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Scoping Study on the Economic (or Non-Market) Valuation Issues and the Implementation of the Water Framework Directive

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EXECUTIVE SUMMARY

Background and objective

The objective of this study is to identify recent developments in the field of economic valuation, and contributing fields such as environmental sciences, that are relevant to the implementation of the Water Framework Directive (WFD). The technical specification establishes that the study is a small desk-based scoping study, which takes stock of recent progress in order to help inform discussions relating to future work concerning economic valuation and the implementation of the WFD.

Economic valuation (which can also be referred to as 'non-market valuation') is a tool that can be applied to assist in the assessment of 'non-market costs and benefits' of projects and policies. These are impacts, or outcomes, that are not reflected in market settings. While market impacts include aspects such as changes in producer revenues and employment, the non-market costs and benefits of interest are environmental and social impacts of projects and policies. Implementation of the WFD influences a potentially broad range of non-market costs and benefits, including:

- Protection and enhancement of health and biodiversity of aquatic ecosystems;
- Protection of human health through water-related exposure;
- Reduced costs of water uses (e.g. reduced costs for drinking water treatment);
- Improvement of the quality of life by increasing the amenity value of water bodies (e.g. for recreation); and
- Mitigation of impacts from climate change and security of water supplies.

Note that this is not a comprehensive list of potential non-market costs and benefits, but it illustrates the types of outcomes that the WFD terms as 'environmental and resource costs'. Application of economic valuation methods (see Section 2.1 of the main report) enables the value of non-market costs and benefits to be estimated in monetary terms. The economic valuation evidence that is generated can be directly compared to market costs and benefits, most commonly via Impact Assessments and Cost-Benefit Analysis (CBA) that inform policy decision-making.

WFD implementation and economic valuation

Implementation of the WFD presents a fairly distinct set of policy questions that economic valuation can potentially help address. In particular where implementation may require an assessment of non-market outcomes:

- *Article 4*: in assessing the need for an exemption based on an economic appraisal of disproportionate cost. Economic valuation can be used to provide monetary estimates for non-market costs and benefits in this assessment.

- *Article 9*: in assessing cost recovery of water services, including environmental and resource costs. Economic valuation can help to provide monetary estimates of environmental costs to be included in cost recovery calculations.

Economic valuation may also usefully input to assessments of the cost-effectiveness of programme of measures under Annex III and Article 11, by providing an account of wider environmental impacts of measures (e.g. climate change, air quality, health, waste, land use, biodiversity, etc.). There may also be scope for applying economic valuation to Article 5 and the economic characterisation of river basins in terms of highlighting the significance of non-market outcomes.

Regardless of the policy question and context, practical application of economic valuation methods builds on qualitative and quantitative assessments of environmental impacts, which are informed by scientific and technical studies. These studies provide the basis for valuation by establishing the details of the cost or benefit to be valued; for example by documenting the current ecological status of a water body and determining how implemented measures will improve the status, including the location(s) and timing of improvements, and the effects to various uses and non-market outcomes associated with the water body. Crucially, without this information, it is not possible to undertake an economic valuation study.

Review of developments

The review of developments follows from a desk-based review of recent Common Implementation Strategy (CIS) documents and various research and workstreams in 'WFD science' and economic valuation. As a scoping study, the purpose is not to provide a comprehensive review of all work undertaken by Member States to date, nor is it an objective to critically appraise this work. Rather the focus is on identifying new areas of work that have emerged since the CIS Water and Economics working group (WATECO) guidance, published in 2002. Section 3 of the main report provides details of key developments in this regard, but in summary they have included the following:

Analytical frameworks

There have been many developments in the approaches to the analysis of environmental goods and services. Two areas of particular note are:

- *The 'ecosystem services approach'*: this helps highlight the range of market and non-market benefits that are provided by water bodies and the complex ecosystem functions and services that contribute to their provision. Examples of ecosystem service approaches include the UN Millennium Ecosystem Assessment[1] and The Economics of Ecosystems and Biodiversity' (TEEB)[2]. While to date there has been little integration of the ecosystem services approach into WFD implementation, it does offer a framework for future application, particularly in terms of systematically establishing the range of environmental outcomes from programmes of measures and other actions. Moreover it further highlights the multi-disciplinary requirements of WFD implementation, and can result in greater

[1] See: http://www.millenniumassessment.org
[2] See: http://www.teebweb.org/

transparency in the assessment of costs and benefits by providing explicit acknowledgement of gaps in evidence and helping to avoid the risk of ‘over-valuation’ of benefits (e.g. in Impact Assessments and CBA).

