longer be relevant or as much important if more wetlands are developed.
- Third, benefits that relate to avoided costs, e.g. for flooding, can only be reaped if it replaces additional flood protection measures.

These indicator data illustrate the potential for positive benefit-cost ratios provided most of the benefit categories are relevant and significant and costs are not extraordinary. For example, in the CBA of flood protection measures in Belgium (Vito-RA-IMDC, 2004) the total costs of 1800 ha of inundation area were estimated to be € 151M, with total discounted benefits (flood protection benefits and other goods and services provides by the ecosystem) estimated to be € 530M. A similar study using the same approach and assumptions also identified a number of more expensive projects for which there is no evidence that benefits will outweigh the costs (De Nocker et al., 2004)

Inclusion of wetlands in WFD-process and link with cost-effectiveness requirements

Although a wide range of studies shows that wetlands are cost-effective and have multiple benefits, it is not guaranteed that these benefits will be fully accounted for in the WFD-process of selection of measures. The network of European experts in EUROWET has been consulted to evaluate the extent so far of the actual inclusion of wetlands in the implementation of the WFD by Member States. The general impression from that consultation is that for the majority of the Member States it is not yet clear to what extent wetlands will form part of the environmental objectives, or the programmes of measures (EUROWET Technical Guidelines 2005).

In principle the selection of the most cost-effective sets of measures under Article 11 and Annex III of the WFD will be done through a cost-effectiveness analysis. The problem here is that a cost-effectiveness analysis of measures does not always indicate the full potential of wetlands. Due to their multi-functionality they may help to achieve different policy objectives at once (WFD, NATURA2000, RAMSAR, flood protection, European Marine Strategy, CAP…). For example, the restoration of floodplains can be a good opportunity to combine flood protection and increasing biodiversity and the restoration of hydromorphological impacts of former flood protection measures. Studies indicate that especially for some areas with HMWB, the creation of wetlands may make it possible to achieve good ecological potential.

8.3.4 Evaluation and lessons learned

The majority of the Member States do not have clear information on to what extent wetlands will form part of the environmental objectives, or the programmes of measures. That is why the Horizontal Guidance on Wetlands and the Technical Guidance of EUROWET can play a role in promoting the usefulness of wetlands in the implementation of the WFD for some regions.

The greatest value from the measures involving wetland enhancement (creation, restoration, management) is in the multi-purpose solutions they offer (i.e. solutions for different policy-objectives). Studies indicate that especially for some areas with HMWB, the creation of wetlands may make it possible to achieve good ecological potential.

Studies show that benefits can outweigh costs provided these benefit categories are relevant and important, which requires assessment of marginal costs and benefits of the proposed projects. The different socioeconomic benefits linked to the different solutions wetlands offer are not likely to be included in classic cost-effectiveness analysis. Cost-benefit- analysis offers a chance to make the values of wetlands and other environmental measures transparent. It is a good illustration of the conclusions given in Section 6 that existing valuation studies can be seen as the building blocks for further work. A cost-benefit type of framework will help to identify these categories, but it will need further steps to quantify and monetise these, building on literature and site specific studies.

8.4 Summary of key points

Fish migration

Fish populations will benefit directly from the achievement of improved water quality, but additional measures are needed to promote fish movements to feeding/breeding grounds to fully reach a GES. The potential measures to improve fish migration vary from the removal of obsolete (i.e. not in use) river obstacles, building fish by-passes and adapting (management of) hydropower installations.

Based on current information, it will be challenging to assess costs and benefits of fish migration measures as it will require a number of specific case studies to develop economic assessment tools. As costs are site and species specific, they may not be easily transferable. The main challenge, therefore, will be to assess the effectiveness of the measures and the related benefits.

Literature indicates that the following steps could help to achieve the objectives of the WFD concerning fish populations (Ovidio and Phillippart (2002)):

- removal of obsolete (i.e. not in use) obstacles in a river could be cost-effective;

- improve the fish by-passing possibilities without building technical fish by-passes for example, for downstream migration upgrading the older installations with fish-friendly turbines could be more cost-effective than building fish by-passes (lower fish mortality, higher productivity) - although
- an integrated approach is necessary for the design of new installations with fish guidance systems and by-passes, as well as the creation of fish habitats.

Wetlands

Although a wide range of studies show that wetlands are cost-effective and have multiple benefits, it is not guaranteed that these benefits will be fully accounted for in the WFD-process to select the Programme of Measures. The Horizontal Guidance on wetlands and the Technical Guidance of EUROWET need to be used to reinforce the role of wetlands in the application of the Directive and to provide additional information and motivation for the appropriate bodies to reconsider the position of wetlands within the context of the catchment approach promoted by the WFD.

As the benefits from wetlands are very different, ranging from flood protection, water quality, hydro-morphology, biodiversity, amenity, etc. it is not straightforward to take all these issues into account in the more traditional process of the selection of measures or a cost-effectiveness analysis. A cost-benefit type of framework will help to identify these categories, but it will need further steps to quantify and monetise these, building on literature and site specific studies.

Both cases illustrate the conclusions concerning economic analysis reached in Section 6.

9 COSTS AND BENEFITS OF SPECIFIC WFD MEASURES RELATED TO AGRICULTURE

9.1 Introduction

From an agricultural perspective, diffuse pollution with nutrients and hydro-morphological modifications appear as the main pressures on water bodies leading to a potentially significant risk of failing to meet the WFD objectives. In terms of nutrients, *nitrogen* compounds are considered to have a greater impact on water than phosphorus compounds inputs. However, *phosphorus* can also induce pressures, particularly if it coincides with soil erosion. Indeed, phosphorus is mainly linked to particles of soil and can be transferred to the aquatic environment in areas particularly concerned by risks of erosion. In many agricultural areas, phosphorus is accumulating in soil and can eventually reach levels such that significant amounts will leach (or already have leached) from the soil towards the aquatic environment. This contributes to eutrophication problems in surface waters.

Agricultural activities such as irrigation, drainage and land reclamation can disturb the natural water balance and thus represent important pressures on water bodies. *Irrigation* as part of intensive agriculture, including horticulture, has often led to an unsustainable use of water in some regions in Europe. Especially in the southern EU Member States, irrigation increases the risk of over-exploitation of the available water resources. *Land drainage* can have a variety of impacts on hydrology and water quality, depending, among others, on the techniques used and the type of soil. In the following section, we therefore consider the costs and benefits of improving water quantitative status through measures targeted at irrigation water use in agriculture.

9.2 Costs and Benefits of improving irrigation methods and management

9.2.1 Current information

At the European level, irrigation is the main water consumer in agriculture, accounting for around 35 per cent of total water abstraction in the EU (EEA 2003). Since the 1980s, the area of irrigated agriculture has risen almost consistently, mostly in France and Spain.[24]

Based on abstraction rates and irrigable area, the IRENA assessment prepared by EEA estimated the annual water allocation rates for irrigation. They were grouped into Northern and Southern EU-15 Member States, each with different amounts of water allocated for irrigation.[25] In southern EU-15 Member States, the water allocation rate decreased slightly from 6,578 to 5,500 m^3 per hectare per year between 1990 and 2000. During the same period, the water abstraction rate decreased from 69,103 to 66,424 million m^3 per year, while the irrigable area increased from 10.5 to 12 million hectare (EEA 2005b).

The 41 regions with the highest use of water for agricultural purposes (more than 500 million m^3 per year) are located in Southern Europe. 21 of these are estimated to require more than 1 000 million m^3 water per year for agriculture. Conversely, in 90 % of the regions in Northern Member States,

[24] It should be noted that the water abstraction rate itself is not an indicator of water stress or water scarcity, as it does not reflect water availability. “Water scarcity” refers to long-term water imbalances, combining arid or semi-arid climate (low water availability) with a level of water demand exceeding the supply capacity of the natural system; for more information, please refer to the outcome of the CIS water scarcity drafting group (Environment Council, 2006).

[25] Northern EU-15 comprises AT, BE, DK, FIN, DE, IE, LUX, NL, SWE and UK; southern EU-15 comprises FR, GR, IT, PT and ES.

abstraction rates are estimated between 0 and 50 m^3 per year (EEA 2005c).

At the same time, the availability of fresh water supplies may be reduced in the future as a consequence of the changing climate. In regions that are already experiencing water scarcity today, this is expected to exacerbate the competition for scarce water resources among different uses, and may limit the development of some sectors. In addition, water scarcity is expected to become a seasonal problem also in regions that have not been affected up to now, for example, the Brandenburg region in Germany.

In regions experiencing water scarcity, over-abstraction of groundwater may become problematic, leading to water table depletion and salt-water intrusion of coastal aquifers. Over-abstraction from surface waters may lead to environmental damages because of lower flow rates of rivers or decreasing water supply to wetlands.

In economic terms, the average productivity of water used for irrigation may be lower than in other sectors, such as industry and services. In Spain, for example, average productivity of water used in the agricultural sector was just above 1 Euro per m^3, compared to a national average of 30,80 Euro per m^3 (MMA 2007, p. 63). Although these are average figures, and the productivity of agricultural water use will be higher for some crops in some regions, in general, water use by other economic sectors or in private households will deliver a higher value added per cubic meter of water consumed. If scarce water resources are allocated to irrigation, thereby limiting other uses, the foregone value added of those other uses constitutes the opportunity costs of using water for irrigation. The Water Framework Directive (Art. 9) proposes, among other instruments, improved water pricing and cost recovery to address such economic problems of agricultural water use. In this context, insights into the costs and benefits of adapting farming practices to improve quantitative water status are crucial. This extends beyond measures that improve the efficiency of irrigation methods, but also includes water-saving measures that target water demand, and policy instruments that influence the economic and legal conditions under which farmers operate.

Currently, Member States have not decided which measures will be selected to reach the objectives of the WFD. In principle, a number of measures are available to improve the quantitative status of European water bodies. This section only focuses on irrigation in agriculture, as this is one of the main water uses in those parts of Europe that experience water scarcity – clearly, potential for reduced water use also exists for industrial water users, private households, municipalities and services (including tourism).

Within agriculture, a range of measures exist to improve water quantitative status. Such measures may either address the efficiency of irrigation water application and reduce losses, they may reduce irrigation water demand by changing crops and cultivation practices, or they may change water supplies. In detail, this includes the following types of measures:

- Technical measures often apply to irrigation infrastructure, and mostly aim to produce the same output with less water input – such as switching from spray to drip irrigation, or from surface flow to pressurised irrigation. More sophisticated irrigation systems generally entail high capital investments for farmers, but can decrease water use per crop output significantly. Measures to increase the efficiency of irrigation systems can be applied at different points in the system. In general surface irrigation techniques have water use efficiencies of around 40-50 per cent, whereas low pressure sprinklers and drip emitters achieve efficiencies of around 90 per cent (ISTAT 2006, p72). By improving the application of irrigation water on the field (including adaptation to wind and sunshine conditions), it can be ensured that irrigation water reaches the plant optimally. By timing the application according to weather conditions and soil moisture, it can be ensured that irrigation water is applied in the right quantities at the right time.
- More controversial are measures that open up new supplies of fresh water, such as water transfers from abundant regions to water scarce regions, or the use of groundwater instead of

surface water. In addition to their possible negative environmental side effects, such measures may require considerable capital investments. Measures such as the Spanish Hydrological Plan have therefore been subject of considerable criticism, and have sparked resistance in some instances. A less critical option for opening up 'new' supplies is to use recycled water instead of fresh water.

- On the demand side, farmers may reduce their water consumption by changing from water consumptive products such as cotton, rice, maize, tobacco or vegetables to less water consumptive products such as wheat and barley. In addition, a reduction in intensive livestock husbandry may decrease demand for water intensive cropping of rotational forage and maize as both crops together can make up large shares of irrigated land (for example, reaching up to 36 per cent of irrigated in Italy (ISTAT 2006, p73)). For some crops in some regions, demand reductions may also be achieved by changing the timing of cultivation within the year, to better align the growing season with precipitation patterns (for example, winter cultivation instead of spring cultivation). These changes can be accelerated by policy instruments that provide an incentive to switch to less water-intensive products (see also next bullets).
- Economic instruments change the incentives for water users. This can be achieved for example, through subsidy reform, through compensatory payments, or through incentive water pricing as prompted under the WFD. The last option includes volumetric pricing, irrigation taxes, quotas, tradable or time-limited abstraction permits, tradable water rights, water naks (water trade centres) etc.. Water users are expected to respond with different use patterns to such measures. Such options require some kind of metering and enforcement mechanism, leading to high administrative costs. At the same time, investment costs are relatively low. Common to all of these instruments is that they encourage farmers to use their water allocation most efficiently.
- Regulatory instruments prohibit irrigation in particularly sensitive areas or at certain times. Passing a regulation as such entails little administrative costs, if no compensation is required, but may cause considerable administrative effort for compliance monitoring and may represent a considerable burden to the regulated parties. Related to this are the re-allocations of water rights among water users.
- Advisory services, education and training measures are flanking measures that can support the adoption of other measures, in particular technical measures to improve irrigation and demand-side management through different crops and cultivation patterns. This ranges from on-farm advice to changes in the curricula of vocational training and agronomic studies.
- Such measures, which are applicable at the local, regional or national level, may be supplemented by measures at the EU level, such as the (further) decoupling of payments to irrigated crops. These measures would effectively function similar to regulatory or economic instruments adopted at the national level. Finally, metering of water abstractions is often named in this context of improved irrigation water management. While metering itself does not improve water quantitative status, it is an essential precondition for the economic and regulatory instruments, as well as some of the technical measures explained above. Such approaches would also help to improve the management of irrigation networks run by the state or user associations.

9.2.1.1 Cost of agricultural measures to improve water quantitative status

In many instances, WFD implementation may involve a re-allocation of water abstraction from agriculture to other sectors, and will tend to reduce the amount of water available for irrigation. While it is not yet known which measures the Member States will employ to achieve the WFD objectives, which renders an estimation of costs more difficult, the following types of costs that can be expected:

- Operation and maintenance cost, for example, if more efficient irrigation equipment requires better or more maintenance;
- Capital (investment) cost, esp. if more efficient irrigation requires investments in irrigation

infrastructure;
- Private transaction costs, i.e. costs incurred by users to ensure their compliance to regulations such as monitoring and control;
- Public transaction costs such as administrative cost, especially for monitoring and enforcement of water abstractions or costs for developing and implementing policy measures;
- Income losses if less irrigation leads to lower crop yields, or if farmers switch to less profitable crops;
- Wider economic impacts or externalities (second order effects), that arise for example, if farming becomes economically infeasible in a region because of restricted abstractions, and farms therefore convert to a less profitable farming system or close down;
- It is conceivable that reducing water abstractions for irrigation will lead to environmental costs, but this will rarely occur and therefore has been neglected.[26]

In the following, these cost categories will be discussed in more detail.

Operational and maintenance costs include labour costs as well as inputs such as energy, lubricants and spare parts. Considerable operational costs can be expected for measures that include desalination measures, which is a highly energy intensive process (Downward and Taylor 2007). Albiac et al. (2005) calculate a cost of desalinated seawater at 0.52 Euro/m³ for the conditions in the coastal regions of South-East Spain. Pumping costs of groundwater under the conditions in South-East Spain, in turn, are much lower and lie within the range of 0.09-0.18 Euro/m³ (Albiac et al., 2005). While these figures also include capital investment costs, these should be comparatively low as energy makes up the lion's share of the costs. Maintenance costs for example may include the cleaning of irrigation canals and pipes or the repair of leakage points and sprinklers.
It is often argued that traditional irrigation systems are more labour intense and modern irrigation is more capital intensive. Measures that modernise irrigation systems will therefore tend to increase energy and maintenance requirements, which, however, should be compensated by an improved efficiency of water use.

Operational and maintenance costs may in part also be attributed to the farming activity, rather than to any specific water quantity measure employed. For example, application rates of irrigation water have to be controlled regularly, irrespective of what quantity control instruments are in place. This may be facilitated by metering. Nevertheless operational and maintenance costs of water quantity measures can be borne by different entities. If measures require changes in the management of irrigation infrastructure and facilities, operational and maintenance costs may be borne by water associations, private water suppliers or public bodies (Garrido 2002). The latter are often responsible for large irrigation infrastructure projects, whereas the others are commonly found at regional and district level (Garrido 2002). For commonly or publicly shared infrastructure operational and maintenance costs may be reflected in water prices or in taxes or levies users are charged (Garrido 2002). However, an adequate attribution of such expenditure to individual water users depends on the availability of metering systems. At the level of individual water users (farms), such metering systems are often not in place (Interwies et al., 2006, p. 20). While metering systems are essential for a water pricing system that provides incentives for a more efficient water use, such systems may be costly to implement (Dinar and Mody, p. 116). One option is therefore to subsidise the installation of metering equipment. This was practised for example, by the French Loire-Brittany water agency where up to 80% of the costs of metering equipment installation were covered by grants (Baldock et al., 2006, p. 105). Using metering for irrigation management implies operational and maintenance costs, though setting up metering systems incurs capital costs.

Capital costs are financial costs incurred when investing into infrastructure such as irrigation canals

[26] Baldock et al. 2000 mention some cases where valuable habitats co-evolved with traditional irrigation systems, which might be negatively affected if irrigation is reduced.

or facilities and equipment. These costs include the financial capital, interest payments as well as depreciation. However, the running costs of existing infrastructure are not the focus of this report: in this understanding, capital costs arise where compliance with WFD requirements or adjustment to changed circumstances necessitates additional investments for the improvement and adaptation of existing systems. This includes investments into new technological measures liked drip or spray irrigation, or for improvements in existing irrigation infrastructure, such as sealing irrigation canals or implementing pipelines instead of surface carriers. In practice, the distinction between the capital costs of existing irrigation infrastructure and equipment, new investments into additional infrastructure and equipment, replacement of old and depreciated infrastructure and equipment, and investments into improvement of existing infrastructure and equipment will not be clear-cut. Likewise, it may not always be possible to clearly relate capital investments to single measures or to single purposes, such as water quantity control. For example, drip irrigation technologies which are often combined with fertigation technologies to improve the efficiency of usage of other inputs such as fertiliser and pesticides.

Capital costs of water quantity measures may be borne by various groups. Investments into irrigation equipment is often made by single farming businesses, though there might be some scope for joint investment between farms. Facilities such as weirs or other infrastructure are often owned by water associations, water utilities or public bodies. Partly these entities charge users for using their facilities and infrastructures and partly users are co-owners. However, large scale infrastructure for irrigation and domestic and industry water supply mostly requires very large capital investments and are thus traditionally financed by national states which often do not recover their capital costs with water pricing (Massaruto 2003). Since such investments are long-term and consist of large sunk costs they lead to strong path dependencies and high switching costs. Indications of capital costs per water volume delivered may be derived from figures such as those provided by Albiac et al. (2005), who estimate costs of water, which has been diverted from the river Ebro by a expensive canal system, ranging between 0.20-1.05 Euro/m^3 depending on the distance of the abstraction point from the river. While these figures do not only reflect capital costs, capital costs do constitute a major part of the additional costs (compared to locally provided water). Albiac et al. (2005) also refer to the proposed AGUA project in Spain with estimated investment costs of 1.2 billion Euro for a 600hm^3 desalination capacity, half of which is dedicated for irrigation purposes.