- *Use of ‘spatial analysis’ via Geographical Information Systems (GIS)*: application of GIS in valuation studies helps better organise locally specific data on water bodies and provides a consistent basis for accounting for the context-specific nature of economic values, in particular in terms of spatial variation. Fundamentally the benefits of attaining Good Ecological Status (GES) in a water body will vary according to the scope of environmental improvement, the availability of substitutes (i.e. other water bodies) and the proximity to and socio-economic characteristics of affected populations. Accounting for these context-specific factors is of key importance for assessments in WFD implementation that require estimates of total benefits or costs of measures (e.g. disproportionate cost assessments under Article 4), in order to ensure robust valuations and avoid over-estimation.

‘WFD Science’

As noted above scientific and technical studies provide the qualitative and quantitative assessments that are the basis for economic valuation studies. Implementation of the WFD has resulted in developments in understanding of the links between GES, wider environmental quality and human uses of water bodies, which has mostly been driven by requirements for ecological characterisation of water bodies (Article 5), the development of monitoring networks (Article 8), and the intercalibration process. The key challenges with respect to economic valuation lie primarily in linking changes in physical indicators of water quality that result from WFD measures, to changes in ecological indicators, in order to establish the changes in the provision of non-market benefits that are to be valued (e.g. the improvement in recreation and amenity value of water bodies). Underlying this, there are gaps in both scientific understanding of processes and data, although to some extent these are being addressed by continuing modelling and monitoring initiatives. Moreover recent economic valuation studies demonstrate how these challenges have been overcome, particularly via multi-disciplinary collaboration. This has resulted in developments in the application of economic valuation methods that improve the robustness of techniques and results.

Economic valuation methods and practice

Developments in economic valuation since WATECO have included refinements in the methodologies aimed at understanding the variation in value estimates between different contexts. For example, the design of studies are improved to better test for sensitivity of economic values to the scope of the environment change (e.g. the magnitude and scale of improvements in water quality), and the availability of substitutes. In addition developments have sought to improve the process of estimating aggregate benefits, particularly via application of GIS as noted above. There have also been developments in value transfer, which is a practical approach to economic valuation that makes use of available evidence (i.e. existing studies) and is typically a less resource and time intensive way in which to estimate the value of non-market costs and benefits.

Recommendations

The recommendations from this study should be interpreted as suggestions for improving the application of economic valuation, if it is determined that valuation is required in a particular instance of WFD implementation. They are largely generic and may need to be tailored according to the policy context, information needs, research resources and institutional capacity in each Member State. Note also that they relate to the assessment of non-market costs and benefits; there are many market costs and benefits which also need to be considered in implementation of the WFD.

The six recommendations for the use of (non-market) economic valuation in the implementation of the WFD in future are:

1. *Use spatial analysis tools*: the advantage of using GIS in valuation studies is twofold. First it allows better representation of the impacts of WFD implementation (e.g. in identifying the location of improvements in environmental quality). Second, it provides a basis for assessing spatial variation in economic values. This implies that more robust estimates of aggregate costs and benefits can be obtained, and additionally, that the distributional impacts can also be examined. Integrating economic valuation and GIS is also beneficial for future value transfer applications (see below).

2. *Make better use of multi-disciplinary expertise*: the robustness of economic valuation studies is in part dependent on the accurate assessment of environmental impacts associated with WFD implementation. In addition, ecosystem services approaches represent a framework within which qualitative, quantitative and monetary assessments can be organised. From a WFD policy perspective, this require multi-disciplinary input to ensure that full range of impacts and associated costs and benefits that need to be accounted for in decision-making, along with identification of key gaps and uncertainties, are recognised. Failure to successfully integrate these elements will likely lead to poor quality evidence on which to base decision-making.