Private transaction costs arise to private bodies or individuals in order to comply with regulations. They include monitoring and control, but also search and information costs.
Although these costs are relevant for farmers, water user associations, water companies and other water users, they are not always readily available in monetary units. This is due to the fact that information and search costs are often not included in their entirety in private budgets. Thus, often transaction costs have to be traced back to efforts spent in terms of time and then be valued in monetary terms. In addition, it may not be determined by a specific measure that pays the transaction costs. Some cost components such as information gathering and provision may also be carried out by public bodies, which will reduce private transaction costs. There is also scope to minimise transactions costs through regulatory and technical arrangements, if regulation is designed in such a way that it requires less compliance monitoring and control.

Public transaction costs consist of those costs which public organisations have to cover when they develop, implement and maintain policy measures. Relevant transaction costs are monitoring and enforcement costs and costs of developing measures targeting agricultural water use. Water management projects carried out by public bodies for example have to be based on site surveys and require effort to find suitable design of projects which contribute to ex ante public transaction costs (Dubgaard et al., 2005).

Public costs of developing new measures targeting water quantity impacts consist of information gathering and processing for the use by decision makers and running the decision-making process until measures are ready to be implemented (see Pretty et al., 2002). It should only include the costs of obtaining and processing new information, which, however, in parts may be derived from monitoring results of measures already in place, pilot projects and so forth. A further public transaction cost component would then be the cost of informing affected parties such as farmers or water companies about the measures to be implemented and their specifications. Monitoring costs are relevant to find out how affected parties respond to implemented measures, and to measure their impacts. Monitoring costs are closely related to control costs which are the costs of determining the degree of compliance with measures. Enforcement costs are those public transaction costs which are incurred with the activities that aim to ensure compliance of affected parties (for example, commissioning sanctions and fines). A further transaction cost component relating to enforcement are incentive payments for example to farmers who employ water saving measures.

Income losses arise from measures that restrict water use and thus reduce output (either because intensity is reduced, i.e. less of the same crop can be produced, or because farmers have to switch to less water-consumptive, but also less profitable crops, or because the cultivation area has to be reduced). However, measures that restrict water use will often be accompanied by incentive payments aiming to compensate for foregone income, which need to be subtracted from the income losses.

The introduction of higher water prices for example may force farmers to reconsider their cropping strategies to prevent income losses or to minimise them. Under Mediterranean conditions, the introduction of higher water prices for irrigation farming often makes cereals and crops such as sunflowers and cotton unprofitable, but also woody crops, such as grapes and orchards may be affected. Albiac et al. (2005) for example estimate that in the coastal regions of South-East Spain, an increase of irrigation water prices in the range of 0.12 - 0.18 Euro/m³ will lead to a drop of water demand by 500-600hm³ - or 20 – 24% of the current demand of 2,550 hm³. This will be mainly due to the abandonment of cereals and reduction of woody crops. This would entail a loss of quasi- rents of farmers in the range of 300-400 million Euro, which is a significant share (18 – 23%) of agriculture's current quasi-rent of 1,711 million Euro in the region. With a loss of 408 million Euro, a prohibition of groundwater overdraft in the region would lead to similar income effects for the farming sector, although water consumption would only be reduced by 422hm³ (Albiac et al., 2005). However, in the case above a combination of policies covering, desalinisation, water markets and overdraft banning should lead to considerably lower income losses of 83 million Euro per year, whilst lowering consumption by 362 hm³ (Albiac et al., 2005).

9.2.1.2 Benefits of improved water quantitative status

In terms of benefits, achieving WFD objectives in terms of water quantitative status may yield the following types of benefits:

- Scarcity rents: as noted, resource costs arise if scarce water resources are not put to their most productive use. Achieving a more efficient allocation of water resources will therefore deliver scarcity rents in the form of an overall increased productivity of water use. Scarcity rents are essentially internalised resource costs, and could thus also be considered as resource benefits;
- Environmental benefits: reduced abstraction of surface water will, on average, lead to increased flow levels, and will reduce the number of days with low flow. Increased flow levels are conducive to the chemical and biological quality of water ecosystems, because pollutants and salts are less concentrated. The increased flow and associated quality improvements yield benefits for associated water uses, such as angling, water sports and other recreational uses. But benefits also arise since the environment itself is also a "water use", for example, in wetlands that are at risk because of water over-abstraction. Finally, soils may benefit in those instances where irrigation contributed to soil salinisation or to soil erosion. In the latter case, there is an indirect link back to water quality (through the negative impacts of eroded sediment on water quality).
- Benefits of improved water availability: By limiting over-abstraction, but also through

measures that enhance water retention in upstream areas, WFD implementation may increase the availability of water in dry seasons and reduce the variability of flow rates, and thereby act as an insurance against water stress.

- Wider economic benefits on other sectors such as the agricultural supply industry which may for example be able to sell more sophisticated irrigation equipment to farmers.
- Administrative and organisational benefits: while this category escapes quantification, it can be argued that the improvement of administrative structures in the course of WFD implementation (for example, improved information base, introduction of monitoring systems and, possibly, abstraction regulation etc.) in itself constitutes a benefit, especially where no adequate systems were in place before.

The different types of benefits will be discussed in greater detail in the following.

Scarcity rents (resource benefits) arise if measures to improve water quantity status direct water to uses that are of greater economic value. Thus, water may be used directly in production processes and be incorporated in the final product – which is the case with irrigation or food and beverage production. Water may also be used indirectly, for example, as cooling water in power generation or irrigation of lawns. Some activities can produce varying amounts of excess water that is returned into local water cycles and thus can potentially be reused. It is thus difficult to distinguish clearly between opportunity costs of using water resources in a way that they can potentially be reused, and using them in such a way that they are used up. This is further complicated by the fact that scarcity rents need to distinguish between upstream and downstream water uses. On the catchment scale, scarcity rents are potentially greater if shares of non-extractive uses are high in upstream areas.
In addition, non-extractive water use can also affect the quality of water. For example, this can be expected with excess irrigation water which may contain pesticides and surplus nutrients from fertilisers. Likewise, the discharge of cooling water into water bodies can have environmentally adverse effects since it may spurt algae growth and reduce oxygen levels of water. Such water uses may therefore not be considered as entirely non-extractive as they may affect further use values of water. By contrast, other uses of water such as recreational fishing, navigation or water sports do not entail such negative externalities.

In general, those who generate the highest value from water use are also set to receive the greatest scarcity rents from water quantity measures. Several studies suggests that greenhouse horticulture in Mediterranean regions generates often high values from the use of irrigation water. For example, in order to curb water demand, water prices for greenhouse agriculture in the Almeria region of South-East Spain need to rise by as much as 3 Euro/m^3, since the high profitability of the vegetable crops in the region implies shadow prices of irrigation water in the range of 3 to 5 Euro/m^3 (Albiac et al., 2005). However, such high marginal values of irrigation water can be considered as exceptional. By comparison, agricultural structures are very different in many parts of inland Spain, where agricultural activities in inland are often of extensive, operate a low margins of productivity, and depend on payments to keep their operations going (MMA 2007, p. 15).. In these regions, marginal values of irrigation water are more than 10 times lower and range between 10 - 20 cents per cubic metre (Albiac et al., 2005).[27]

Few studies compare the social and economic efficiency of surface and groundwater irrigation. However, those that do, point to a higher socio-economic productivity of groundwater-irrigated agriculture. One study by Hernández-Mora et al. (2001) shows the average economical productivity of groundwater irrigation to be five times greater (at 2.16 Euro/m^3 than that of surface water irrigation (0.42 Euro/m^3). In addition, groundwater irrigation was observed to generate three times as many jobs. This study covered 810,000 ha in the Southern Spanish region of Andalucia, which

[27] This considerable difference is also reflected in average margins of productivity. For Spain (nationwide figures), these are reported at 0,04 Euro / m^3 for cereals, and up to 0,85 Euro / m^3 for vegetables (MMA 2007, p. 137) .

precludes a generalisation of results. However, Garrido et al. (2006, p.344) cite further evidence pointing in a similar direction, and discuss different possible explanations for the alleged higher efficiency of groundwater irrigation. [28] Still, even if it can be generalised, the observation that groundwater irrigation may deliver a higher productivity does not change the problem that abstractions from many aquifers in Southern Europe exceed the recharge rate, putting the achievement of the WFD good quantitative status objective at risk. In other words, even if aquifers are overexploited efficiently, they are still overexploited.

Garrido et al. (2006) also present a somewhat different approach to the scarcity rents of water availability by measuring the effect of irrigation water availability on land prices. They find that this effect is significant: for example, in central Spain, the value of agricultural land that comes with water rights is 50% higher for vineyards and 100% for olive trees. This translates into an implicit value of irrigation water of 2 – 4 Euro/m^3.

Values even higher than those of greenhouse agriculture may be generated by the leisure industry. Irrigation of golf courses is often mentioned as an example in this respect. In 2004, irrigation of golf course in Spain accounted for 125 hm^3, or about 1% of the water demand (MMA 2007, p. 48). 80% of this demand stems from five provinces alone. Water demand is expected to more than triple in the Segura and Júcar province, and to increase significantly in several others. One reason for this is the high income that can be generated from golf courses, and the associated high water productivity of up to 16 Euro per m^3 (MMA 2007). From this, Downward and Taylor (2007, p. 285) to conclude that even if golf courses were charged a 10-fold price for their water, this would be unlikely to curb their growth. Auernheimer and González (2002) point out that it takes around 1,500 litres of water to produce one Euro's worth of agricultural output in the South of Spain, whereas only about 25 litres are required for one Euro in the tourist sector in a hotel or restaurant; i.e. the productivity of water differs by a factor of 60 between the sectors. [29]

However, when assessing the benefits of alternative water uses at the catchment scale, the economic characteristics of different water uses also need to be considered. For example, greenhouse horticulture can expand in a catchment without immediately meeting diminishing returns to scale, since the increased output may be exported to a larger extent. For many tourist and recreation uses, including golf courses, this is debatable. On the one hand, as the demand for such uses in a certain area is limited, so that one would at some stage expect diminishing returns to scale for example for extending the number of golf courses in an area. On the other hand, however, there may also be positive externalities from a cluster of such uses in one region, where the existence of some activities may promote the growth of others.

Environmental benefits of measures arise if they support environmental services, such as improved flow rates of rivers or distribution of water to environmentally important water uses such as wetlands. Improved water quantity status of surface water bodies leads to a number of benefits relating to recreation and maintenance of ecological functions. In addition water quality can be improved due to lower concentrations of salts and pollutants.

While there is considerable literature on the ecosystem services provided by wetlands (see for

[28] For instance, farmers using groundwater for irrigation often bear the full direct cost of well-drilling, pumping and maintenance themselves, which provides an incentive to use water resources efficiently. By contrast, farmers using surface water usually receive highly subsidised water at a lower cost

[29] This does not mean that tourism does not generate significant impacts on water quantitative status – which it does, in many regions on the Mediterranean coast and on islands. For example,, on the Balearic Islands, water supply to hotels and restaurants is the main water use, the service industry in total accounting for more than 30% of the water used (MMA 2007, p. 48). Rather, where water use in tourism leads to an over-abstraction of water, it will often also generate considerable income from this water use, which limits the effectiveness of water pricing.

example, Brander et al., 2006, Turner et al., 2003), there is little evidence how these benefits are affected by an over-abstraction of water and hence a fall in flow levels. Only two European examples are documented in the Environmental Valuation Reference Inventory (EVRI):

- Birol et al. (2005) estimate the environmental benefits of the Cheimaditida wetland in Greece. The wetland, which contains one of the few remaining freshwater lakes in Greece, is under threat from several anthropogenic activities, including the drainage resulting from excessive irrigation in agriculture, but also the conversion of wetlands to intensive agricultural use and to industrial and residential uses and nutrient pollution from intensive agricultural production. A choice experiment survey was conducted with a randomly selected sample of the Greek population – none of whom were actually used the wetland for recreation or otherwise – to elicit their willingness to pay for improved management of the wetland. For different alternative management schemes, willingness to pay ranged from 17 to 86 Euro per person per year, with improvements in biodiversity being valued most highly.
- Miliadou (1997) provides an estimate of use and non-use values attached to Lake Kerkini in Greece, a RAMSAR-designated wetland in the Northern Greek province of Macedonia. The lake experiences annual water level fluctuations of up to 5.5 metres, which are related to irrigation water abstractions for agriculture. Miliadou interviewed local residents and respondents from more distant locations to elicit their willingness to pay in order to preserve the wetland in its current state. The mean willingness to pay was estimated at 20 Euro per person per year, 96% of which was attributed to non-use-values. For the entire population of Macedonia, this aggregates to an annual willingness to pay of 37.5 million Euro.

Improved water availability provides several benefits mainly relating to improved flow rates of surface water bodies and to saved water resources. Such water helps to reduce the risk of water scarcity, contributes to more stable river flow rates and can be used to amend other water sources in dry seasons.

In the UK, four studies have been conducted to assess the benefits of improved flow conditions in rivers: Hanley et al. (2006) for two catchments in Eastern Scotland, ERM (1997) on seven rivers in the Southwest of England, House et al. (1994) on three rivers in Southern England, and Garrod and Willis (1996) on the River Darent in Kent, England.

- Hanley et al. (2006) estimate the benefits of reducing low flow conditions in the Motray and the Brothock catchments, two small catchments in the East of Scotland. Both of these experience low-flow conditions in the Summer, due to excessive irrigation water abstractions of the agricultural sector. The low-flow episodes have negative impacts on water quality, river ecology, and on the appearance and smell of the river. Through a choice experiment, the survey elicited the respondents‘ willingness to pay for an improved abstraction regime, which would reduce the number of months with low flow conditions, and which would improve water quality and river ecology. The survey showed that households would be willing to pay between 4 and 5.70 Euro (£2.70 - £3.87) per household per reduced month of low-flow conditions, and between 31 and 47 Euro (£24 - £36) per year for an improvement in river ecology. For different scenarios of improved water management in the basin, this adds up to a willingness to pay from 75 to 129 Euro (£58 - £99) per household per year. It is assumed that all of the proposed scenarios would improve water quality towards achieving good ecological status.
- A study by ERM (1997) estimated the use and non-use benefits of improving low-flow conditions on seven rivers in the South-West of England (the River Piddle in South Dorset, the Malmesbury Avon in North Wiltshire / South Gloucestershire, the Wylye in South Wiltshire, the Allen in North East Dorset, the Tavy in South West Devon, the Meavy in South West Devon and the Otter in South East Devon). The respondents included organised anglers, visitors of the river for informal recreation, and the general public. Willingness to pay for additional flow alleviation measures was estimated at 68 – 71 Euro (£52.50 - £54.50, 1996 prices) per household per year.

- House et al. (1994) studied the recreational use benefits from three rivers in Southern England (Misbourne, Ver and Wey) at different flow levels. The contingent valuation studies asked visitors and residents at the river to value their enjoyment of the current visit, how this valuation would change with different flow conditions, and how much they would be prepared to pay for a scheme to increase flow levels. In the case of the Wey, respondents valued their visit under current conditions at Euro 3.16 (£2.43), as compared to 1.56 Euro (£1.20) under low-flow conditions or 5.90 Euro (£4.54) under improved flow conditions. For the Misbourne, values were slightly higher at 4.48 / 6.40 / 8.35 Euro (1993 prices). Based on these estimates, aggregate annual values for improving the river flows were estimated by multiplying the estimated numbers of visits per year by the gain in benefits from alleviating low flows. This resulted in estimated benefits of 180 – 585,000 Euro (£140 - £450,000) for the river Misbourn and 91 – 130,000 Euro (£70 - £100,000) for the river Wey. Angling benefits of improved flow conditions were estimated at 57,000 Euro (£44,000) for the river Ver and 242,000 Euro (£186,000) for the Misbourne.
- Garrod and Willis (1996) conducted a contingent valuation study to elicit the benefits of enhancing river flow for recreational purposes at the River Darent, a Thames tributary that was experiencing extreme low flow conditions since the late 1980s.The study found a willingness to pay of 12.70 - 24 Euro (£9.76 - £18.45, 1993 prices) for improved flow conditions.

9.2.2 Analytical review

There is a considerable body of literature on the issue of water pricing and irrigation water demand. Consequently, much of the academic and political debate centres on the issue how the cost recovery requirement of Article 9 WFD will affect water prices and, hence, water demand. Most scholars agree that a differentiated approach is necessary when it comes to evaluating these impacts, distinguishing between regions and types of crops. For example, the coastal areas of Southern Spain are among the most water-scarce regions in Europe. Yet, despite the appearance of significant water table drops, lowered extracted water quality and the pressing demands of the tourist and urban sectors, irrigation water demand in agriculture continues to be high. This holds even in the face of very high water prices (up to 0.25 – 0.30 Euro/m^3), because of the high productivity of some parts of the agricultural sector (in particular citrus fruit, pepper and tomato) (Garrido et al., 2006).

By contrast, agricultural activity in the interior regions of Spain, irrigation is also widespread, but for different reasons. Irrigation water is supplied at very low rates of 1 – 2 cents per m^3, which implies that only 10 – 20% of the costs of water services are recovered. Up to half of the farmers' revenue comes from farm support under the CAP (Garrido et al., 2006, p. 342, with other sources indicating lower support levels). Downward and Taylor (2007) list olive farming as another activity that was largely induced by payments until 1998, but still has a high comparable profitability, leading to exacerbated water scarcity in some parts of the country.

The scarcity rents of an improved allocation of water resources are among the main benefits of improving water quantitative status. These benefits are perhaps best illustrated by calculations that were made for the Levant region in the South-East of Spain, summarised in Albiac et al. (2005). They investigate different options to improve water quantitative status – ranging from a ban on groundwater overdraft, to a tax on water consumption, to a combined approach involving water trading and desalinisation, to the proposed (and now-abandoned) Ebro water transfer scheme. The authors find that the economic impacts of the options for the study region differ considerably in terms of costs and demand effects, ranging from 83 to 408 million Euro in terms of foregone quasi rent. In relation to the agricultural production in the region, this equals between 5 and 24% of the production value. Thus, depending on the instruments applied between one 20th and one fourth of the agricultural production would be affected to reach a comparable improvement in water quantitative status.

In the context of scarcity rents one issue that needs to be considered are the impacts of climate change on water availability. Dore (2005) cites evidence that precipitation in the Mediterranean region has decreased by as much as 20% in some regions. From the mid-1960s to the mid-1990s, the number of days with precipitation has gone back by 50% over the Spanish southern coast. In the South of Italy, total precipitation is estimated to have fallen by 15% over the 20th century. These trends will clearly exacerbate existing water scarcity problems in the future, and thereby increase the (economic) value of water.

In terms of the environmental benefits of improved quantitative water management, there appears to be very little economic evidence that has quantified these benefits in monetary terms. In the UK, four studies were identified that have investigated the recreational and environmental benefits of alleviating low flows conditions in rivers through willingness-to-pay surveys. However, only one of these studies applies to low-flow conditions related to over-abstractions of irrigation water; in the other studies, low-flow conditions are caused by water abstractions for public water supply. Also, only of the studies makes reference to the WFD, whereas the others date back to the 1990s and are hence unrelated to the WFD implementation. The studies estimated benefits at 75 to 129 Euro per household per year (rivers Motray and Brothock, Scotland), 68 to 71 Euro per household per year (seven rivers in the SW of England, 1996 prices) and 13 to 24 Euro per household per year (River Darent, 1993 prices). Only the Scottish figures (Motray and Brothock) are at all related to the implementation of the WFD, and could be interpreted as an approximation of its benefits in the study regions. However, the authors underline that the results are not even transferable between the two Scottish cases studied, hence deriving any general statements from these values – other than the assertion that tangible benefits do exist, and are measurable – is very difficult.

A similar picture emerges for damage to ecosystems related to irrigation water abstractions. While there is considerable literature on the valuation of wetlands, there are only two European studies listed in the Environmental Valuation Reference Inventory (EVRI)[30] that have valued an the functions of a wetland that are threatened because of water abstractions for irrigation. These studies of the Greek Cheimaditida and Keriki wetlands have both found evidence for considerable non-use values attached to the wetlands – i.e. people not residing near the wetland, and not using it for recreation or otherwise, were willing to pay 17 to 86 Euro per year for the preservation and improved management of the Cheimaditida wetland. For the Keriki wetland, annual willingness to pay was 20 Euro per household, which aggregates to a total annual willingness to pay of 37.5 million Euro for all residents of the Makedonia province. However, none of these studies is related to the WFD. It is therefore not possible to state how much of these benefits could be realised through its implementation.

9.2.3 Evaluation and lessons learned

One of the main impacts of the WFD on irrigation water demand will be through the Art. 9 requirement that water services should recover the costs, including environmental and resource costs. This will affect agricultural sectors in different ways: some parts of agriculture (esp. fruits and vegetables) account for a high share of irrigation water demand, but at the same time the marginal productivity of irrigation water is high in these sectors. Hence the price elasticity of demand for irrigation water is relatively low: if the water price rises, irrigation water demand will not fall very much. Thus, if the WFD should lead to higher cost recovery levels and thus higher prices for irrigation water, demand for irrigation water *in these agricultural sectors* will not be affected very much. The objective of cost recovery would thus be reached without significant improvements of water quantitative status. In these regions and for these types of crops, water pricing may thus be

[30] http://www.evri.ca

helpful as a support instrument to provide adequate incentives, but it will need to be complemented by other measures and instruments to bring about improvements in water quantitative status. By contrast, cereals and crops such as sunflowers and cotton can only be produced in many regions because the irrigation infrastructure is subsidised and because cost recovery levels are low. If the WFD should lead to higher cost recovery levels, such production could become unprofitable for many farms. Thus, cost recovery would be achieved as well as improvements of water quantitative status, but at the risk of reducing the profitability of many farms. Again, water prices should therefore not be the sole instrument of choice, but need to be complemented with measures targeted at reducing irrigation water demand. In this context, the rapid adoption of more efficient drip irrigation systems at rates of 400 per cent from 1982 to 2000 in Italy (ISTAT 2006, p 140) suggests a promising pathway.

In Spain, groundwater is becoming increasingly important as a source of irrigation water (Garrido et al., 2006). The resulting pressure on scarce groundwater resources is bound to lead to conflicts, including over-abstraction and its consequences. Since groundwater has the properties of a common pool resource, there is a need to limit and allocate groundwater abstractions. In the past, the Spanish groundwater regime was largely characterised by farm abstractions, long-established water abstraction rights, and to some degree also unlicensed abstraction. Through investments into metering, this situation is changing; however, the scope for monitoring and controlling abstractions is still limited. At the same time, since many farmers use the same aquifer, there are a number of cases of groundwater overexploitation. This leads both to rising costs of exploitation, since deeper wells have to be drilled and the water pumped higher, as well as to degradation of groundwater quality, for example, through salinisation of aquifers. Such damages are often irreversible, and cause considerable costs if wells have to be closed and water imported from elsewhere. One key benefit of the WFD implementation in this context could be to improve the management of groundwater – for example, by inventorising wells, and by clarifying abstraction rights.

One key benefit of the WFD implementation in this context could be to improve the management of groundwater – for example, by inventorising wells, establishing metering systems, and by clarifying abstraction rights. Thus, the potential benefits of the WFD include not only the actual improvement in water quantitative status, but also the improved knowledge of water abstractions and their uses, which is a precondition for a more efficient water management system.

The WFD will lead to scarcity rents in cases of actual water scarcity, where available water resources are not sufficient to satisfy all existing and potential future water uses. However, it remains difficult to assess which alternative water uses would actually develop in a given region if the scarcity constraint was relieved – for example, if a further development of the tourist industry can simply be assumed, and if this would be simple quantitative growth, or also a qualitative development towards more sustainable tourism. Calculations therefore need to be based on scenarios or demand projections, which introduces an element of uncertainty.

A particular concern is the relation between irrigation water demand and climate change. Already now, water scarcity is a huge concern in parts of Southern Europe. This conflict will become more pronounced as the effects of climate change will exacerbate. The Impact Assessment for the Commission’s Climate Strategy for 2020 points out that water availability, together with extreme heat, will become one of the two main constraints that will limit and eventually reduce tourism (and other economic activities) along the Mediterranean coast. Already now, water scarcity leads to real costs as water is allocated to agricultural uses, thereby limiting the development of other, higher-value uses or limiting drinking water supply. By supporting a more efficient allocation of scarce water resources, the WFD will already now deliver a benefit in terms of resource use and generate additional income. This benefit will increase in the future, as climate change will exacerbate water scarcities in many parts of Southern Europe, at many times of the year. This will increase the value of clean and sufficient water in the future and therefore the protection of these resources nowadays is an important issue.

In this case, the implementation of the WFD does not only create a benefit through the physical improvements that it brings about (i.e. a more efficient allocation of water resources), but also through the institutional solutions that it brings about. The need for institutions that ensure a more efficient, equitable and sustainable allocation of water resources is apparent already now. As water scarcity and conflicts about water allocation are set to exacerbate, the institutional solutions established by the WFD will become ever more important.

The empirical evidence on non-market benefits of improved water quantity management (environmental benefits and benefits of improved water availability) is quite thin, and most of the few empirical studies are not directly related to the WFD implementation. What can be drawn from the evidence is, first, that the methods for such economic assessments are available in principle, but that the experience is limited (and concentrated in few countries); and second, that such assessments, where they have been conducted, did find evidence of considerable non-market benefits. However, the available evidence is far too limited to support any general statements about the extent of the benefits of WFD implementation.

9.3 Costs and Benefits of specific measures to reduce the diffuse pollution of Phosphorous from agriculture

Phosphorus (P) is an important determinant of the ecological status of European inland water bodies and is a key contributor to eutrophication. There are different sources for P emissions: besides discharges from urban wastewater and industry, agricultural activities also contribute to phosphorus pollution in water bodies (both livestock and fertilisers). P emissions from industry and households traditionally constitute the major share of overall P emissions. In recent years, however, they have been significantly reduced due to both improved sewage treatment reduced use of phosphate detergents[31]. Many water bodies are at risk of failing to meet the water quality objectives set by the Water Framework Directive (WFD). P emissions from agriculture have been suggested to be a major reason, especially in those countries where industrial and household sewage treatment is widely implemented (Herbke et al., 2006). It should be noted that reducing P emissions from agriculture is less certain to have an effect than upgrading waste water treatment, as P used in agriculture is buffered in the soil and gradually released into the water, whereas reductions due to waste water treatment immediately reduces the P load in surface water. However, it is also true that P reductions from waste water treatment mostly benefit larger downstream water bodies, whereas reductions in smaller upstream areas are only possible through P reductions in agriculture (Ligtvoet et al., 2006).

Phosphorus can be transferred along surface and sub-surface pathways. Agricultural P emissions are largely non-point source in nature and are linked to areas prone to surface run-off and erosion. However, subsurface drainage systems are increasingly seen as an additional pathway. In this context, the distinction between particle bound P and dissolved P is critical, as the latter effects eutrophication more readily, while both tend to follow different pathways and thus respond differently to mitigation measures. The risk of P losses is site specific in every catchment, depending on P loading of sites and site characteristics such as slope, proximity to water bodies or the existence of buffering landscape features. Measures specifically targeted at critical source areas therefore

[31] According to a May 2007 report by the European Commission, the equivalent of 110,000 tonnes of phosphorous are used in detergents, primarily in domestic laundry and dishwashing. This compares to 1.25 million tonnes of phosphorous in fertilisers. In recent years, a number of EU Member States have introduced limits in the phosphate content for laundry detergents, including Belgium, Germany, Ireland, Italy, Luxemburg, the Netherlands and Austria, where phosphate-free laundry detergents have a market share of 100% (CEC 2007). The European Commission is expected to propose such restrictions EU-wide in 2008 (ENDS Daily, 'EU phosphate detergent controls due in 2008', 14 May 2000).

appear useful. In addition, approaches comparable to Nitrate Vulnerable Zones may be effective.

A number of different P mitigation measures are being proposed, such as

- reducing P input or increasing P output (in the sold product) in farming operations;
- reducing P use in animal husbandry;
- application of immobilising agents to manure or soil;
- changes in fertiliser and manure management;
- changes in cropping patterns;
- soil management practices to reduce soil erosion, such as minimum or no-tillage;
- buffer strips and riparian zone management;
- sedimentation ponds and artificial wetlands;
- Economic instruments, such as taxation of P; and,
- Regulatory instruments, such as restrictions of P application per area or under specific conditions.

Negative impacts of historic P loads in surface water could be reduced by stimulating growth of sub-pressed water plants, removing biomass or sediments from water bodies, flushing lakes with nutrient poor water;

While the physical effectiveness and the costs of such measures has been researched to some extent, there is still little information about their cost-effectiveness and the associated benefits. Nutrient management, minimum tillage and mulching have been described as effective measures to reduce P losses from agriculture. However, both the costs and the effects of measures are site specific, which limits the scope for general statements about their cost-effectiveness. A study for UK evaluates the potential to reduce P inputs in agriculture to be high (DEFRA 2003). The potential for additional measures will also depend on the extent to which these measure have already been introduced in the reference scenario.

9.3.1 Current information

The programmes of measures for achieving the WFD objective have not yet been set up in any Member State. This is the main reason why a definite assessment of the costs and benefits of reducing diffuse agricultural phosphorous pollution is not possible at this stage.

9.3.1.1 Country-wide estimates of the cost of P reductions

Some Member States (for example, Denmark, Netherlands) have started by estimating of the need for countrywide reductions in P load in order to achieve good ecological status. Based on these, rough calculations of the costs of achieving the necessary reductions have been made. These need to be treated with some caution, as they represent only very rough estimates, intended to illustrate the scale of the challenge at hand.

- Jacobsen et al. (2004) have estimated the cost of reducing agricultural phosphorous emissions in **Denmark** . In their study, they investigated the countrywide economic effects of different measures. The most effective measure is through a change in feeding practices (increase use of phytase and use of phase feeding). This measure, which will reduce total P surplus by more than 40%, is almost cost neutral according to the authors. A further measure is a nationwide norm that limits the phosphorous surplus to 10 kg per ha (and thereby reduce the surplus by 25% on average). If implemented after the change in feeding practice, this would mean that 5 % of all manure would need to be redistributed, affecting intensive dairy and poultry farms in particular. This would increase the transportation costs by 2.4 million Euro in total. From this, cost savings on P in mineral fertiliser of 2.3 million Euro have to be subtracted, so that the net costs are relatively low. As a third measure, achieving a balance between incoming and outgoing phosphorus at the farm level is expected to cost around 47 million Euro. This measure would also lead to substantial redistribution of animal manure between parts of the country. However, the authors also underline that these calculations represent rough estimates only, and should therefore be treated with caution.

- For the UK, an early study by Andrews et al. (1999, p. 121) presented some rough estimates for the cost of reducing P emissions from agriculture. Based on three earlier studies, an average cost of £35,000 (45,000 Euro, 1999 prices) per tonne of reduced P emissions per year was assumed. This would represent a combination of improved nutrient management, conservation tillage and changed farming practices. Based on this figure, the total annual cost for P reductions in agriculture were estimated in the range between £63 million to £84 million (82 – 109 million Euro, 1999 prices). These costs represent annually recurring, additional costs to farmers, either in the form of lost revenues or as additional expenditure. The total costs would also include the costs of administering the regulatory programme and implementing the strategies. However, these figures cover only England and Wales, as the authors did not calculate costs for Northern Ireland, and used a different procedure to calculate costs for Scotland.

  Based on cost figures by RPA (2003), comparable numbers are presented in the 2003 Regulatory Impact Assessment (RIA) of the WFD (DEFRA 2003). In Appendix D (p. 110-111) of this document, indicative cost brackets to reduce nutrient pollution from agriculture are reported at £80 to £209 million per annum (104 – 271 million Euro, 2003 prices). However, the authors underline that they chose a crude method of grossing up costs and that their estimates are provided for illustrative purpose only and should not be viewed as estimates of expected costs. In addition, the estimates include nitrogen as well as phosphorous emission reductions.

  More recently, the draft partial regulatory impact assessment of environmental quality standards for implementation of the WFD, published for consultation in March 2007, presents calculations on the costs and benefits of proposed standards for phosphorus in rivers (DEFRA 2007). Costs and benefits are presented for different scenarios and policy options, and for different degrees of compliance with standards are being assessed. The baseline standards are extrapolated from existing classification schemes (not adopted for regulation purposes because of uncertainties over cause and effect) and compared with proposed UKTAG standards proposed for WFD purposes which are cross-referenced through the EU intercalibration exercise. All figures are expressed as present value terms at 2006 prices with 3.5 per cent discount rate over 30 years.

  It should be noted that the UKTAG WFD standards, which are related to types of water bodies are more stringent for low alkalinity rivers, but less stringent for high alkalinity rivers. Thus, it will introduce changes in the distribution of rivers that fail the proposed standards compared to the existing schemes, due to the introduction of typology. As a result over P loading will be lower and attributed to smaller set of rivers. This will result in more focused management of P in rivers and that the overall costs and benefits associated with UKTAG WFD standards being less than that of theoretical application of existing river classification schemes across the board.

  At 100 per cent compliance, non-use benefits of compliance with phosphorus pollution standards translated from river classification schemes relating to rivers are estimated at a net present value of £1.39 billion (2 billion Euro) for the entire UK. For 50 per cent compliance under otherwise similar conditions, benefits are about half. As a significant proportion of the mitigation effort will largely fall on the UK farming sector, a significant proportion of the calculated benefits are therefore also largely related to mitigation of P-losses from agriculture. Benefits are slightly lower if the proposed UKTAG WFD standard is used as a baseline: for 100 per cent compliance, the relating non-use benefits are estimated at £1.32 billion (1.96 billion Euro) for the entire UK, with the lion's share of benefits occurring in England. For 50 per cent compliance under otherwise similar conditions benefits are about half as well. The above calculations draw heavily on a study by Pretty et al. (2003). Regarding the use-values, it is suggested that these benefits can not be added to the above figures without risk of double accounting.

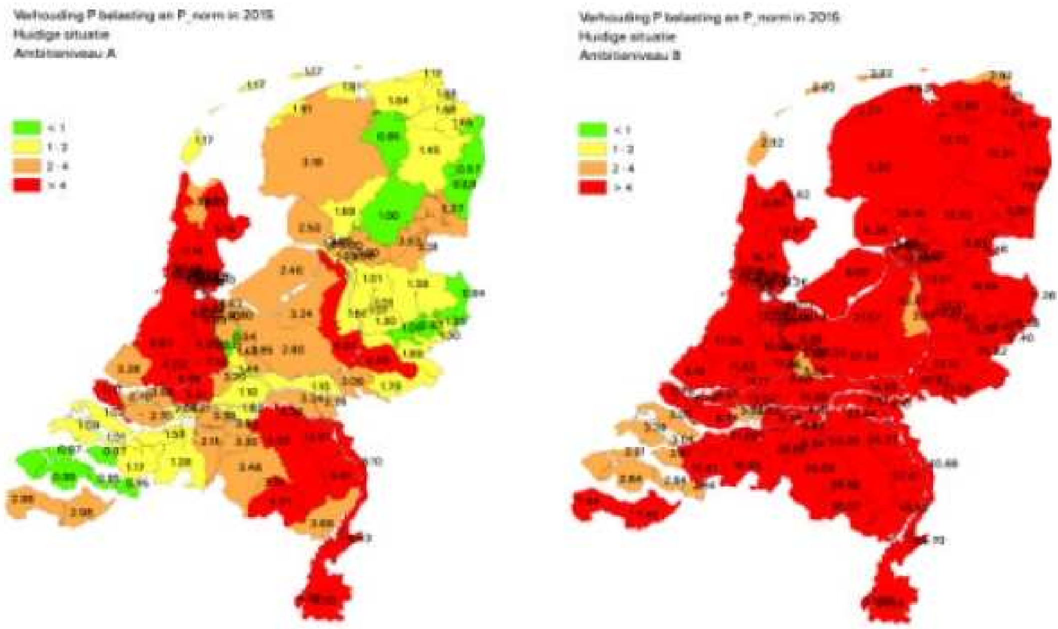
Concerning the relating costs of P-loss mitigation from agriculture the study cites costs of individual measures as estimated in the DEFRA (2003) cost curve assessment for phosphorus reduction. The study takes also the results of the 1999 WRc report on the potential costs and benefits of the WFD into account, which proposed a marginal abatement costs of £35,000 per tonne phosphorus (52,200 Euro). These figures consider the out of the pocket expenses and opportunity costs of abatement measures which accrue to farmers. Considering further studies, the authors assume an average abatement cost of £40,000 (60,000 Euro) per tonne agricultural phosphorus. To comply with current standards with the standards extrapolated from existing rivers classification schemes and assumed being applied under regulation, 11,040 tonnes of P have to be mitigated, and 8,592 tonnes of P to comply with the UKTAG WFD standards.

Costs of monitoring rivers at sites at risk have also been estimated in terms of operational and surveillance environmental monitoring. For 100 per cent compliance, the relating costs at current standards are estimated at £2.7 million (4 million Euro) for the whole of UK (net present value), which corresponds to an annual cost of £200,000 (300,000 Euro). At UKTAG standards these costs are about 6% lower. The administrative costs relating to site investigation, developing response strategies to failed standards, developing and imposing national measures and checking their effects have also been estimated. For diffuse pollution under current standards, and assuming 100 per cent compliance, they are estimated at £192,000 (287,000 Euro) net present value for the UK. For 50 per cent compliance these costs are about half. Under UKTAG standards and otherwise similar conditions the corresponding costs are marginally higher.