3. *Provide better and more appropriate scientific information*: undertaking economic valuation requires good quality data particularly on water quality status, along with good understanding of the links between GES, ecological indicators, better environmental quality and human wellbeing outcomes. As scientific understanding of complex and dynamic water systems improves along with data availability on the monitoring of water quality and indicators of GES, there is the need for these advances to be reflected in the application of economic valuation, so that future studies are based on appropriate scientific input. Gaps and uncertainties in evidence are likely to remain, and this emphasises the continuing need for expert judgement from science and technical experts to inform the design of valuation studies.

4. *Apply economic valuation where it provides the most 'added value' to policy making*: economic valuation is not explicitly required to implement the WFD. However it is widely recognised (e.g. WATECO) that it can play a useful role in implementation with respect to assessments of non-market costs and benefits. Targeting the use of economic valuation means that it is applied in instances where it provides the most 'added value' to policy

making; for example in cases where qualitative and quantitative assessments alone cannot provide sufficient evidence to help determine policy decisions. In other instances, however, it may be the case the improved implementation of the WFD will result from concentrating effort on improving scientific information rather than undertaking economic valuation. Improved scientific information is, in any case, a pre-requisite for better economic valuation. Policy makers should also make better use of current and ongoing research studies. Much of the literature reviewed for this report is from European Commission and Research Council funded projects, rather than directly by Member State Government Agencies. While there may seem to be a 'disconnect' between academic research projects and the practical needs of policy making, there is plenty to learn from such projects and also scope for policy makers to influence research agendas for more directly relevant results.

5. *Develop value transfer tools*: the geographical scale of the WFD – covering all water bodies in the EU and policy questions at different spatial scales (i.e. local, regional and national level actions) – implies that value transfer represents the most feasible way in which the use of economic valuation can support the WFD implementation. However value transfer should be used in a way to provide an adequate account of the context-specific nature of economic values. A particular opportunity exists to develop value transfer tools from studies combining GIS and economic valuation in order for value transfer to be robustly applied.

6. *Improve communication*: better communication is needed in particular so that: (i) the potential role for valuation; (ii) information requirements for undertaking good quality studies; and (iii) the limitations of valuation are understood. It should ultimately lead to more helpful use of valuation in addressing policy issue concerned with the WFD. Improved understanding of the role of economic valuation can also facilitate improvements in both science and valuation as a result of multi-disciplinary collaboration, resulting in better decision-making.

Section 4 of the main report presents further detail on each recommendation. The recommendations are relevant to all of the WFD policy where application of economic valuation may be useful. In addition the recommendations are 'medium-term' and can help inform continued implementation of the WFD over the next 2-5 years; for example, in determining the scope of valuation evidence needs for the next round of RBMPs. Future use of economic valuation beyond this will likely require further review of developments in science and economics, given the rapid rate of development in both fields.

1. INTRODUCTION

This is the final report of a 'Scoping Study on Economic (or Non-market) Valuation in the Implementation of the Water Framework Directive' (WFD)[3]. It provides a summary of relevant developments in both the environmental sciences and economics in the recent years. This Section introduces the background to the study (Section 1.1), lists its objectives and scope (Section 1.2) and presents the structure of the rest of the report (Section 1.3).

1.1 Background

The WFD establishes the basis for the protection and restoration of all water bodies across Europe to ensure their long-term sustainability. Water bodies include surface and groundwater bodies, wetlands, transitional and coastal waters. The overall aim of the Directive is to achieve 'Good Ecological Status' (GES) for all water bodies by 2015 by:

- Preventing deterioration and protecting and enhancing the status of water resources;
- Promoting sustainable water use based on long-term protection of water resources;
- Protecting and improving the aquatic environment through specific measures for reducing and phasing out discharges and emissions of hazardous substances;
- Reducing and preventing further pollution of groundwater; and
- Contributing to mitigation of the effects of floods and droughts.