Overall, at 50 per cent compliance, the compliance cost (under the theoretical assumption that the of current standards used for GQA classification are used for regulatory purposes) for the agricultural sector only amounts to an annual cost of £131.5 million (196 million Euro) for the UK, of which almost 90% occur in England alone. For 100 per cent compliance with this theoretical assumption, the costs amount to £315.5 million (471 million Euro). This corresponds to 7,888 tonnes of phosphate emissions mitigated in agriculture. Under UKTAG standards, but otherwise similar conditions the costs for the agricultural sector are considerably lower: £86.3 million (129 million Euro) for the UK for 50 per cent compliance, and £242.6 million (362 million) for 100 per cent compliance, mitigating 6,064 tonnes of phosphate emissions. This reflects the type-specific derivation of UKTAG standards. The assessment also suggests that these costs are difficult to pass on for the agricultural sector. Yet, there are large variations in these figures, which may be both, over- and under-estimated. In addition the analysis is based on the assumption of linear relationships between levels of reductions achieved and the costs relating to it. This assumption is unlikely to fully hold in practice.

- For the **Netherlands**, Ligtvoet et al. (2006) have analysed the expected effects of the new Dutch manure policy, which took effect in 2006. The study found that the new policy will only stabilise phosphorous emissions from agriculture, but will not achieve any notable reductions. Further reductions of phosphorous emissions are only to be expected from sewage treatment, with the effect of an overall reduction of P loads by 5 % until 2030. Thus, in the absence of additional measures, no major improvement of the nutrient situation would be achieved. In order to achieve the WFD objectives, further reductions of the phosphorus load are therefore necessary. If this is to be achieved through a proportionate contribution from agriculture and wastewater treatment, a 1,000 tonnes reduction of phosphorus emissions would need to come from agriculture, and approximately 640 tonnes reduction from wastewater treatment plants. This corresponds to 20 and 25% of total emissions, respectively. While a range of measures is available in principle to reduce agricultural P emissions, some of these are associated with considerable socioeconomic impacts, and will therefore face acceptance problems. The measures ultimately considered to reduce agricultural phosphorous emissions were buffer strips and banning of phosphor fertilisation in phosphate-saturated wet sandy soils. The additional annual costs that these measures would impose on the agricultural sector were roughly estimated at Euro 60-120 million. This represents an increase of 30-60% compared to the costs that were estimated for the current (new) manure policy. The report finds that P reductions in waste water treatment plants tend to be more cost-effective, and their effects more certain, than P reduction measures in agriculture. However, measures targeted at waste water treatment will mainly be effective in larger downstream water bodies. Given the large uncertainties, both in terms of duration and effectiveness, there is a serious risk that agricultural measures will not achieve the required reduction in emissions.

- A second study from the **Netherlands**, the Aquarein study by van den Bolt et al. (2003), has estimated the impact of the WFD on agriculture, nature protection, recreation and fisheries. For the case of phosphates, a small number of standardised measures were considered (assuming average nation-wide figures for the cost-effectiveness of measures). Measures included for example, an overall reduction in P applications, a change of crops from maize to grass, installing buffer strips or taking land out of cultivation, where the last measure is applied as a measure of last resort, if all others are not sufficient to realise the objectives. Since the definition of "good ecological status" is not yet known, the need for reductions in P loads was calculated for two different ambition levels. Figure 25 (taken from van den Bolt et al. (2003) p. 69) presents the necessary reductions of P loads. For the Netherlands. There are only a handful of sub-catchments where the lower ambition level will be realised in 2015 without further measures (green areas in the left figure). In most sub-catchments, the P loads is twice (yellow areas) or even up to four times (orange areas) as high as the objective for the lower ambition level. Compared to the stricter ambition level, almost all of the Netherlands will exceed the objective by a factor of four or more in 2015 without further measures.



Source: v.d. Bolt et al. 2003, p. 69

Figure 25: Reduction targets for phosphates in the Netherlands.

The set of standardised measures were then applied to the sub-basins in the Netherlands, in order to calculate the changes in net value added per ha and the changes in employment (direct and indirect) necessary to realise the WFD objectives for the two different ambition levels. The calculated effects are quite drastic: even to realise the lower ambition level, the study calculates that two thirds of all agricultural land would need to be taken out of production, as all other measures combined would not be sufficient to achieve the necessary P emission reductions. This would imply a loss in net value added from agriculture of Euro 1.8 billion, and a loss of 58,000 man-years of direct and 73,000 man-years of indirect employment. For the higher ambition level, the study argues that the objective could not be reached, even if agricultural production in the Netherlands was abandoned altogether, at a cost of Euro 2.7 billion net value added. While the Aquarein study thus shows that the cost of achieving the necessary P reductions can be substantial, it should also be noted that the study results have been criticised as overstating the true costs. First, the two ambition levels that were assumed in the study both present a very high standard; and second, it was remarked that by basing calculations on current technologies, the study underestimates the potential for on-farm adaptation.[32]

- For the countries around the **Baltic Sea**, two studies have assessed the costs of three types of P mitigation measures (Gren et al., 1997, Turner et al., 1999). In contrast to the other studies, however, this research is not specifically geared at the cost of WFD implementation, but more generally at the cost of reducing nutrient emissions to the Baltic Sea. The measures considered include deposition measures like decreased fertiliser use, land use measures like catch crops and retention measures like restored wetlands. In the case of wetland restoration, the cost figures have been derived from Swedish experiences and then extrapolated to the other countries, whereas the costs of fertiliser reduction (deposition measure) have been estimated for Denmark, Germany, Sweden and Finland, and then extrapolated to the

[32] If the available measures are ranked by their cost-effectiveness, it is often observed that a large part of emission reductions can be achieved at modest cost. If the ambition level is set at a very high level, the cost-effective measures are exhausted, and more costly measures – such as converting arable farmland to extensive fallow plots – need to be adopted, rapidly driving up the total cost. This is indeed what the Aquarein study did.

remaining countries. *Table 26* presents the marginal abatement cost estimates of different measures for the Baltic Sea countries.

Table 26: Marginal abatement costs of P-mitigation measures in the Baltic Sea region (Euro/kg P/annum)

Region	Deposition	Land Use	Retention
Sweden	5 – 255	57 – 717	28 – 74
Finland	5 – 162	77 – 661	28 – 74
Russia	3 – 132	44 – 479	22 – 30
Poland	3 – 62	27 – 181	22
Latvia	3 – 165	85 – 673	45
Estonia	3 – 153	83 – 588	110
Lithuania	3 – 208	77 – 728	35
Germany	5 – 129	45 – 322	22
Denmark	5 – 217	39 – 284	29

Source: Gren et al. 1997

Using the most cost-effective combination of these measures, the overall costs of a 50 per cent reduction of P-losses in the entire Baltic Sea basin was estimated at about 350 million Euro annually (Gren et al., 1997). Two thirds of the necessary reduction achieved in this scenario would come from improved sewage treatment. Total costs would be much higher, ranging up to 1.5 billion Euro annually, if each individual country was required to reduce its P emissions by 50 per cent (Gren et al., 1997). This is mainly because countries that have already achieved significant P reductions would then have to resort to more expensive measures. The authors also find that abatement costs increase rapidly for reduction levels above 40 percent. It is also found that a 50 percent reduction in nutrient loads will take many years for actual nutrient levels in the Baltic Sea to decrease to acceptable levels: up to 10 years for N and up to 25 years for P.

9.3.1.2 The cost of measures to reduce agricultural P emissions

In addition to such countrywide estimates, some Member States have collected information on the costs and the cost-effectiveness of individual measures to reduce agricultural P emissions. Some of the most developed information in this respect can be found in the UK (DEFRA 2003). Information on the costs and effectiveness of individual measures obviously must be interpreted with some caution, given the large variation due to site specific factors. Thus, the risk of P losses depends on the pre-existing P loading of sites as well as site characteristics such as slope, proximity to water bodies, hydrological linkages between the field and the watercourse or buffering landscape features. DEFRA (2003) points out that the uncertainty about the effectiveness of measures tends to increase along the pathway of P input – P mobilisation – P transport: Measures that target P input and mobilisation control P losses at the point of origin, and can therefore be planned and implemented with a greater chance of success. For measures targeted at P transport, effectiveness is more dependent on local site conditions. They must therefore be better targeted at local conditions to be effective.

The following section provides some illustrative evidence on the cost of different measures to reduce agricultural phosphorous emissions. Costs estimates have been grouped into the broad types of operation and maintenance costs, investment costs, administrative costs, opportunity costs (foregone income), wider economic impacts and environmental costs.

- **Operation and maintenance costs** are the costs of implementing and running a P-mitigation measure. For many measures that reduce phosphorous emissions through changes in agricultural practice, operation and maintenance constitutes the largest share of the costs. For example, a reduction of slurry application rates implies that the slurry has to be applied to a larger area. This increases operating costs, mainly due to larger transportation costs and associated time requirements. For the UK, it has been estimated that halving application rates would impose additional cost of 41 Euro per hectare on dairy farmers, or 36.5 million Euro for the UK in total (DEFRA 2003). Restricting livestock access to marginal places or at critical times – for example, during winter and wet seasons – causes costs for fencing and additional forage, with the latter making up the major share of costs (DEFRA 2003). For arable farming, P emission reductions can be achieved through cover crops, which protect the soil over the winter until a spring crop is sown. For the UK, the costs of establishing cover crops have been estimated at about 100 Euro per hectare. If cover crops would be required for all root crops in the UK, the total cost would amount to 5 million Euro (DEFRA 2003). Contour cultivation prevents soils erosion and run-off, thus mitigating P-losses, but may require more time, at a cost of 15 Euro per hectare (DEFRA 2003). Tramlines can be an important cause for gully erosion. They can easily be prevented by sowing the entire field, which leads to minor increases in seed costs and possibly less precise fertilising and spraying operations. Increasing surface roughness can also reduce erosion, at an estimated cost of 160 million Euro for all UK arable crops, if savings due to lower cultivation efforts are not included (DEFRA 2003). Subsoiling is another measure with some positive effects on reducing P-detachment. Operational costs have been estimated at around 70 Euro per hectare in the UK (DEFRA 2003).

- **Capital (investment) costs** occur if the implementation of a measure necessitates on-farm investments, for example, machinery for nutrient management and improved fertiliser application or any other specialised equipment. For example, an increase of on-farm slurry storage capacities by 30 days – which allows for better application timing – would require investments of 90 million Euro for all farms in the UK. Specialised machinery for improved application timing of fertilisers and slurry would cost 30 million Euro for the whole of the UK (DEFRA 2003). Likewise, the construction of wetlands or sedimentation ponds as a P prevention measure consists mainly of (one-off) capital costs. Such measures are estimated at around 112 Euro per hectare (DEFRA 2003). When applied to ten per cent of the grassland and arable land of the UK, the total cost would be 110 million Euro (DEFRA 2003). Moving gateways away from points of drainage up-slope may have an initial capital cost of about 38 Euro per hectare on average, and a total costs of 38 million Euro for the UK (DEFRA 2003). Another measure that requires some investment is the installation of new hedges and reducing field size, the costs of which have been estimated at 425 Euro per hectare on average, or 210 million Euro for the UK in total (DEFRA 2003). Farm track sediment traps are another option to prevent P losses and cost about 532 Euro each (DEFRA 2003). The adoption of precision farming systems can contribute to a targeted optimisation of P-application rates. Among other cost components, the related measures require capital investments in specialised monitoring, control and data processing equipment, as well as specialised machinery. Likewise, capital investments are required when specialised no-tillage or minimum tillage machinery is used. In addition, incorporation of phosphate fertilisers directly after spreading and improved application timing prevents P losses but come at higher machinery costs since the technical capacities for applying fertiliser have to be larger. Additional costs to farmers for direct incorporation have been estimated at 16 million Euro for the UK and the costs for improved timing at 30 million Euro (DEFRA 2003). For grassland, slurry injection may be a useful measure, which incurs on average an additional cost of 46 Euro per hectare, mainly due to the specialised machinery needed. Applied to all UK dairy farms, it would cost 40 million Euro (DEFRA 2003).

- **Administrative costs** arise for regulation, monitoring, training and enforcement. The estimation of such transaction costs is not fully developed. However, some authors provide some indications. Vatn (2002) argues that transaction costs generally increase with precision of policy measures, and with the uncertainty about outcomes of measures. By contrast, transaction costs tend to decrease the more repetitive transaction are. Norwegian data provided by Vatn (2002) suggests low transaction costs of taxes on fertilisers below 0.1 per cent of the tax imposed, while the less frequent and more asset specific support of reduced tillage has higher transaction costs of up to 6.8 per cent of the underlying payment. Conversion to organic farming may also contribute to mitigation of P-losses. According to the Norwegian data, however, support payment for conversion to organic farming involve high transaction costs (up to 29 per cent of the payments) mainly due to monitoring and control. By contrast, an Austrian Study cited by Falconer (2000) for example suggest that public transaction costs of certifying for organic farming are ten times lower for public agents than for farmers, and cost public budgets between 13 to 14 € per farm and year. Both, Vatn (2002) and Falconer (2000) suggest that the set-up costs of measures are higher than the running transaction costs of many measures and thus long-term farmer-state relationships lead to lower average transaction costs of measures. Pretty et al. (2002) provide a fairly rough general indication of the public transaction costs associated with developing eutrophication control policies and strategies, which they estimate at 300,000 Euro per year for the whole of UK, and a further 670,000 Euro for compliance monitoring. Other, more general, figures are cited by McCann et al. (2005), who report transaction costs of a pollutant trading scheme at 35 per cent of total costs and transaction costs of an agri-environmental management agreement scheme at 30 per cent of total costs.

- **Private transaction costs** include cost of training and information, compliance costs, costs of contracting etc. incurred by private individuals affected by measures. Falconer (2000) provides account of relevant private transaction costs for measures related to P-mitigation. In Austria, the private transaction costs of certifying for organic farming have been estimated at 5 per cent of the total premium received per farm, or 150 to 160 Euro per farm and year. Comparable figures from Belgium mentioned by Falconer (2000) on private certification costs of an organic aid scheme ranged between 493 and 305 Euro for one auditing firm and about 125 Euro for the alternative auditing firm. In Greece transaction costs of certifying for organic farming were similar to the Austrian case and ranged from 133 - 163 Euro per farm (Falconer 2000). Falconer also mentions transaction costs incurred by farmers participating in a Swedish agri-environmental programme where private transaction costs were around 12 per cent of the payments received on average. For larger payments, the share of transaction costs was much lower (around 5 per cent), and much larger for smaller payments (up to 40 per cent). Regarding the impact of the WFD on these costs, the widespread use of agri-environmental measures means that the necessary administrative structures and procedures are already in place in most regions and on many farms. The additional transaction costs for WFD-related measures may thus be minor.

- **Foregone income or opportunity costs** occur if measures affect the profitability of production, for example, by reducing crop yields due to lower P application, less livestock per area, or through foregone crop yields on buffer strips that are taken out of cultivation. Thus, for example, the conversion of arable land to grazing land can lower P losses, but implies a significant drop in land rents. In a Danish case described by Dubgaard et al. (2005), land rents fell from between 195 and 346 Euro per hectare to approximately 28 Euro per hectare and year. Thus conversion to grazing land under this circumstances only recovers 5 to 10 per cent of the land rent foregone by giving up arable farming. For the UK, the cost of establishing a six metre wide grass strip along rivers have been estimated at about 52 Euro per hectare (DEFRA 2003). If such strips were deployed on five per cent of all UK arable and grassland, the cost would amount to 6.3 million Euro (DEFRA 2003). The reduction of stocking densities is being proposed as an effective P-mitigation measure as well. Such measures can, however, incur large income losses. For the UK, the financial impact of reducing stocking densities in the dairy sector from 2.25 cows per forage hectare to 1.75 cows per forage hectare has been estimated at 608 Euro per hectare (from a baseline return of 3040 Euro per hectare), which implies foregone incomes of 26 million Euro for the agricultural sector in total (DEFRA 2003). However, this figure does not include benefits of related labour savings. The situation is comparable for sheep production in the UK, where a reduction of stocking rates by 25 per cent would entail an economic loss of 110 million Euro to the sector (DEFRA 2003). Overall, changes in stocking density and conversion of arable fields into grassland come at abatement costs up to 20,000 Euro per kg P saved (DEFRA 2003), and thus belong to the most expensive measures available. By contrast, opportunity costs of reducing P-applications in arable farming (i.e. crop yield reductions) are much less pronounced. Indeed, several studies have found considerable scope for optimisation, where P inputs may be reduced without any detrimental effects, as P-levels in soils are sufficient for plant growth. Buffer strips, restricting access for livestock, constructed wetlands and sedimentation ponds are another group of measures with the potential to create opportunity costs, if productive land is set aside for these measures. The land rent estimates by Dubgard et al. (2005) could serve as suitable indications of the opportunity cost, which range from 195 to 346 Euro per hectare for arable land and approximately 28 Euro per hectare and year for grazed areas in West-Denmark. In practice, however, income losses will tend to be lower because farmers will set aside the least productive land for such measures, where possible. In addition, areas may not completely be taken out of production and serve as grazing and forage production areas. In addition, only minor shares of about 0.25 per cent of the affected land (DEFRA 2003) would be needed for locating such measures.

- **Wider economic impacts** or second order costs, like foregone income for suppliers of P fertilisers are generally not well researched. For example, measures that increase the efficiency of phosphate fertiliser application (such as precision farming or increased storage capacity for liquid manure) may reduce the demand for mineral fertiliser, or eliminate it altogether (see DEFRA 2003 for indications). However, phosphate products are only minor group of many inputs which farmers buy from agricultural merchants. Other effects may arise from measures that affect the overall workload on farms (such as minimum tillage or setting aside arable lands). However, these issues have not been of significant research and are difficult to estimate quantitatively.

- **Environmental costs** of P-mitigation measures can occur under particular circumstances. Some of the proposed measures may induce farmers to take up additional measures with adverse affects on the environment. However, these effects so far have rarely been quantified or costed. DEFRA (2003) for example notes that measures like rough soil surface or minimum tillage may increase the likelihood of weed infestations and thus drive farmers to apply higher rates of herbicides. In addition, minimum tillage may reduce P availability in upper soil layers and may thus drive farmers to apply additional P-fertilisers directly after sowing, when run-off of non-detached phosphorus is more likely. Generally, however, the improved soil cover compared to conventional tillage decreases erosion and run-off risks.

9.3.1.3 Information on the benefits of reducing agricultural P emissions

While there is thus some information on the costs of reducing diffuse phosphorous emissions from agriculture, there is considerably less data on the associated benefits. The benefits will largely consist in reduced eutrophication, and the avoided costs associated with eutrophication. This implies two problems in particular: first, it is not possible to define an absolute limit at which nutrient enrichment becomes a problem, i.e. when it has adverse effects on water uses (Pretty et al. (2002) p. 16). Second, phosphorous is only one of the factors that leads to eutrophication.[33] It is therefore difficult to make general statements what share of the total benefits of reduced eutrophication is due to reduced P emissions, and which share is due to N emissions. It is therefore not possible to clearly

[33] Although both phosphorus and nitrogen play a role in eutrophication, it can be argued that phosphorous pollution as the limiting nutrient is the decisive factor for eutrophication. Bateman et al. (2006) cite evidence that increased loadings of phosphorus are usually considered to have played a central role in accelerated eutrophication of rivers and lakes.

distinguish what share of the total benefits of reduced eutrophication is due to reduced P emissions, and which share is due to N emissions. Neither is it possible to distinguish between benefits of reducing P emissions from agriculture or from other sources. This study followed a compromise approach by looking at the benefits of reduced eutrophication (risk), which have been assessed in a number of studies. It should be borne in mind that only a part of these benefits can be attributed to P emission reductions, and even less to P emission reductions in agriculture.

Bearing these limitations in mind, the benefits of reduced eutrophication can either be measured directly as the perceived benefits of water users, or indirectly through the saved costs of responding to eutrophication damage (i.e. avoided damage).[34] In the first case, benefits mostly accrue to the general public, and can be estimated with economic valuation methods, that measure the economic benefits that individuals derive from preventing eutrophication. An example of this is provided by Bateman et al. (2006), who have elicited individuals' preferences for a policy that would reduce algae blooms in rivers and lakes in East Anglia. Such benefits accrue to the general public, in particular to recreational water uses (bathing, fishing, bird watching, water sports). The authors found that households in the study region were willing to pay 110 Euro on average for a policy that would reduce P emissions and thus prevent eutrophication. For the entire region, this amounts to an annual benefit of more than 250 million Euro. From this, the authors conclude that the gains from reduced phosphorous emissions in East Anglia alone are comparable in size to the costs of phosphate prevention that Andrews et al. (1999) report for the whole of England and Wales.[35]

The second approach, benefit as avoided damage, includes the avoided cost of treating algae blooms as well as reduced clean-up costs, for example, for industrial water filters that would clog up. It also includes the economic damage that algae blooms cause where they do occur, such as foregone income in tourism if bathing is prohibited in a coastal region. Such benefits accrue to the parties who would otherwise bear the costs – i.e. the government department responsible for water management (and thus ultimately tax payers), or firms that abstract water from the affected water bodies. An indication of this is provided by Pretty et al. (2000). In an assessment of the total external costs of agriculture in the UK, the authors estimate that the total cost of P removal incurred by water supply companies (and presumably passed on to consumers). The total annual capital expenditure for phosphate and soil particle removal in the UK is reported at £73.5 million (95 million Euro, 2000 prices), of which £15.7 million (20.4 million Euro, 2000 prices) can be attributed to agricultural phosphorous emissions. In addition, Pretty reports a conservative estimate of 4 million (5.2 million, Euro, 2000 prices) for the costs of eutrophication. This only covers remedial costs of reservoirs, that have to close treatment works for extended periods because of excessive plankton concentrations. Other costs for water supply, irrigation, fisheries, navigation, water sports and angling are not included (for example, algae blocking filters, stimulating bacterial growth, and giving drinking water an unpleasant taste). However, there are no indications as to how this figure would change because of the implementation of the Water Framework Directive.

While there are few studies that have estimated the monetary benefits of reducing phosphorous loads, there are a number of studies that have measured the monetary benefits of reduced eutrophication more generally, without distinguishing which share of the benefits is due to phosphorous or to nitrate emission reductions.

[34] In addition, some measures aimed at P emissions have secondary benefits, such as measures that reduce P-emissions by controlling erosion. Buffer strips have positive effects on the ecological status of the river by increasing habitat- and species diversity. However, such secondary benefits are hardly ever quantified.

[35] In their paper, Bateman et al. (2006) use a different comparison: they refer to estimates of the total costs of responding to eutrophication by Pretty et al. (2002), and find that the benefits of reduced eutrophication in East Anglia alone exceed the costs for all of England and Wales by a factor of 1.5 to 3. However, the policy response costs reported by Pretty et al. (2002) are dominated by sewage treatment costs to remove phosphorus from large point sources, which account for £50 million (65 million Euro) and hence more than 90% of the total cost.

- Söderqvist and Scharin (2000) estimate the benefits of reduced eutrophication effects in the Stockholm archipelago, Sweden. To this end, they elicit resident's willingness to pay for a hypothetical nutrient reduction programme, using the contingent valuation method. The average willingness to pay of adult resident in the region is estimated at 47 – 79 Euro per year, which corresponds to an overall willingness to pay of the whole population in the region of 55 – 92 million Euro per year.

- Turner et al. (1999) estimated the costs and benefits of reducing eutrophication in the Baltic Sea. The benefits were estimated through contingent valuation studies conducted in Poland and Sweden, in which respondents were asked to state their willingness to pay for a large-scale international action plan to reduce eutrophication in the Baltic Sea. For Sweden, the mean annual WTP was estimated to be between 350 and 630 Euro. Based on these estimates, the total national WTP for Sweden (based on total adult population) was calculated to be in the range of 1.2 – 2.2 billion Euro. For Poland, the WTP per person was estimated to be between 46 and 90 Euro. The countrywide WTP was found to be between 0.6 and 1.2 billion Euro. It is not surprising that the estimates for Poland were significantly lower than for Sweden, given the difference in income levels. Based on these estimates, and accounting for income differences, the authors also calculated the total basin-wide benefits (for nine countries) to be between 4.1 and 7.4 billion Euro per year. While the authors note that this is a highly uncertain figure, it does at least indicate that the benefits of reducing nutrient emissions to the Baltic Sea are substantial. The authors also put these figures into perspective by comparing them to the costs of achieving the necessary nutrient reductions (Gren et al. (1997), discussed above). The result is that benefits exceed costs by a factor of 1.2 to 2.2, and are thus at least in the same range, if not higher than the estimated costs of reducing nutrient loads.

- Using the travel cost method, Sandstrom (1996) estimated recreation benefits from reduced eutrophication of Swedish lakes. Sight depth is used as the measure for water quality, since it is related to the recreation users' perception of water quality, and since it is highly correlated with nutrient load. The study showed that the increased benefits of a 50 percent reduction in nutrient load is between 15 and 34 Euro per trip. For the entire population, the total recreational benefits from a 50 percent nutrient reduction are found to be between 26 and 59 million Euro. These estimates are thought to be on the low side. A possible downward bias may stem from the fact that one-day trips were not considered in the analysis, and secondly, since non-use values are not captured by the travel cost method.

- A French study (Goffe 1995) employed the contingent valuation method to estimate recreational benefits of improving water quality at the Brest natural harbour. The harbour on the western coast of Brittany suffered from eutrophication. Goffe (1995) carried out surveys to elicit willingness to pay for two different water quality improvements. In the first case, interviewees were asked how much they would be willing to pay for improvements of the microbial quality of the harbour, which would enable them to bathe and consume shellfish without risk. The mean annual WTP was estimated at 33 Euro per person (1993 prices), which is equivalent to 10 percent of the respondents' annual water bill. The second scenario involved the high nutrient concentration in the water and their consequences on the marine ecosystem. Interviewees were asked their annual WTP to prevent the depletion of oxygen in harbour waters due to high nutrient concentrations. The average WTP was estimated at 24 Euro (1993 prices).

- Becker et al. (2005) estimated the willingness to pay for improved water quality in the lower River Rhine and the River Ems catchments in Germany. Phosphorus losses are a major determinant of surface water quality in the two catchments. The River Ems mainly suffers from diffuse pollution due to drainage of agricultural land, which accounts for almost two thirds of the annual P load. The River Rhine receives 1574 tonnes of P per year, of which 11 per cent are attributed to the erosion of agricultural soils. In both catchments eutrophication is driven by P losses. Considering the effects of eutrophication, the willingness to pay has been established for a reduction of turbidity and smells from water bodies 30 days to 40 days per year together with a 25 per cent increase of salmon populations in the catchments. The majority of respondents, however, refused to pay for the suggested improvements. Thus, the average willingness to pay among all respondents of both catchments amounted to 19 Euros per year, while the average willingness to pay was 44 Euros, considering only those willing to pay. For even further-reaching improvements, an average willingness to pay of 28 Euros among all respondents was estimate, respectively at 63 Euros among those willing to pay. Although agricultural P losses are a very important water quality in this context, it is not possible to assess what share of these benefits is due to P or N emission reductions from agricultural or other sources.

Table 27: Monetary values of cleaner surface water and lower eutrophication (annual WTP)

Study	**Study region**	**Method**	**WTP per capita (lower bound - upper bound)**	**Total WTP (lower bound - upper bound)**
Aarskog 1998	Inner Oslo Fjord (Norway)	CV	68 (non-users) – 104 (users)	
Bateman et al. (2006)	East-Anglia (UK), Norwich region	CV	104 – 126	254 million (mean)
Magnussen and Navrud (1992)	South Eastern Norway	[CV]	126 – 252	
Turner et al. (1999)	Sweden, Poland, Baltic Sea basin	CV	46 – 90 (Poland), 350 – 630 (Sweden)	0.6 – 1.2 billion (Poland), 1.2 – 2.2 billion (Sweden), 4.1 – 7.4 billion (Baltic Sea)
Mäntymaa 1997	Oulujärvi, Finland	[CV]	92 – 133	
Markowska and Zylicz (1999)	Poland and Sweden, Baltic region	CV	353 (Sweden), 43 (Poland)	1.2 billion (Sweden) 1.1 billion (Poland), 6.0 billion (Baltic Sea basin)
Sölderquist and Scharin (2000)	Stockholm Archipelago (Stockholm and Uppsala)	CV	47 – 79	55 – 92 million
Zylicz et al. (1995)	Baltic Sea coast of Poland	CV	65 (mean)	
Gren et al. (1995)	Sweden, Poland, Balstic Sea basin	CV	326 – 630 (Sweden), 33 – 65 (Poland)	2.2 billion (Sweden), 0.85 billion (Poland), 3.4 billion (Baltic Sea basin)
Sandstrom (1996)	Sweden	TC	15 – 34 per trip	26 – 59 million
Goffe (1995)	France (Brest)	CV	24 – 33	
Becker (2005)	Ems, Rhine (Germany)	CV	19 – 28 (all respondents) 44 – 63 (excluding protest)	

9.3.2 Analytical review

Some Member States have estimated the need for phosphorous load reductions, and the associated costs, at the national level. Such estimates are subject to many uncertainties, since assumptions have to be made about the necessary ambition level for reducing emissions, and about the effectiveness and efficiency with which measures are actually implemented.

The available figures for the nationwide costs of reducing agricultural diffuse P emissions show considerable divergence. For example, for the Netherlands, two different model-based calculations diverge by a factor of 20. The higher estimate, provided in the Aquarein study, suggests that two thirds – if not all – of agricultural production in the Netherlands would have to be phased out in order to reach the WFD objectives. By contrast, the lower estimate would imply that farmers face an increase of compliance cost of 30 – 60% compared to the current manure policy – which is still considerable, but nowhere near the disastrous effect suggested by the higher estimate. Key differences between the two estimations, which may explain part of the stark difference between the two, are the assumed need for phosphorous emission reductions (i.e. the different levels of ambition), variations in physical assumptions on the effectiveness of measures, and the assumed potential for farm-level emission reductions through more efficient use of fertiliser. [36]

Except for the Aquarein study, which estimated the economic consequences at 1.8 – 2.7 billion Euro per year (or 60 – 100% of agricultural net value added), most other nationwide estimates are in a comparable order of 50 million Euro (DK), 60 – 120 million Euro (NL), 80 – 110 million Euro (UK_{1999}) and 130 – 470 million Euro per year (UK_{2007}). If put into proportion to the agricultural production in the respective countries, this corresponds to 2.6% (DK), 2.2 – 4.4 % (NL), and 0.9 – 1.3% (UK_{1999}) / 1.0 – 5.6% (UK_{2007}) of net value added of the agricultural sector (Figure 26 below provides a graphical overview of these figures). These are countrywide average figures, hence the share will be higher for some subsectors of agriculture, such as intensive dairy and poultry farming, and in some regions. For other sectors and regions, impacts will be lower. Even if one considers that the estimates are very crude calculations and rest on a number of strong assumptions, the overall costs appear feasible, also in light of the fact that some of the surveyed countries (DK, NL) have fairly intensive farming practices.

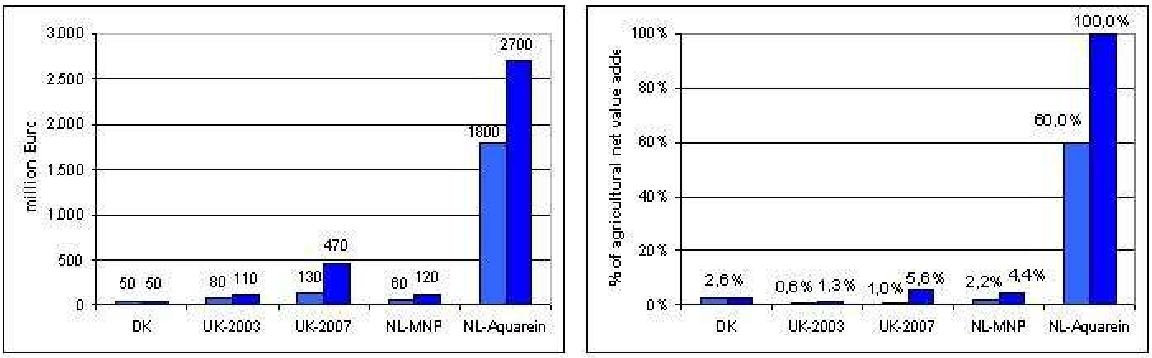


Figure 26: Overview of nationwide cost estimates (DK, UK and NL)

For the cost estimates presented above, it should be noted that some of the measures considered

[36] A more recent cost estimate in the 2006 'Decembernota' falls in between the two estimates (MinVenW 2006). The document (p. 35) argues that the additional cost for the agricultural sector to comply with WFD requirements could run up to more than 1 billion Euro per year. This number is related to nutrients as such rather than to phosphorous only, and is unfortunately not substantiated further in the document.

(such as buffer strips along river courses) are not only effective for combating phosphorous pollution, but also against other types of diffuse pollution from agriculture, including nitrates and pesticides. As a consequence, it may be difficult or impossible to identify whether such measures are necessary to comply with the WFD or with other legislative requirements, such as the Nitrates Directive. This is similar for the calculation of benefits, where benefits can often be assessed only for reduced (risk of) eutrophication, but not for P or N reductions separately (see below).

In addition to aggregated, nationwide figures, there is also considerable information on the costs of individual measures to reduce on-farm P emissions. While the costs and effects of measures are often highly site-specific and therefore difficult to generalise, it appears that there is still some scope for efficiency gains at little or no additional cost. It will depend on the measures in the reference scenario to gauge to what extent that potential has already been exploited.

Bearing in mind the general caveat that the cost and effectiveness of measures may vary considerably between sites, several authors find that there is considerable potential to further reduce agricultural P emissions at little or no cost (see for example, Jacobsen et al., 2004, DEFRA, 2003, Sorensen et al., 2006). These comprise for example, measures reducing the use of P containing inputs like fertilisers and feedstuffs, whose application rates are often higher than crop and livestock demands, leaving some scope for optimisation of application rates (DEFRA 2003). In the case of arable farming and forage production significantly lower P-application rates may however be possible without yield reductions, because P-levels of soils have built up over the past or are traditionally sufficient for plant growth. Some research suggests that nutrient management is the most effective way to reduce P losses from agricultural activity (Sharpley and Rekolainen 1997). Others point at the efficacy of curbing P emission through minimum tillage and mulching which tends to reduce run-off by 20 per cent and P loss by 60-70 per cent compared to conventional ploughing (Strauss et al., 2003). A report produced by ENTEC under the UK Collaborative Research Programme (Sorensen et al., 2006) provides a benchmark cost database with generic data for a set of standard measures. Of the measures relevant for diffuse phosphorous emissions, a number of basic measures (restrict fertiliser spreading on high risk fields / at high risk times; on-farm measures to contain contaminated run-off etc.) provide fairly inexpensive options to reduce P emissions at little cost (i.e. less than 10 Euro per ha per year).

The scope for such no-regret-measures appears to be considerable. DEFRA (2003) mention the case of preventing P fertiliser application on arable land of > P index 4 and halving the amount of P fertiliser on land of > index 3, which could reduce P inputs in the UK by 90,000 tonnes and total losses by 320 tonnes – at zero cost. Jacobsen (2004) estimate that increases in the use of phytase and phase feeding could reduce P surplus in Denmark by 15,000 to 19,000 tons per year. The potential will also depend to what extent these measures have already been introduced in the reference scenario.

The available information on the benefits of reducing diffuse phosphorous emissions from agriculture is somewhat patchy. Benefits of reducing P emissions will mostly take the form of a reduced risk of eutrophication, and the associated amenity benefits and avoided costs for filters and water treatment. Benefits of reduced eutrophication are manifold and difficult to quantify, since all the benefits associated with biodiversity conservation are involved (use values like recreation, as well as non-use values).

Phosphorous is only one of the factors that causes eutrophication (together with nitrogen). However, for valuation studies, it is usually not possible to consider the contributions of phosphorous and nitrogen separately, the benefits of reduced eutrophication are rather valued as one sum.[37] Also,

[37] The reason is that, for an individual water user, it is only the end result – the eutrophication – that impedes his/her use of the water (e.g. for fishing, swimming, boating, or as non-use value). Whether the eutrophication is caused by an overload of N or of P is relevant for the choice of counter measures, but not for the valuation.

studies usually consider phosphorous from agricultural sources as well as from sewage treatment. An additional problem is that the existing valuation studies – unlike most studies on the costs of reducing P emissions – are not specifically related to the WFD implementation, but are either based on hypothetical policy interventions, or on pre-WFD national policies. [38]

If these limitations – lacking distinction between N and P emissions, lacking distinction between agricultural emissions and sewage treatment, and lacking relation to WFD implementation – are ignored, there is considerable evidence of the monetary benefits of reducing eutrophication. Estimates of willingness-to-pay for reducing eutrophication have been carried out in the UK, Denmark, Sweden, Finland, Norway and Poland. In addition, a comprehensive study for the entire Baltic see was carried out by an international research team in the late 1990s. Per-capita estimates of willingness to pay show quite some divergence – which is not surprising, given the different valuation methods used, the different times at which the valuation was carried out, the differences in income between countries, differences in attitudes towards environmental protection, and the differences in the proposed policy options for nutrient removal schemes that respondents were asked to value. That said, most of the estimates are in the range of 50 – 140 Euro per capita per year (neglecting inflation or exchange rate fluctuations). Figure 27 gives a graphical overview of the values found in the literature (annual willingness to pay for reduced eutrophication).[39]

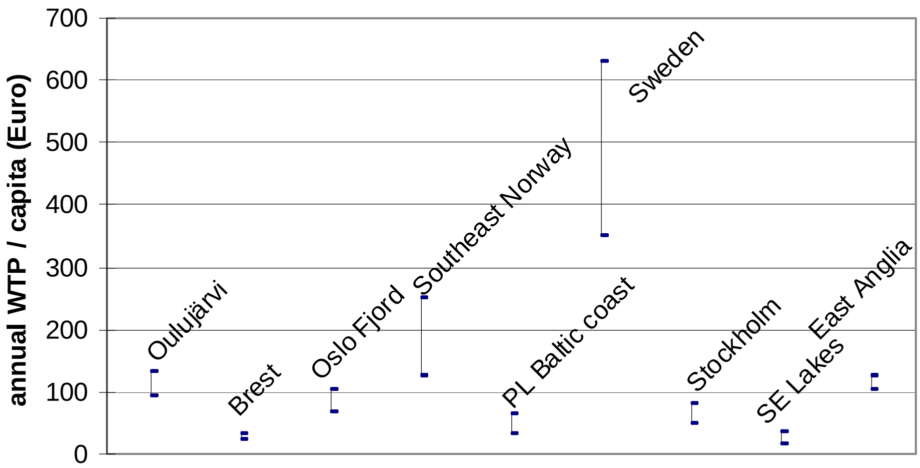


Figure 27: Selected estimates of the benefits of reduced eutrophication (annual WTP per capita)

If extrapolated to the study region, the total benefits of reducing eutrophication can be substantial, also when compared to the costs: for example, Bateman et al. (2006) estimate a total annual benefit of 130 – 250 million Euro for East Anglia; for the Stockholm and Uppsala region, Söderqvist and Scharin (2000) find an annual benefit of 55 – 92 million Euro. For the entire Baltic sea, Turner et al. (1999) estimated the benefit of halving nutrient emissions at 4.1 – 7.5 billion Euro per year. Where the authors compare the estimated benefits to the costs of reducing nutrient emissions, they find

[38] This complicates the comparison of benefit estimates to cost estimates discussed before: the valuation studies discussed are usually about the perceived benefits of clear, algae-free water. To what extent this will be achieved through the WFD would need to be assessed on a case-by-case basis.