A key theme of the WFD is 'integration' in the management of water resources by combining water quality, quantity and ecological targets for protecting aquatic ecosystems across all water bodies at the river basin scale within a common policy framework. The output of such integration are River Basin Management Plans (RBMPs), which assess pressures and impacts on water resources and identify programmes of measures for achieving environmental objectives. Implementing an integrated approach requires multi-disciplinary input from hydrology, ecology, engineering, economics and other expertise as relevant.

In particular relevance to the topic of this study, a significant feature of the WFD is that it is the first piece of EU water legislation that explicitly introduces economic principles and methods. WATECO (2002) guidance prepared under the WFD Common Implementation Strategy (CIS) sets out the basis for various aspects of economic analysis to include within the WFD implementation process. Overall, the role for economic analysis in the WFD involves:

1. Economic characterisation of river basins (under Article 5);
2. Cost-effectiveness analysis (Article 11 and Annex III);
3. Disproportionate costs (Article 4), and
4. Cost recovery and incentive pricing (Article 9).

The focus of this study is the role of economic valuation in particular in assisting the meeting of the above requirements.

[3] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy (Official Journal L327 of 22 December 2000) http://eurlex.europa.eu/LexUriServ/site/en/oj/2000/l_327/l_32720001222en00010072.pdf

1.2 Objectives and scope

The objective of this scoping study is to identify the developments in economic valuation and other contributing fields such as environmental sciences since the WATECO guidance. The focus is on the developments that have implications for the use of economic valuation for implementing the WFD and on what these implications are. The purpose of the study is to widen the discussions within the WFD CIS process as part of its 2010-2012 work programme regarding the economic aspects of the WFD.

In order to fully capture these developments, the study comprised of three main tasks as required in the technical specification[4]:

1. Identify the areas where (non-market) economic valuation could be applied within the WFD;
2. Review relevant existing and on-going research and policy work and critically assess the linkages to the implementation of the WFD requirements for economic valuation; and
3. Develop recommendations for further work in the area of economic valuation and the implementation of the WFD.

The technical specification further establishes that the study is a small desk-based 'forward looking' scoping study, that takes stock of the progress in order to help inform discussions relating to future work related to economic valuation and the implementation of the WFD:

- *With respect to the possible application of (non-market) economic valuation within the WFD* - the scope is to establish the potential range of 'valuation questions' that can be identified from the Directive itself and subsequent guidance documents that have primarily been produced under the CIS.

- *With respect to the relevant literature and experience* - the scope includes both published and 'grey' literature. As a scoping study, the purpose of this report is not to provide a comprehensive review or identification of all work undertaken by Member States to date, nor is it an objective of the report to critically appraise this work. The intention is to identify 'new' areas of work that have emerged in recent years that are relevant for economic valuation as a whole and to consider their implications for the use of economic valuation in the implementation of WFD.

- *With respect to geography* - while empirical applications of interest relate to the European Union, methodological developments from anywhere in the world are relevant.

- *With respect to the role of economic analysis within WFD* - the review covers applications related to all types of water bodies and all aspects of the analysis listed in Section 1.1 to which (non-market) economic valuation is relevant.

[4] Invitation to Tender ENV.D.1/ETU/2009/0102rl: A scoping study on the economic (or non-market) valuation issues and the implementation of the Water Framework Directive 2000/60/EC.

1.3 Structure of report

The report is structured in terms of the three main tasks set out in Section 1.2:

- Section 2: provides a brief overview of economic valuation and reviews the role of economic valuation implied by the requirements of the WFD. Potential WFD policy questions that can be addressed by application of economic valuation methods are identified. This is intended to establish the context within which economic valuation and other analyses are needed to implement WFD.
- Section 3: reviews developments since WATECO guidance in terms of analytical frameworks developed, scientific research and economic valuation methods. The focus is on the implications of these developments for the implementation of WFD.
- Section 4: concludes the report with a summary of findings and presents recommendations for the future use of economic valuation in WFD implementation on the basis of the developments to date.

The report is also accompanied by:

- Glossary of relevant terms used in (non-market) economic valuation literature; and
- Annex 1: A summary of economic valuation studies examining water quality improvements and WFD implementation.

2. WFD IMPLEMENTATION – THE ROLE FOR ECONOMIC VALUATION

Implementation of the WFD requires information from a range of science, engineering and economic practice areas. This Section provides an overview of how economic valuation can be used in the implementation of WFD (Section 2.1). The use of economic value evidence is policy context-specific and accordingly the context of its use for WFD implementation is dependent on specific policy questions and the details of the good(s) and/or service(s) to be valued (Section 2.2).

2.1 A brief overview of economic valuation

2.1.1 Concepts and basic principles

The economic value of a good or service is generally measured by what is 'given up' (or 'foregone' or 'exchanged') in order to obtain that good or service. In the case of a good or service traded in a market, an individual will compare the cost (the price) and benefit (the wellbeing derived from consumption of the good or service) before making a decision whether to purchase it. Therefore, where a good or service is traded in competitive markets, the price paid for it ordinarily reflects its (minimum) economic value.

Not all goods and services from which individuals derive wellbeing, however, are traded in markets. These are referred to as 'non-market' goods and services and are consequently 'un-priced'. Many environmental resources are classic examples of non-market goods and services. In order to estimate the economic value of these goods and services, and impacts on them (e.g. environmental degradation), the use of economic valuation methods (which are also known as 'non-market valuation' methods) is required. These methods include market price, revealed preference and stated preference approaches (see below).

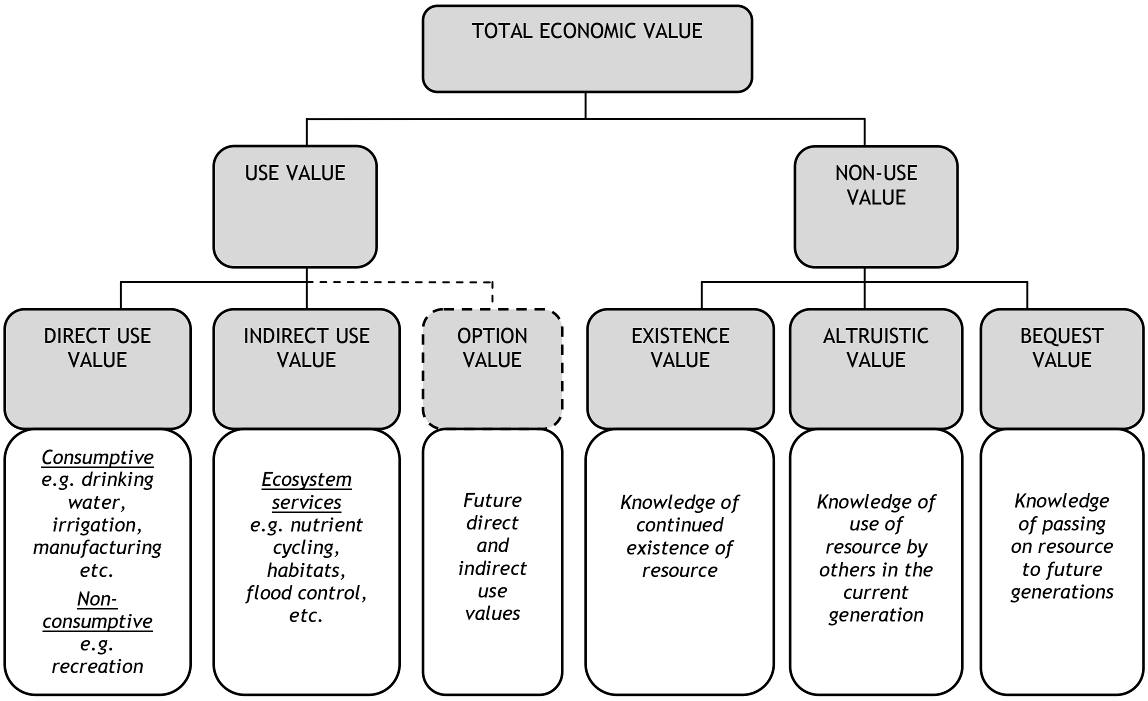
Generally economic valuation methods provide estimates of 'willingness to pay' (WTP) for a non-market good; this is simply a measure of economic value in monetary terms (e.g. Euros) and is analogous to market price for market goods and services. So, for example, the economic value of an improvement in river water quality would be measured by the willingness to pay of individuals for that improvement.