[39] The high value for Sweden can partly be explained by the fact that respondents were asked for the willingness to pay for a programme that would reduce eutrophication nationwide, whereas all other estimates apply to the study region only. Note that no adjustments have been made to account for differences in the study year, valuation method, valuation scenario used, or any other differences between the studies.

them to be within the same order of magnitude (e.g. Bateman et al. (2006), Turner et al. (1999)). However, the authors warn that such comparisons should be interpreted with caution, given the huge uncertainties surrounding aggregate costs and benefits figures.

9.3.3 Evaluation and lessons learned

In many European basins, diffuse phosphorous emissions from agriculture are among the main pressures that pose a risk for the achievement of good ecological status, especially in those countries where industrial and household sewage treatment is widely implemented and phosphorus in washing detergents prohibited. The required efforts to reduce diffuse agricultural phosphorous emissions can be substantial for some subsectors of agriculture and in some parts of Europe, although some studies have also identified potential no-regret measures that reduce P emissions at little or no additional costs, such as adding phytase to animal foodstuffs..

Since the objective of “good ecological status” has not been defined for all types of European waters, and since neither the programmes of measures nor exemptions decided at this stage, any assessment of the costs and benefits of WFD implementation is at this stage speculative in nature. For the case of diffuse phosphorous pollution from agricultural sources, helpful insights can be gained from estimations that assess the necessary efforts at the national level. Some Member States have estimated the costs of reducing agricultural phosphorous emissions to a level that would presumably guarantee the achievement of good ecological status (in particular Denmark, Netherlands, UK). Such estimations are necessarily subject to much uncertainty, and require strong assumptions – starting with the necessary overall emission reduction – but they may illustrate the order of magnitude of the required efforts. It could also be noted that the investigated countries – in particular Denmark and the Netherlands – are countries where agriculture is practiced in a relatively intensive way, and with a high proportion of cattle farming. It would therefore be plausible to assume that other countries / regions with a less intensive pattern would experience lower costs.

In conclusion, the picture that emerges from the available evidence is that the costs for the agricultural sector for achieving the necessary phosphorous emission reductions will be substantial Yet, while WFD implementation will certainly impose hardships on some parts of agriculture and in particular regions, most estimates of the overall costs of the Directive range between 0.6 and 5.6% of agricultural gross value added. In particular, there still appears to be some potential for emission reductions at little or no additional costs. Also, while the costs imposed by the WFD implementation in the case of phosphorous are substantial, so are the benefits. A number of valuation studies have found benefits from reduced eutrophication risk in the range between 50 – 140 Euro per capita per year. However, the available evidence does not support a direct comparison of costs and benefits, as the benefits are calculated for reduced eutrophication (i.e. a distinction between the benefits of P and N reductions, or between the benefits of P reductions from agriculture and those from other sources is not possible). In addition, it should be noted that the costs and benefits are distributed unequally among the affected parties. Third, it will depend to what extent cheaper measures have already been introduced in the reference scenarios and the marginal contribution of these measures to limit eutrophication.

Accounting for payments: It has to kept in mind that all economic assessments are affected by the high degree of payments, which result in distorted markets (and no reliable market prices). Without the use of shadow prices statements about costs or efficiency of the WFD are difficult to make. Perhaps more importantly, payments also have a distorting effect as some provide negative environmental incentives to farmers. This continues despite recent efforts to decouple payments from production, since several agricultural products have not been fully decoupled. Hence farmers’ decisions on which crop to farm still reflect agricultural payments rather than economic rationale, let alone environmental considerations. This includes crops that have a high water consumption and / or require high levels of fertilisation (for example, maize), jeopardising achievement of the WFD objectives in some instances.

Consumer interests and consumer demand: in contrast to other actors, farmers only have very limited options to pass on higher production costs through higher prices, including the costs of environmentally motivated measures. In the case of phosphorous emissions, this constitutes a major difference compared to the other main source of P emissions, wastewater treatment: for the latter, higher prices can generally be passed on to the users / customers. In the short run, this inability of farmers to pass on higher costs may benefit consumers though low prices. In the longer term, however, consumers end up paying the bill – either as taxpayers, who have to fund restoration measures from public budgets, or as citizens, whose options to use the environment become limited. Thus, consumer interest in cheap food effectively means that environmental costs have to be paid later.

10 RECOMMENDATIONS

10.1 Economic analysis and tools

The development and use of economic information is a stepwise process, in which more generic and qualitative information may be enough to guide the first decisions for selection of measures but that will require more detailed and comparable information as many measures need to be evaluated. Member States are recommended to develop longer term strategies on how to generate the required tools and data for economic analysis and the capacities to use these results for decision making.

These strategies should build up or be part of a European wide strategy. The development and use of economic information throughout Europe would offer major opportunities to share information. One particular goal would be to identify measures and situations with good Benefit-cost ratios, and to pin-point measures and situations that require further study. An important additional issue is how to integrate the efforts by different Member States to estimate costs and benefits for international river basins, to ensure that comparisons are feasible.

The monitoring of the costs of the WFD is a difficult exercise, made more so by the problems of differentiating between WFD and pre-WFD measures. There is a need therefore to develop a standard means of monitoring and agreeing in principle on how to define WFD and pre-WFD measures.

Different top-down and bottom-up methods of benefits assessment are highlighted. One important issues is how to relate changes in the status of water bodies to the provision of “goods and services”. Agreement on typical dose-responses, to describe and quantify this relationship should be sought.

Single WTP surveys can be used to assess the benefits for a river basin or country, but the information is not sufficient to select individual measures or prioritise between locations – so more detailed bottom up approaches are needed in addition.

Currently there are no guidelines which help to estimate scarcity rents. These guidelines will help in the improved allocation of water resources, especially where water resources are in decline.

Initiatives to develop international frameworks, tools and models to evaluate water policy in the same way as the air quality and energy issues, will provide the means to assess the impact of EU policy on the water sector.

In this context, data (benefit) transfer will be required, both within and between countries. They are required for both impact assessment indicators (linking water bodies and measures with expected impacts (volumes of surface or groundwater used for drinking water), information on users de:; (number of hikers, bikers, anglers per km river, number of houses per km river bank/dyke) and data and functions for valuation. More research is needed to build on a set of reference values, with rules to aggregate benefits of different categories, types of users, the timing of benefits and appropriate discounting rates. The UK, France and Netherlands have started to develop and use tools to estimate the full economic value of improvement of all water bodies within a river basin and country. Lessons can be learned from these experience to develop a set of guidelines and tools to assist other MS

More efforts are needed to validate the quality of statistical data on environmental expenditures provided by National Statistical Offices of individual Member States.

10.2 Specific issues and measures

Administrative costs - More efforts are required to monitor and evaluate administrative costs. Economic analysis can help in directing cost-effectiveness measures to reduce administrative costs that would be paid back in the long run.

Fish migration – More information is needed to assess the benefits of measures to improve fish migration, at the same time studies indicate that there are a number of low cost solutions to improve the situation.

Wetlands – Use cost-benefit and ecosystem function approaches to evaluate measures related to wetland restoration, creation or protection, apply the existing frameworks for assessing costs and benefits, but ensure that the potential benefit categories are relevant for the specific case and assess marginal impacts,.

10.3 Agriculture and water use

Inventorising wells, establishing metering systems, and clarifying abstraction rights are important ingredients for improving the management of groundwater.

Water pricing can be a helpful support instrument to recover the costs of significant improvements in water quantitative status, but it will need to be complemented by other measures and instruments to ensure sustainable water resources development.

Where the competition for water between sectors is great – scenarios and demand projections are required to ensure the sustainable use of water.

Technical and legal support needs to be given to promote the efficient allocation of scarce water resources, this is particularly relevant as climate change will exacerbate water scarcities in many parts of Southern Europe, at many times of the year.

10.4 Agriculture and phosphorous

There is a general conclusion that, while the costs of limiting P emissions from agriculture can be substantial, there also considerable benefits. While, a general comparison of costs and benefits is not possible based on the available evidence, the existence of considerable use- and non-use benefits of reducing eutrophication risk suggests that this aspect merits closer attention.

Regarding the costs, it is clear that some sub-sectors of agriculture will be more affected than others, and hence also some countries / regions more than others. Some studies have asserted that, in some countries, there still seems to be an untapped potential for P reduction at little or no cost.

10.5 General strategic recommendations

Develop a longer term strategy in which information gathered and developed can serve multiple uses and questions, at different policy levels and scales ((sub)river basin; national), and can stepwise be improved over time. For example,

- cost information will serve cost-effectiveness analysis, cost-recovery, financial planning, cost-benefit, …
- effectiveness analysis will serve as input for cost-effectiveness, cost-benefit, development of

PoMs, EIA of measures, etc.
- benefit assessment can deliver inputs for cost-effectiveness, cost-benefit, selection of locations and measures, identification of win-win solutions with other sectors or policies,

Develop a strategy that combines different expertise in a common framework. (Do not rely on a single set of expertise or do not shift the burden to one level (local or national)) Take care of some simple basic rules that are important for economic analysis.
- a combination of local expertise within (sub)river basins with technical expertise which can be developed more efficiently at higher level (national, international).
- define a wide set of different and competing measures to be evaluated. Take care that applying certain measures in one situation may lead to quite different costs (or cost effectiveness) than in another setting (phosphate removal at WWTP can be seen as a single measure but experience shows that there is a wide variation in costs (and thus cost-effectiveness, which is often ignored in a top-down analysis approach).
- Cost effectiveness analysis is at the core of most economic analysis. It requires integration of expertise related to defining and assessment of costs and definition and assessment of effectiveness.
- Benefit assessment combines expertise related to (environmental) impact assessment of measures and the valuation in economic terms of these results.
- Take care of capacity building for both development of data, methods and assessments in all area’s of expertise and for interpretation and use of results among a wide range of potential users.

Economic analysis will be most useful if it is used in a stepwise strategy as it allows different disciplines to improve stepwise methods and data collection and to interact with each other. Stakeholders could be asked to supply cost-effectiveness analysis (applying certain common standards to make results comparable), which enables water authorities to decide which measures can be best taken. If water authorities themselves will assess cost-effectiveness one may fear that the stakeholder may have small or large objections to the outcome, involving the stakeholder would at least partly cope with this problem.

In the short run, build on lessons from other countries and literature to identify and select potential measures, the main factors that will impact on costs and benefits and orders of magnitudes. Improve information for the most promising measures. This transfer of knowledge could be organized at the EU level. The additional costs for economic analysis can be earned back as it will help to identify more efficient measures and policy instruments. Try to estimate this benefit using some simple assumptions and use that to gain support for the analysis. Use results of benefit assessments for the identification of beneficiaries, and to gain support for the selection of measures.

11 CONCLUSIONS

The following sections summarise the main conclusions drawn from our overview and analysis of existing information of the implementation of the WFD. In addition, a section is included that points the way forward for future work.

11.1 The current status of the use of cost and benefit analysis in the Member States

The information on the nationwide studies of costs and benefits of the WFD is limited to a few Member States that have a long tradition of economic assessments in the water sector. The review of these studies shows that these countries are far enough in their process of economic assessment to have produced first rough estimates, but not far enough to paint a complete and definitive picture of costs and benefits. In the years to come, these Member States will complete their analysis, while others are likely to release first estimates.

Member States are obliged to draft river basin management plans by 2009, including an analysis of the cost-effectiveness of proposed measures to achieve the WFD targets. The overview of progress illustrates both the complexities involved and the lack of economic tools and indicator data in the water sector.

The overall methods for carrying out a CBA of the WFD are well established, but currently there are insufficient tools and data to implement economic assessments. Member States, such as the United Kingdom and the Netherlands, with their own CBA requirements and traditions have the data and the tools available to carry out these types of assessments. The report therefore relies heavily on the studies produced by these two Member States in addition to information on specific measures from other Member States. In the environmental domains of energy and air pollution – CBA has been carried out at the European level, building on the fact that adequate national and European tools for the assessment of costs and benefits have been developed.

11.2 The review of costs and benefits

The review of costs and benefits of the WFD has concentrated on identifying the major factors that drive the level of costs and benefits. Some factors are particular to either costs or benefits, whereas in some cases the factors apply to both estimating costs and benefits.

The factors that apply to both estimating costs and benefits are: the GAP analysis; the selected Programme of Measures; income level; effectiveness of measures, timing of measures, assumptions about the time frame and discounting rates. The factors particular to only costs are: efficiency of policy instruments and efficiency of implementation. The factors particular to only benefits are: the number of people affected and the degree of willingness to pay.

As noted above it is too early to have information on the costs and benefits of implementation of the WFD. It would require a full cost-benefit analysis based on recent assumptions on reference scenarios and ambition levels for a good estimate to be made. The information that is available today (reports and studies from the Member States, and on the basis of the available data on costs of environmental measures from Eurostat) suggests that the implementation of the WFD is likely to involve substantial costs. However there are large uncertainties associated with these estimates, and will depend largely on the level of ambition in terms of reaching good ecological status. The level of ambition can effect costs by a factor of 3 to 5. In addition, it is very unsure what the efficiency of measures is likely to be, which will depend on the costs of measures in the pipeline and renewal of existing infrastructure. Only for one country (NL) can we compare WFD and current costs, and with current information this gives a range from 5 to 30 %, compared to the baseline situation. Although uncertainties are very large, the information available today indicates that costs of WFD implementation in the EU are likely to be substantial but unlikely to be greater than costs for current measures and measures in the pipeline.

The information on benefits of the WFD across Europe is limited. Three Member States that have a long and extensive traditions in benefit assessment have published first results, as a starting point for further research into the benefits of WFD. The review of these studies show that even for these countries it remains difficult to get a complete picture of the full benefits. The overview will become more complete in the coming years.

These first raw and incomplete data show that benefits are very diverse and include avoided costs for water supply and management, benefits for water related recreation (angling, kayaking) and informal recreation, amenity benefits for populations close to rivers, non-use benefits related to improved environments for plants and animals, and the better protection of water resources. None of these single categories dominate the total benefits.

The factors that determine benefits include definition of GAP and ambition levels, the extent to which all relevant benefit categories and water bodies have been included, the number of people affected and their willingness to pay, and the scope for win-win measures with water supply and management. Again it is not possible at this stage to predict what the scale of the benefits may be, though available assessments indicate the benefits in the region of quantified is 10-100 €/household/year. These assessments were based on assumptions that reflect the understanding of WFD implementation at that time, and for some without sufficient information on the status of water bodies or the standards which are needed to deliver good status.

This variety in benefits is good news for those that look for support for the implementation of the WFD, because a wide range of people are likely to benefit from the WFD measures, especially through non-market benefits. The other side of the coin is that it makes benefit estimation a complex and challenging task, especially in Member States that have no tradition in economic benefit assessment, and less studies and expertise to build on.

Further assessments of potential benefits of the WFD at the national or EU level could be carried out by using a top-down questionnaire approach. However the benefit analysis of individual or packages of measures requires using bottom up accounting techniques. The identification and quantification of benefits is only appropriate at the river basin level. The FP6 AquaMoney research project is developing guidelines for the valuation of benefits of WFD and will ease the use of benefit transfer. In addition, the WFD will give a boost to valuation studies throughout the EU.

The information available today is not accurate enough for Member States to already fine tune the selection of measures but rather to indicate in which direction further development of packages of measures should head and identify priorities for further research or data collection. Studies on specific WFD measures suggest that there is a large potential for cost-beneficial measures. But with benefit-cost ratios depending on the context it is necessary to undertake a local analysis of the cost and benefits in the further selection of the Programme of Measures.

The studies illustrate that the WFD is not a single, well defined objective or set of measures, but offers the opportunity for Member States to define ambition levels and select measures taking economic analysis into account. The data suggest that there may be large differences for both costs and benefits between small and big gap scenario's or between low to high ambition levels.

11.3 Specific issues and measures

A review of information available on the administrative costs related to the WFD indicates that there are certainly some extra administrative costs that will be attributable to the to setting-up of plans for and implementation of the WFD. Presently, estimates are not easy to make, but are roughly estimated at € 50 million per year for the Netherlands, being 25% more to the current administrative costs of managing water bodies. Although in absolute terms the administrative costs of water management may assumed to increase (in line with additional expenditures due to implementation of policies in pipeline and the WFD), it is reasonable to assume that administrative costs in relation to total costs will remain constant.

It should also be pointed out that the benefits of administrative requirements that attribute to setting up plans for the WFD will result from integration with other water/nature related policies/planning and result in a more effective decision making process (obligation to achieve results). If sound administration really supports cost-effective implementation, the savings may be much larger than the additional costs. However, to reap these benefits sound economic analysis is required.
A review of the costs and benefits associated with wetlands indicates that the most important value attached to measures enhancing wetlands (creation, restoration, management) is in the multi-purpose solutions that are on offer (solutions for different policy-objectives). In addition, it is observed that the creation of wetlands (floodplains), can be, in some cases, the most cost effective measure for HMWBs to achieve GEP. It needs, however, a case specific assessment of marginal costs and benefits to check to what extent this message applies to the measures evaluated.

Our analysis shows a great deal of information is available on different fish by-passes, but little information on actual costs and benefits. There were no published assessments of the costs and benefits of fish migration measures in Europe. A couple of North American studies, however, provided evidence that the removal of unused dams or weirs brought benefits to local communities in the form of improved recreational fishing facilities.

A good cost-effectiveness analysis is needed to compare different measures:
- removal of obsolete (i.e. not in use) obstacles could be cost-effective;
- upgrading the older installations with fish-friendly turbines could be more cost-effective than building fish by-passes/ new installations (lower fish mortality, higher productivity) – but cannot not accommodate fish that migrate upstream;
- an integrated approach is necessary for the design of new fish by-pass installations and creation of suitable habitats.