In the case of water, as with most other natural resources, its economic value is attributed to:

- Direct uses made of it (e.g. abstraction for public supply, agriculture, industry etc.);
- Indirect uses made of it (e.g. ecological services provided by water such as provision of habitat for species, pollution abatement, and so on);
- Preferences for ensuring future uses of water; and
- Reasons that are independent of use, including ensuring a sustainable water environment for others to use, for the future generations and for the sake of a sustainable environment.

All these value components sum up to the 'Total Economic Value' (TEV), which provides a comprehensive description of the sources of economic value for a good or service (see Box 2.1).

Box 2.1: Water and the TEV framework



Use value involves some interaction with the resource, either directly or indirectly:

- *Direct use value*: Use of water in either a consumptive manner, such as household water supply or in a non-consumptive manner such as for recreation (e.g. angling).
- *Indirect use value*: The role of water in providing or supporting key ecosystem services, such as nutrient cycling, habitat provision, climate regulation, etc.
- *Option value*: Not associated with current use of water but the benefit of making use of water resources in the future.

Non-use value is associated with benefits derived simply from the knowledge that the natural resources and aspects of the natural environment are maintained (i.e. it is not associated with any use of a resource). Non-use value can be attributed to three motivations:

- *Altruistic value*: Derived from knowing that contemporaries can enjoy the goods and services related to natural resources.
- *Bequest value*: Associated with the knowledge that natural resources will be passed on to future generations.
- Existence value: Derived simply from the satisfaction of knowing that a natural resource continues to exist, regardless of use made of it by oneself or others now or in the future.

It goes without saying that a resource such as water has a 'total value' which is infinite since it is essential for supporting all life. 'Total' in terms of TEV refers to the sum of all components of economic value (i.e. direct and indirect use values and non-use values). Crucially, what is measured by economic valuation is the relative value of a change from one state to another. For example, in the context of WFD, a relevant change that could be considered would be a shift from the baseline status of a water body to Good Ecological Status.

2.1.2 Practical application

Practical application of economic valuation can be described as a three-stage process that requires information from a range of disciplines. For example, for an environmental good or service, information from environmental science disciplines (e.g. hydrology, ecology, etc.) is needed to define the good or service and the expected change in its provision resulting from some policy measure. Consequently undertaking each stage of the process is dependent on the requisite scientific and technical information being available. The three stages are:

(i) *Qualitative assessment of the good or service and the change that is to be valued*: this requires input from other disciplines and topic specialists, for example to provide an assessment of the baseline level of environmental quality (e.g. water quality) and the scale of the change in quality that may result due to proposed programmes of measures.

(ii) *Quantitative assessment of the good or service and the change that is to be valued*: again this requires input from other disciplines and can rely on modelling or actual data collection. In the context of implementation of the WFD the quantitative assessment is largely based on indicators of physio-chemical quality (e.g. biological oxygen demand, ammonia levels, etc.), ecological quality (e.g. measures of fish and plant communities) of water bodies, and the scale of improvement (e.g. location and length of river improved).

(iii) *Monetary assessment of economic values*: here economic valuation methods are used to estimate the monetary value of the change in the provision of the good or service; for example to estimate WTP for attaining GES in a water body.

The particular approach to economic valuation will depend on the type(s) of costs and benefits to be estimated, related context-specific details, and also data availability, particularly in terms of the quantitative assessment stage. The economic valuation evidence that is generated allows for a direct comparison of environmental costs and benefits to financial costs and benefits in policy-making. This is done most commonly via Impact Assessments and Cost-Benefit Analysis (CBA). Section 2.2 identifies a broad range of WFD policy questions that economic valuation can potentially help address.