A review of the costs and benefits of specific measures to improve irrigation methods and management indicates that one of the main impacts of the WFD on irrigation water demand will be through the Art. 9 requirement that water services should recover the costs, including environmental and resource costs. This will affect agricultural sectors in different ways: some parts of agriculture (esp. fruits and vegetables) account for a high share of irrigation water demand, but at the same time the marginal productivity of irrigation water is high in these sectors, even in the absence of CAP payments. Hence the price elasticity of demand for irrigation water is relatively low: if the water price rises, irrigation water demand will not fall very much. Thus, if the WFD should lead to higher cost recovery levels and thus higher prices for irrigation water, demand for irrigation water *in these agricultural sectors* will not be affected very much. The objective of cost recovery would thus be reached without significant improvements of water quantitative status. In these regions and for these types of crops, water pricing may thus be helpful as a support instrument to provide adequate incentives, but it will need to be complemented by other measures and instruments to bring about improvements in water quantitative status. By contrast, cereals and crops such as sunflowers and cotton can only be produced in many regions because the irrigation infrastructure is subsidised and because cost recovery levels are low. If the WFD should lead to higher cost recovery levels, such production could become unprofitable for many farms. Thus, cost recovery would be achieved as well as improvements of water quantitative status, but at the risk of reducing the profitability of many farms. Again, water prices should therefore not be the sole instrument of choice, but need to be complemented with measures targeted at reducing irrigation water demand.

A review of the costs and benefits of specific measures to reduce the diffuse pollution of Phosphorous from agriculture indicates that the costs for the agricultural sector for achieving the necessary phosphorous emission reductions will be substantial. While WFD implementation will certainly impose hardships on some parts of agriculture and in some regions, most of the available estimate expect that the overall costs of the Directive would lie between 0.6% and 5.6% of agricultural gross value added. Whether or not this represents an unacceptable hardship is clearly debatable. In particular, there still appears to be some potential for emission reductions at little or no additional costs, but their importance will depend inter alia to the extent these have already been implemented in the reference scenario. The benefits will be mainly due to limiting eutrophication, and the evidence suggests that the public in many European countries attaches a high value to reduced eutrophication. It needs further and case specific assessment to evaluate to which extent reduction of P from agriculture contributes to that objective.

Finally, it should be noted that the cost and benefits are distributed **unequally** among the different agricultural sectors.

11.4 The way forward for the further use of economic tools in the WFD

The further development of the CBA of the WFD requires more detailed, stepwise analysis that feeds in with cost-effectiveness analysis and river basin planning. Exchange of information and collaboration for the development of tools will help to realise this goal. An important step is to rationalise the lessons from the first experiences, with this report being a suitable starting point. One particular goal would be identify measures and situations with good benefit-cost ratios, and to pin-point measures and situations that require further study. An important issue additional issue is how to integrate the efforts by different Member States to estimate costs and benefits for international river basins, to ensure that comparisons are feasible.

REFERENCES

Aarskog, E. M. (1998). Betalingsvillighet for ytterligere rensing av Indre Oslofjord, Oslo: Senter for Industriforskning.

Albiac, J., Martinez, Y. and Tapia, J. (2005). Water quantity and quality issues in Mediterranean agriculture. OECD Workshop on Agriculture and Water: Sustainability, Markets and Policies, 14-18 November, Australia.

Andrews, K. (2002). The Future for Scotland's Waters: Analysis of Costs and Benefits, this report has been produced by WRc plc, Authors: With thanks for material contributed by A Black and N D Hanley, June 2002.

Auernheimer, C., and González, G. (2002). Repercussions of the national hydrological plan on the Spanish Mediterranean coast (water versus tourism and agriculture). Presented: Agriculture and Urbanisation in the Mediterranean Region—Enabling Policies for Sustainable Development, Rabat, Morocco, 25–30th April 2002.

Baldock, D., Caraveli, H., Dwyer, J., Einschütz, S., Petersen, J. E., Sumpsi-Vinas, J. and Varela-Ortega, C. (2000). The environmental impacts of irrigation in the European Union. A report to the Environment Directorate of the European Commission. London / Brussels: IEEP http://ec.europa.eu/environment/agriculture/pdf/irrigation.pdf.

Bann , C., Fisher, J. and Horton, B. (2003). The Benefits Assessments Guidance (BAG) for PR04 : Review of Non-Use Values for Water Quality and Water Resources and Values for Bathing Water Improvements, Report of an Experts Workshop in Peterborough, Environment Agency.

Bateman, I., Day, B., Dupont, D., Georgiou, S., Gonca Noceda Matias, N., Morimoto, S., and Subramanian, L. (2006). Does Phosphate Treatment for Prevention of Eutrophication pass the Benefit-Cost-Test? CSERGE Working Paper EDM 06-13. Norwich: University of East Anglia.

Becker, H., Kreins, P. Rudloff, B., Stonner, R. and Witzke, P. (2005). Zahlungsbereitschaft- und Nutzen-Kosten Analyse (ZANK). Management regionaler Flusseinzugsgebiete in Deutschland (REGFLUD) – Rahmenbedingungen und Politikoptionen bei diffusen Nährstoffeinträgen (N und P) der Landwirtschaft in den Rhein und in die Ems. Schlussbericht, FAL, Braunschweig. Institut für ländliche Räume der Bundesforschungsanstalt für Landwirtschaft (FAL), Braunschweig, Germany

Bonnieux, F., Guerrier, C., Fouet, J.P. (2002). Valorisation économique des usages de l'eau sur le Lignon du Velay, Electricité de France, Institut National de la Recherche Agronomique, Unité d'économie et sociologie rurales.

Brander, L.M., Florax, R.J.G.M.and Vermaat, J.E. (2006). The Empirics of Wetland Valuation: A Comprehensive Summary and a Meta-Analysis of the Literature.

Bräuer, I., Shbaita, H. and Rode, M. (submitted). Analysis and optimization of cost-effectiveness of measures to minimise P input in river systems. Water Resources Management (Special Issue).

Brouwer, R., Langford, I., Bateman, I., Turner, R.K. (2003). A meta-analysis of wetland ecosystem valuation studies. Chapter 5 in Turner, R.K., Jeroen, C., van den Bergh, J.M., Brouwer, R., 2003. Managing Wetlands: An Ecological Economics Approach. Edward Elgar, Cheltenham, UK.

Brouwer, R. (2004). Wat is schoon water de Nederlander waard? RIZA, Lelystad.

Brouwer R, Hess S, Bevaart M, Meinardi K (2006) , The Socio-Economic Costs and Benefits of Environmental Groundwater Threshold Values in the Scheldt Basin in the Netherlands, IVM report EO6 – 02, 2006.

Broniewicz, E. (2006), Application of environmental protection expenditure account, Technical University of Bialystok, POLAND.

CBS StatLine (2006). Kosten en financiering milieubeheer, waterschappen 1985-2003. www.cbs.nl

CBS StatLine (2006). Milieukosten waterschappen 1999-2003. www.cbs.nl

CBS StatLine (2006). Waterschapslasten en –baten 1998-2003. www.cbs.nl

CBS StatLine (2007). Milieukosten van waterschappen 1999-2003 (Environmental costs of water bodies) www.cbs.nl

Chegrani P. (2005). Evaluer les bénéfices environnementaux sur les masses d'eau, Document de travail, MEDD. D4E, Ministère de l'Ecologie et du Développement Durable, dec 2005 (www.economie.eaufrance.fr).

Cooper, J and Loomis, J. (1991). Economic Value of Wildlife Resources in the San Joaquin Valley: Hunting and Fishing Values, in Dinar, A. and D. Zilberman, eds., The Economics and Management of Water and Drainage in Agriculture, Kluwer Academic Publishers.

CIS WFD (2003). Wetlands Horizontal Guidance on the role of wetlands in the Water Framework Directive.

CIS WFD (2005). European Workshop on WFD and Hydromorphology. Workshop summary report. 17-19 October 2005, Prague. Prepared by: Eleftheria Kampa and Nicole Kranz (Ecologic).

Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R.V., Paruelo J., Raskin R.G., Sutton P. and van den Belt M. (1997). The value of the World's ecosystem services and natural capital. Nature 387:253-260.

De Groot, R., Mishka S., Finlayson M, and Davidson N. (2006). Valuing Wetlands: guidance for valuing the benefits derived from wetland ecosystem services (66 pp). Ramsar Technical Report No. 3, CBD Technical Series No. 27.

De Nocker L., Liekens I., and Broekx S. (2004). Natte natuur in het Schelde-estuarium. Een verkenning van de kosten en baten. ProSes research report. (www.proses.nl)

DEFRA (2003). Cost Curve Assessment of Phosphorus Mitigation Options Relevant to UK Agriculture
http://www2.defra.gov.uk/research/project_data/More.asp?I=PE0203&M=CFO&V=IGER

DEFRA/WAG (2003). Third consultation paper on the implementation of the EC Water Framework Directive (2000/60/EC), Department for Environment, Food and Rural Affairs and Welsh Assembly Government, August 2003.

DEFRA (2003b). Appendix D – Costs and Benefits. http://www.defra.gov.uk/corporate/consult/waterframe3/

DEFRA (2005). Development of economic appraisal methods for flood management and coastal erosion protection. R&D technical Report FD2014/TR3.

DEFRA (2006). River Basin Planning Guidance, Department for Environment, Food and Rural Affairs, London, 2006, downloaded from
http://www.defra.gov.uk/environment/water/wfd/pdf/riverbasinguidance.pdf

DEFRA (2007). Draft partial regulatory impact assessment of environmental quality standards for implementation of the Water Framework Directive in the UK.. Accessible at http://www.defra.gov.uk/environment/water/wfd/ria.htm

DEFRA (2007). Draft partial regulatory impact assessment of environmental quality standards for implementation of the Water Framework Directive in the UK. Annex 3: Proposed standards for phosphorus in rivers. Accessible at http://www.defra.gov.uk/environment/water/wfd/ria.htm

DEFRA (2007). Cost Benefit Analysis on the implementation of the Water Framework Directive including a specific focus on agriculture: Final Report.

DHV/Atkins (2006). Zagyva-Tarna River Basin Management Plan, INTERIM REPORT 3b), Economic analysis and funding possibilities , 20 April 2006.

Direction des Etudes Economiques et de l'Evaluation Environnementale (D4E) (DERONZIER, P. and TERRA, S.) (2005). Etude sur la valorisation des aménités récréatives du Loir. Directive cadre d'eau, calcul du coût des pertes ou des deplacements de productible hydroelectrique, guide des bonnes pratique en phase valeurs guide.

Dierickx Visschers Manuel (2003). Regulatory Impact Analysis of the EU-proposal for a daughter directive on the protection of groundwater against pollution. Competence Unit for Regulatory Management, Flanders.

Downward, S.R. and Taylor, R. (2007). An assessment of Spain's Programa AGUA and its implications for sustainable water management in the province of Almería, southeast Spain. Journal of Environmental Management 82 (2007), p. 277–289;

Dubgaard, A., Kalleoe, M.F., Ladenburg, J. and Petersen, M.L. (2005). Cost-benefit analysis of river restoration in Denmark. In Brouwer, R. and Pearce, D. (Eds.) Cost-Benefit Analysis and Water Resources Management. Edward Elgar, Cheltenham. pp. 124-150.

ECOFLOOD (2001-2004). Towards natural flood reduction strategies. http://levis.sggw.waw.pl/ecoflood/

Elvira B., Nicola G.G. and Almovadovar A. (1998). Impacto de las obas hidràulicas en la ictiofauna.

Environment Agency (2003). Assessment of Benefits for Water Quality and Water Resources Schemes in the PR04 Environment Programme – Guidance, Benefits Assessment Guidance (BAG).

Environment Agency (2004). Cost-benefit analysis of schemes that go beyond existing commitment, Periodic Review of the Water Industry (PR04) Environment Programme.

ESA (2006), Environment protection expenditure, 2004, Statistical office of Estonia, 2006.

European Commission, (2007). Commission Staff Working Document. Annex to the Communication from the Commission to the European Parliament and the Council. 'Towards sustainable water management in the European Union'. First stage in the implementation of the water framework directive 2000/60/ec. 4th Commission Report (executive summary) on implementation of the Urban Waste Water Treatment Directive.

European Environment Agency (2005b). Agriculture and environment in EU-15 – the IRENA indicator report. EEA Report No 6/2005. Copenhagen: EEA. [http://reports.eea.europa.eu].

European Environment Agency (2005c). IRENA Indicator Fact Sheet, IRENA 22 - Water abstraction. Copenhagen: EEA.

EVALUWET (2001-2004). European Valuation and Assessment Tools: Supporting Wetland Ecosystem Legislation.

Falconer, K. (2000). Farm-level constraints on agri-environmental scheme participation: a transactional perspective. Journal of Rural Studies 16: 379-394.

Francfort, J.E., Cada, G.F., Dauble, D.D., Jones, D.W., Rinehart, B.N., Sommers, G.L. and Costello R.J. (1994). Environmental Mitigation at Hydroelectric Projects. Prepared for the U.S. Department of energy.

Fisher, J. (2003). Proposed R&D Project : Assessing costs and benefits of options in River Basin Management (RBM) for Implementing the Water Framework Directive (WFD), Environment Agency.

Fischer, J. (2004). Environmental and Resource Costs and the Water Framework Directive: Practical Experience by the Environment Agency for England and Wales, information available from : www.environment-agency.gov.uk.

Foundation for Water Research (1996). Assessing the benefits of surface water quality improvements, Manual, Foundation for Water Research.

Garrido, A. (2002). Transition to full-cost pricing of irrigation water for agriculture in OECD countries, Document COM/ENV/EPOC/AGR/CA(2001)62/FINAL. Paris: OECD. Available at: http://www.worldbank.org/html/fpd/water/pdf/GarridoPricingofwaterinagriculture.pdf

Garrido, A. (2005). Using good economic principles to make irrigators become true partners of water and environmental policies. OECD Workshop on Agriculture and Water Sustainability, Markets and Policies. November. available at: http://www.oecd.org/agr/meet/water/ (restricted access)

Garrido, A., Martínez-Santos, P. and Llamas, M. R. (2006). Ground water irrigation and its implications for water policy in semiarid countries: the Spanish experience. Hydrogeology Journal 14: 340–349

Georgiou, S., Langford, I.H., Bateman, I.J. and Turner, R.K. (1998). Determinants of individuals' willingness to pay for perceived reductions in environmental health risks: A case study of bathing water quality. Environment and Planning A, 30: 577-594.

Goffe, Ph. Le (1995). The Benefits of Improvements in Coastal Water Quality: A Contingent Approach. Journal of Environmental Management 45: 305-317.

Gren, I.-M.m Elofsson, K., and Jannke, P. (1995). Costs of nutrient reductions to the Baltic Sea. Beijer International Institute of Ecological Economics, Royal Swedish Academy of Sciences, Stockholm. Beijer Discussion Papers Series No. 70.

Gren, I-M., Söderqvist, T. and Wulff F. (1997). Nutrient Reductions to the Baltic Sea: Ecology, Costs and Benefits. Journal of Environmental Management 51 : 123-43.

Hakansson, C., Kriström, B., Johansson, P.O., Leonardsson, L. and Lundqvist, H. (2004). Salmon and Hydropower: Dynamic Cost-benefit Analysis, Proceedings, 5th International Symposium on Ecohydraulics, 12-17 september 2004. Madrid, Spain (/www.vattenkraftmiljo.nu/).

Halsing, D.L. and Moore, M.R. (2006). Cost-effective Recovery strategies for Snake River Chinook Salmon: A Biological Economic Synthesis, US Department of the Interior.

Hanley N. (2001). Benefit analysis of the impacts of the water framework directive for Scotland, a report to the Scottisch Executive (summarised in Interwies, E.).

Hanley, N., Colombo, S., Tinch, D., Black A. and Aftab A. (2006). Estimating the benefits of water quality improvements under the Water Framework Directive: are benefits transferable? European Review of Agricultural Economics Vol 33 (3) (2006) pp. 391–413.

Hanley, N. and Spash C.L. (1993). Cost-Benefit Analysis and the Environment. Edward Elgar.

Hanley, N., Wright, R.E. and Alvarez-Farizo, B. (2006b). Estimating the economic value of improvements in river ecology using choice experiments: an application to the water framework directive. Journal of Environmental Management 78:183-193.

Heatco (2006), Proposal for Harmonised Guidelines, Deliverable 5, Heatco, Developing **H**armonised **E**uropean **A**pproaches for **T**ransport **Co**sting and Project Assessment, IER Stuttgart, Germany, 2006.

Heinz, I. (2005). "The Economic Value of Water and the EU Water Framework Directive: How Managed in Practice", Proceedings of the International Conference on Water Economics, Statistics and Finance. International Water Association (IWA), Specialised Group on Statistics and Economics and Department of Economics, University of Crete, 8-10 July 2005, Rethymno, Greece.

http://www.infu.uni-dortmund.de/Mitarbeiter/Ingo.Heinz.

Helpdeskwater (2007), Werkwijzer MKBA in de Regio, April 2007.
http://www.helpdeskwater.nl/water_en_ruimte/economische_aspecten/oei_bij_snip/

Herbke. N., Dworak, T. and Karaczun Z.M. (2006). WFD and Agriculture – Analysis of the Pressures and Impacts, Broaden the Problem's Scope - Interim Report Version 6 – 18/10/2006.

Hernández-Mora N., Llamas M.R., and Martinez-Cortina L. (2001). Misconceptions in aquifer over-exploitation. Implications for water policy in Southern Europe. In: Dosi C (ed) Agricultural use of groundwater: towards integration between agricultural policy and water resources management, Kluwer Academic Publishers, pp 107–125.

HM Treasury 2003, The Green Book, Appraisal and Evaluation in Central Government, Treasury Guidance, London.

Hoogheemraadschap van Rijnland, (2006). Water in beweging. Jaarverslag 2005.

Horton, B. and Fischer, J. (2004). The 4th Periodic Review of the UK Water Industry : a large scale practical application of environmental cost-benefit analysis, Environment Agency.

Interwies, E. et al. (2004). "Basic principles for selecting the most cost-effective combinations of measures for inclusion in the programme of measures as described in Article 11 of the Water Framework Directive", HANDBOOK, UBA-Texte 24/04. Berlin: Federal Environmental Agency, June 2004.

Interwies, E., Dworak, T., Görlach, B. and Best, A. (2006). Deliverable 13. WFD and Agriculture Linkages at the EU Level. Final Paper about Incentive water pricing and cost recovery in the WFD Elements for linking EU Agricultural and Water Policies. Berlin: Ecologic.http://www.ecologic.de/download/projekte/1950-999/1966/1966_deliverable_13.pdf

Interwies E. et al. (2005). The case for valuation studies in the context of the WFD, Study for SNIFFER , Ecologic. May 2005.

ISTAT (2006). Water resources assessment and water use in agriculture. Essays n. 18 – 2006, National Institute of Statistics (Istat), Rome. http://www.istat.it/dati/catalogo/20070227_02/

IVM et al. (2006). "Ex-post estimates of costs to business of EU environmental legislation, Final report", edited by Frans Oosterhuis (IVM), Contributions by: Monier,V., and des Abbayes,C. (BIO), Görlach, B. (Ecologic), Jarvis, A. and Medhurst, J. (GHK), Kuik, O. (IVM), Vanner, R. and Ekins, P. (PSI), Jantzen , J. and van der Woerd , H. (TME), Vercaemst, P., Huybrechts, D. and Meynaerts, E. (VITO), reviewed by Gerlagh, R. (IVM), in commission of DG Environment, Amsterdam, April 2006.

Jacobsen, B.H., Abildtrup, J., Andersen, M., Christensen, T., Hasler, B., Hussain, Z.B., Huusom, H., Jensen, J.D., Schou, J.S. and Orum, J.e. (2004). Costs of reducing nurient losses from Agriculture – Analyses prior to the Danish Aquatic Programme III. Rapport nr. 167, Fodevareokonomisk Institut, Copenhagen.

Jantzen, J. et al. (1999). "Technical report on enlargement", Jantzen, J., Cofala, J., de Haan, B.J., RIVM report 481505022, Bilthoven, May 2000.

Kotchen, M.J., Moore, M.R, Lupi, F. and Rutherford, E.S. (2006). Environmental constraints on Hydropower: an ex post benefit cost analysis of dam relicensing in Michigan. Land Economics, August 2006, 82 (3): 384-403.

Kroes, M.J., Gough, P., Schollema, P.P. and Wanningen, H. (2006). From sea to source; Practical guidance of fish migration in European rivers.

Kroes, M.J. and Monden, S. (2005). Vismigratie, een handboek voor herstel in Vlaanderen en Nederland. AMINAL, afdeling Water in samenwerking met OVB.

Kuik O., Brander L., Schaafsma M. (2006). Globale Batenraming van Natura 2000 gebieden, IVM, Amsterdam, mei 2006

Laine, A.S. (2006). Opening of ascension routes for migratory fish in the River Kymijoki – a cost-benefit analysis. Master Thesis. Department of Economics and Management, University of Helsinki pages 96.

Larinier, M. (2000). Dams and Fish Migration. Prepared for the World Commission on Dams, Thematic Review II.1: Dams, ecosystem functions and environmental restoration.

LBOW/MRE (2006). Richtlijnen monitoring oppervlaktewater Europese Kaderrichtlijn Water.

Maestu, J. and Andreu, J. (2004). Practical experiences in Spain. Brouwer R. and P. Strosser (eds.): Environmental and Resource Costs and the Water Framework Directive – An overview of European practices. Workshop Proceedings. RIZA Working Paper 2004.112x. Amsterdam.

Magnussen, K. and Navrud, S. (1992). Verdsetting av redusert forurensning til Nordsjøen (Forskningsmelding B-015-92), Oslo: Norsk Institutt for Landbruksøkonomisk Forskning (NILF).

Malzubris J., Senkane S., Ready R.A. (1997). Contingent Valuation Study Estimating Willingness To Pay for Improved Water Quality in Sigulda, Latvia, Report to the Harvard Institute for International Developmen ,May 1997

Mäntymaa, E. (1997). Essays on Environmental Benefits and Hypothetical Markets, Oulu: Oulu University Press.

Markowska, A. and Zylicz, T. (1999). Costing an international public good: the case of the Baltic Sea. Ecological Economics 30: 301-316.

Massarutto, A. (2002). Irrigation water demand in Europe: the impact of Agenda 2000 and the Water Framework Directive. Paper prepared for the international conference Irrigation Water Policies: Micro and Macro Considerations Agadir, 15-17 June 2002.

McCann, L., Colby, B., Easter, K. W., Kasterine, A. and Kuperan, K.V. (2005). Transaction cost measurement for evaluating environmental policies. Ecological Economics 52(4): 527-542.

MED (2006). Compte-rendu du séminaire sur le thème de l'évaluation des coûts et bénéfices environnementaux dans le domaine de l'eau (MEDD, 29 Septembre 2006), Ministère de l'Ecologie et du Développement Durable, novembre 2006 (www.economie.eaufrance.fr).

Metroeconomica Limited (UK) and WRc Plc, (2006). Report on Project 2e: Deriving the Costs and Effectiveness of Delivery Mechanisms Collaborative Research Programme, On River Basin Management Planning Economics, 2006

Metropolitan Consulting Group (2006). VEWA, Vergleich Europäischer Wasser- und Abwasserpreise, Berlin.

MVW (2005). "Decembernota KRW/WB21 2005 Beleidsbrief", Ministerie van Verkeer en Waterstaat , Den Haag, 2005.

MVW (2006a). "Decembernota KRW/WB21 2006 Beleidsbrief", Ministerie van Verkeer en Waterstaat , Den Haag, 15 December 2006.

MVW (2006b). De strategische MKBA voor de Europese Kaderrichtlijn Water (the strategic CBA for the European Water Framework directive), Ministerie van Verkeer en Waterstaat , Den Haag, December 2006.

Ministerio de Medio Ambiente (2007). El Agua en la Economía Española: Situación y Perspectivas. Informe integrado del Análisis Económico de los Usos de Agua, Artículo 5 y Anejos II y III de la Directiva Marco de Agua. Madrid, January 2007: Ministry of the Environment

Négrel, PH., Petelet-Giraud, E. and Sgouridis, F. (2005). EUROWET, Integration of European wetland research in sustainable management of the water cycle. Significance of wetlands in the water cycle.

Négrel, PH., Maltby, E., Petelet-Giraud, E., Sgouridis, F. (2005). EUROWET, Integration of European wetland research in sustainable management of the water cycle. Technical Guidance.

NERI (2006). Modelling Cost-Efficient Reductions of Nutrient Loads to the Baltic Sea. Model specification, Data and Cost Functions, by Schou, J.S., Neye, S.T., Lundhede, T., Martinsen, L. and Hasler, B. 2006, National Environmental Research Institute, Denmark. 69 pp. – NERI Technical Report no 592. http://www.dmu.dk/Pub/FR592.pdf

NUS consulting group (2006) International Water Report and Cost Survey, Utility Cost Management Solutions, July 2006.

Ocƒeb (1997). Mogelijkheden tot marktwerking in de Nederlandse watersector (possibilities of a market based approach in the Dutch Watersector), by drs. E. Dijkgraaf, drs. R. de Jong, drs. E.G. van de Mortel, prof. dr. A. Nentjes, M. Varkevisser, dr. D. Wiersma, Erasmus Universiteit Rotterdam, May 1997.

Odgaard, et al., (2005). Current practice in project appraisal in Europe – Analysis of country reports. HEATCO Work Package 3. HEATCO – Developing Harmonised European Approaches for Transport Costing and Project Assessment. Funded by the 6th Framework RTD Programme. IER Stuttgart, Germany.

OECD (2003). Pollution Abatement and Control expenditure in OECD countries, Working Group on Environmental Information and Outlooks, document ENV/EPOC/SE(2003)1, Organisation for Economic Co-operation and Development, Paris, 17-Jul-2003.

Ofwat (2005). Water Framework Directive – Economic Analysis of Water Industry Costs. Final Report.

Oglethorp, A.R. and Miliadou, A. (2000). Economic valuation of the non-use attributes of a wetland: A case study for lake Kerkini. Journal of Environmental Planning and Management, 43: 755– 767.

Ovidio, M. and Philippart, J.C. (2002). The impact of small physical obstacles on upstream movements of six species of fish. . Synthesis of a five years telemetry study in the River Meuse Basin. Hydrobiologia, 483: 55-69.

Pate, J. and Loomis, J. (1997). The effect of distance on willingness to pay values: a case study of wetlands and salmon in California, Ecological Economics, 20, 199-207.

Pretty, J. N., Brett, C., Gee, D., Hine, R.E.,Mason, C.F., Morison, J.I.L., Raven, H., Rayement, M.D. and van der Bijl, G. (2000). An assessment of the total external costs of UK agriculture. Agricultural Systems 65:113-136.

Pretty, J. N., Mason, C.F., Nedwell, D.B., and Hine, R.E. (2002). A preliminary assessment of the environmental costs of the eutrophication of fresh waters in England and Wales. Centre for Environment and Society and Department of Biological Sciences, University of Essex.

RPA (2004). CEA and Developing a Methodology for Assessing Disproportionate Costs, Final Report, prepared for Department for Environment, Food and Rural Affairs (Defra), Welsh Assembly Government (WAG), Scottish Executive (SE) and Department of the Environment in Northern Ireland (DOENI) by Risk & Policy Analysts Limited, in association with: Jacob Tompkins (Policy Research Consultants), Prof. Paul Younger (NuWater Ltd, Bioscience Centre Times Square, Newcastle-upon-Tyne), Prof. Joe Morris (Resource Economics and Management Cranfield University at Silsoe, Bedfordshire), Kenny MacDougall (Envirocentre). June 2004

Ready, R.C., Malzubris, J. and Senkane, S. (2002). The Relationship Between Environmental Values and Income in a Transition Economy: Surface Water Quality in Latvia. Environment and Development Economics 7: 147-156.

Reid V.W. et al. (2006). Ecosystems and Human Well-being, Synthesis, A Report of the Millennium Ecosystem Assessment, WRC, 2006

Ruijgrok, E.C.M., Brouwer, R. and Verbruggen, H., (2004). Waardering van natuur, Water en bodem in maatschappelijke kosten-batenanalyses, aanvulling op de OEI leidraad, MVW, dec 2004.

Ruijgrok, E.C.M et al. (2006). Kentallen waardering Natuur, Water, Bodem en Landschap, hulpmiddel bij MKBA’s, eerste editie, nov. 2006, Ministerie LNV.

Ruijgrok, E., R. Nieuwkamer and R. van der Veeren (2007). Baten van KRW hangen af van verandering chemische en ecologische toestand water, In: H2O 40 (2007) nr. 8, p. 4

RIZA, (2003). Monitoring oppervlaktewateren volgens de Europese Kaderrichtlijn Water.

RIZA (2005a). Op zoek naar optimale maatregelenpakketten, Handboek kosteneffectiviteitanalyses voor de EU Kaderrichtlijn Water, door Rob van der Veeren, September 2005.

Sale, M. and Coutant, C. From ORNL’s Environmental Sciences Department. Interview in “Hydropower licensed to protect the environment”.

Sandström, M. (1998). Recreational Benefits from Improved Water Quality: A Random Utility Model of Swedish Seaside Recreation. Licentiate Thesis, Working Paper in Economics and Finance No. 121, Stockholm, Stockholm School of Economics.

Savenije, H. and van der Zaag, P. (2002). Water as an economic good and demand management – paradigms with pitfalls. Water International, Vol 27 (1): 98-104.

Seffer, J. (with Rybanic R. and Cierna M.) (2000). The economic value of floodplains in the Danube Basin: the Morava Meadows on WWF/EC seminar “The role of wetlands in river basin management”.

SCB, (2004). Environmental protection expenditure in Swedish industry, Evaluation of new variables, data quality and estimation methods, by Nancy Olsson, Mats Eberhardson. Statistics Sweden, Environmental Statistics.

Stigler, H. (2005).Analysis of potential energy management and economic impacts of the EU Water Framework Directive on water power. Institute for Electricity Management and Energy Innovation of the Technical University of Graz.
http://gpool.lfrz.at/gpoolexport/media/file/Auswirkungen_WRRL_auf_Wasserkraft-Studie.pdf

Söderqvist, T. and Scharin, H. (2000). The regional willingness to pay for a reduced eutrophication in the Stockholm archipelago. Beijer International Institute of Ecological Economics. Beijer Discussion Papers Series No.128, Stockholm.

TME (1998). “Cost assessment of the approximation of Poland to EU environmental legislation”, DISAE funded project, the Hague, 1998.

TME (2006). Milieukosten Nederland, Ramingen en achtergronden (Environmental costs Netherlands, Estimations and backgrounds), by J. Jantzen and Henk vd Woerd, Nootdorp (Netherlands), May 2006.

Trout Unlimited (2001). Small Dam Removal, A review of Potential Economic Benefits.

Turner, R. K., van den Bergh, J.C.L.M. and Brouwer, R. (eds.) (2003). Managing wetlands: an ecological economics approach. Cheltenham: Edward Elgar.

Turner, R. et al. (1999). Managing nutrient fluxes and pollution in the Baltic: an interdisciplinary simulation study. Ecological Economics vol.30 issue 2. pp.333-352.

Turner R.K. (2007). Limits to CBA in UK and European environmental policies, retrospects and future prospects, CSERGE Working Paper EDM 06-17

US-EPA (2004). Fact sheet - constructed Treatment Wetlands.

Vatn, A. (2002). Multifunctional agriculture: some consequences for international trade regimes. European Review of Agricultural Economics 29(3): 309-327.

Veeren, R.J.H.M. van der (2002). Economic analyses of nutrient abatement policies in the Rhine basin. Vrije Universiteit, 272 pp. Amsterdam: Instituut voor Milieuvraagstukken

Vereniging voor Energie, Milieu en Water (2006). www.vemw.nl.

Vito-RA-IMC (2004). VITO en Tijdelijke vereniging Resource Analysis – IMDC, Maatschappelijke kosten-batenanalyse voor de actualisatie van het Sigmaplan, studie in opdracht van AWZ, afdeling Zeeschelde), September 2004, www.sigmaplan.be

WATECO (2002). Economics and the Environment - The Implementation Challenge of the Water Framework Directive. A Guidance Document.

Waterschap De Dommel (2006). Waterschap in de peiling. Jaarverslag 2005.

Waterschap Hollandse Delta (2006). Vijf eilanden, één waterschap. Jaarverslag 2005.

Waterschap Hunze en Aa's (2003). www.hunzeenaas.nl/content/bestuur/agenda's2003/17_09_2003/10_2.pdf

Waterschap Vallei & Eem (2006). Begroting per beleidsproduct 2006.

WWF (2000). Implementing the EU Water Framework Directive. Seminar 2: The Role of wetlands in River basin management.

WWF (2005), Can we afford not to? The costs and benefits of a partnership approach to the Water Framework Directive, by Tom Le Quesne and Colin Green, August 2005

WRc plc (1999). “Potential Costs and Benefits of Implementing the Proposed Water Resources Framework Directive”, Final Report to the Department of the Environment, Transport and the Regions, Andrews, K., Nixon, S., Rees, Y., Crathorne, B., Rudge, L., Clark, E. (OXERA), Smale, R. (OXERA) and Acreman, M. (Institute of Hydrology), January 1999, Medmenham, Marlow, Buckinghamshire.

Zylicz, T., Georgiou, S., Markowska, A., Dziegielewska, D.,Turner, K., Graham, A. and Langford, I. H. (1995). Contingent Valuation of Eutrophication Damage in the Baltic Sea. CSERGE Working Paper GEC 95-03.

ANNEX 1: BACKGROUND TO THE DATA ON BENEFITS OF WFD IN TABLE 9.

	Country, Scope	Results €/hh/year	Method	Source *
	UK			
1	Engl/Wales, Impl. WFD, GES	~ 37 *	bottom-up	UK 1 , 2003 (2)
2	idem	~ 65 – 90	bottom-up	Env. Agency (2)
3	Scotland, Impl.WFD, GES	~90 – 160 - 230	bottom-up	Hanley, 2001, (3)
	NL			
4	Benefit GES	~ 90 - 105	top-down	NL 1, 2004 (4)
5	CBA : 3 ambition levels GES	~ 10 - 30	Bottom-up	NL 2, 2006 (6)
6	Ground water protection	~ 35 - 72	top-down	Brouwer, 2006 (7)
	France			
7	ground water/water supply	~ 40	top-down	Fr. 2005 (5)
	GES surface waters	~ 5	bottom-up	Fr, 2005 (5)
	Subtotal all categories	~ 45	mixed	Fr, 2005 (5)

Explanation

Study Nr 1
Basic data: benefit in the region of 560 million per annum (see table 17)
scope: England and Wales , implementation WFD, subtotal
source : Defra, RIA WFD, (2003)
assumptions/parameters used for recalculation
N° of inhabitants: 53 million
N° of people per household : 2.2
exchange rate : exchange rate : 1 £= 1,5 euro
price level: indexed from 2003 to 2006 (+ 5 %)
rounded to : 37

Study Nr 2
Basic data: benefit in the region of £ 1000 to 14000 million per annum (see table 17)
scope: England and Wales , implementation WFD, subtotal
source : Environment Agency, quoted in Defra, RIA WFD, (2003)
assumptions/parameters used for recalculation
N° of inhabitants: 53 million
N° of people per household : 2.2
exchange rate : exchange rate : 1 £= 1,5 euro
price level: indexed from 2003 to 2006 (+ 5 %)
rounded to : 65 to 90
remarks: is based on 1 plus undocumented assessments for missing categories

Study Nr 3
Basic data: 130, 228 to 325 million £ per annum, subtotal of benefits of benefits of reaching GES in Scotland
- remarks: scope: England and Wales, subtotal, bottom-up
- source : Hanley (2001), summarized in Interwies, 2005

assumptions/parameters used for recalculation
- exchange rate : 1 £= 1,5 euro

- N° of households in Scotland, 2.27 million (2.2 inhabitants per household)
- price level : 2001, corrected to 2006 prices (price level for UK , Eurostat)

results rounded to : 85 - 150 – 210 €/hh/year

Study Nr 4
Basic data : 90 to 105 euro/hh/year
source : Brouwer 2004
assumptions/parameters used for recalculation : none
remarks

Study Nr 5
Basic data: range: 1.7; 4.6 and 5 billion euro, see box C
- remarks: scope: Netherlands, implementation WFD for 3 scenario's
- units: PV, for 100 year period, discounted at 4 %, price level 2006
- subtotals from bottom-up analysis, see box C
- source: MVW, 2006;
- assumptions/parameters used for recalculation
  N° of households : 7.15 million (MNP, 2007)

results: annual benefits: 70- 187 - million €/year
in €/hh/year: 10 – 30 €/hh:yr

Study Nr 6
Basic data : 32, 46 and 72 €/hh/year, WTP estimate for preservation of groundwater quality at a level suited for irrigation(32 €/hh:yr); drinking water (46 €/hh/year) and natural background (72 €/hh/year).
source : Brouwer 2006
remarks : only values for preserving quality for drinking water or natural background have been used.

Study Nr 7
Basic data: range: see table below, annual values, implementation reaching GES, Fr 2005
- for min-max scenario for GAP
- source : Chegrani, 2005, based on WTP studies for France
- assumptions/parameters used for recalculation
  N° of households : 58.5 million inhabitants, 2.3 persons/household (inep)

results: 40 €/hh/year for preservation of groundwater and water supply
5 €/hh/year for benefits related to rivers, lakes,…
45 /€/hh/year for subtotal of total benefits /household/year.

	Annual value for France in € million /year					Benefit/houselld
Benefit category	min	max	mid	inhabitants	persons/hh	€/hh/year
water supply	815.5	1191	1003	59	2.3	**39.4**
fish	9	9	9	59	2.3	0.4
angling	11.25	11.25	11.25	59	2.3	0.4
walking	11.5	23	17.25	59	2.3	0.7
kayak	0.5	0.5	0.5	59	2.3	0.0
non-use	95	111	103	59	2.3	4.0
subtotal without water supply						**5.5**
Sub-total	942.75	1345.25	1144			**45.0**