Overall, there are three main types of economic valuation methods[5]. Largely these are distinguished by the type of economic value data that are used or generated:

- *Market prices*: if environmental goods and services can be associated with competitive markets where money is traded off for purchases of goods and services, price data are used to estimate economic value. This is typically the case for agricultural products and timber[6]. However whilst there are markets for water and wastewater services, prices are not determined in competitive markets. In addition, water provides many more services than those directly consumed by household, agriculture and industrial sectors, such as the indirect use values and potential non-use values described in Box 2.1. Therefore using the

[5] For technical details of applying these methods to estimating the economic value of water, see Young (2005).
[6] Subject to accounting for price distortions caused by taxes and subsidy payments (so-called 'shadow pricing').

(market) price of water will typically not be sufficient to estimate the total economic value of water.

- *Revealed preference methods*: while most environmental goods and services are not traded in markets, in a number of cases their characteristics (e.g. their quality or quantity) affect demand (and hence price) of other goods and services that are traded in markets. For example, in the context of water, the quality and dependability of water supply could affect the sale price of a property. Likewise the quality, quantity and recreational facilities of a water body will affect the number and type of visitors, how much money is spent for this purpose and hence determine recreational value of the water body.

  Valuation methods that establish a statistical relationship between the characteristics of non-market goods and services and the demand for related market-priced goods and services are known as 'revealed preference methods'. Specific methods include hedonic pricing, travel cost models and multi-site recreation demand models. While these methods potentially cover a wider range of direct and indirect use values than market prices, they are still incomplete as not all aspects of the water environment (e.g. climate regulation, habitat provision) influence demand for market goods and services.

- *Stated preference methods*: many natural resources are not traded in markets at all, or what is traded is only one or a partial aspect of the ecosystem services they provide. Stated preference methods are applied to estimate economic value when there is an absence of market-based price and consumer behaviour data. These methods use questionnaires as means of creating hypothetical markets and asking (a representative sample of) survey respondents to trade-off money – i.e. state their WTP - for goods and services as they would in 'real-world' markets. The most commonly applied methods are contingent valuation and choice experiments.

  In the context of implementation of the WFD, stated preferences methods have been used to estimate the economic value of change in: (i) specific types of non-market benefits (e.g. informal recreation); and (ii) all improvements associated with meeting GES as a single package (e.g. simultaneous provision of numerous non-market benefits, including recreation, local environmental amenity, biodiversity, etc.). In addition these methods are the only way all components of TEV, and in particular non-use values, can be assessed.

Where primary research using the above methods is not possible, 'value transfer' can be undertaken to use evidence from previous economic valuation studies. Value transfer, which is also known as 'benefits transfer', is a process by which readily available economic valuation evidence is applied in a new context for which valuation is required. It is a quicker and lower cost approach to generating economic valuation evidence, compared to commissioning a primary valuation study; i.e. a revealed or stated preference study. It therefore can be used when time and resource constraints are present. This is particularly the case when economic value evidence is to be applied on a scale that would be unfeasible for primary research; for example in terms of valuing changes in a large number of water bodies across a country or multiple countries (see also Section 3.3.3). While value transfer also has the methodological attraction of providing consistency in the estimation of values across sites, it also has acknowledged limitations, particularly with respect to selecting and transferring appropriate evidence from previous studies[7].

In general there are uncertainties and data gaps associated with each stage of the practical process of undertaking economic valuation – i.e. qualitative, quantitative and monetary assessments - and also with each valuation method. Moreover, as discussed subsequently in Section 3.2, this uncertainty may lie as much in the available scientific and technical evidence as in the economic valuation evidence. Uncertainties related to science and valuation will accumulate through the process and hence policy making is usually informed by incomplete non-market valuations more often than not. This though is ordinarily the case for all aspects of evidence-based policy making and is not an issue that is specific only to economic valuation. Moreover good practice guidelines are available with the aim of ensuring that what is and is not included in economic valuation estimates is transparent, and what is included is based on sound foundations.

2.2 The role for economic valuation in the WFD

2.2.1 Guidance for economic valuation in WFD implementation

An initial assessment of the potential role of economic valuation in implementation of the WFD was provided by the WATECO guidance. Box 2.2 provides a summary of main aspects of the WATECO guidance in relation to the application of economic valuation.

Box 2.2: Economic valuation and WATECO guidance

In 2002 the Water and Economics working group (WATECO) produced guidelines aimed at establishing the role for economic analysis in the multi-disciplinary approach required for implementation of the WFD.

Among other possible economic analyses, the guidelines identify cases where assessments of non-market costs and/or benefits are likely to be required to assist WFD-policy decisions. This includes Article 4 (exemptions), Article 5 (economic characterisation of river basins), Article 9 (cost recovery) and Article 11 (programmes of measures). In the main WATECO makes these links by highlighting where the Directive itself calls for an account to be made of 'resource costs' and 'environmental costs and/or benefits', and where it implies that use values (both direct and indirect, current and future) and non-values should be considered. In these instances WATECO references the TEV framework (see Box 2.1 above) as the basis for valuing 'non-priced' environmental costs and benefits. It also recognises that assessments of environmental impacts (e.g. qualitative and quantitative assessments by environmental scientists and other technical experts) are required to provide the basis for monetary valuation.

[7] For further discussion see: Navrud, 2007; and eftec (2010).

Box 2.2: continued

WATECO does provide brief descriptions of methods for estimating 'environmental values', including market prices, revealed preference and stated preference methods. Use of value transfer is also recognised. WATECO also describes 'cost-based valuation methods'; these are a proxy approach to estimating the value of environmental cost and benefits in the absence of formal economic values based on the above methods. In addition WATECO notes that it is likely that some non-market costs and benefits will not be 'quantifiable' due to technical reasons (i.e. limitations in scientific assessments) or resource constraints (e.g. insufficient time or funding to undertake studies). Here WATECO states that qualitative assessments of impacts should be sought.

Since WATECO the application and sophistication of economic valuation methods has generally advanced; including the incorporation of Geographical Information Systems (GIS) into valuation studies to better account for spatial variation in economic values (see Sections 3.2 and 3.3). Hence while the principles and relevance of economic valuation to WFD implementation outlined in WATECO remain germane, the finer details on how methods can be applied to assist implementation, including case study examples, are now somewhat dated. In Section 3.3 the relevant developments in the application of economic valuation to the WFD are reviewed to highlight key areas of progress.

Following WATECO the role for economic valuation in WFD Implementation was further reviewed in the CIS Information Sheet by ECO2 (2004) 'Assessment of Environmental and Resource Costs in the Water Framework Directive'. ECO2 focuses on clarification of the terms 'environmental' and 'resource costs', providing definitions, examining their role in the WFD implementation, and how they can be measured. As with WATECO, ECO2 highlights the need for economic valuation to be based on sound qualitative and quantitative assessments, for example, of programmes of measures. Overall both documents provide fairly general discussion of the role of economic valuation, focused mainly on principles and concepts, rather specific details and practical aspects of their application to WFD implementation. For instance, ECO2 states that, "the role of environmental and resource costs in the context of Article 4 can be to show whether the costs outweigh the benefits, including the environmental and resource costs avoided by, for example, specific pollution control measures"[8]. Subsequent non-CIS documents also typically provide high-level discussion of the role of economic valuation and application of methods; see for example Brouwer (2006), Brouwer et al. (2007) and De Nocker et al. (2007).

Other CIS documents also reference environmental and resource costs/damages. These include Information Sheets on the 'Methodology to Prepare a Baseline Scenario' (2A, EC01, 2004), 'River Basin Characterization: Economic Analysis of Water Uses' (2B, EC01, 2004), and 'Assessment of the Recovery of Costs for Water Services' (2B, EC01, 2004). In general these documents refer to WATECO and ECO2 for further information of valuing non-market costs and benefits.

More recently analysis to estimate costs and benefits of measures to support implementation of the WFD in relation to Article 4 is discussed in the CIS Guidance Document on 'Exemptions to

[8] See: p10, 'Assessment of Environmental and Resource Costs in the Water Framework Directive', ECO2, Final Draft, November 12, 2004.

the Environmental Objectives' (European Commission, 2009c). While this too refers to WATECO and also De Nocker et al. (2007) for details of methodologies for estimating costs and benefits, it does list a range of potential effects that should be accounted for, including: protection and enhancement of health and biodiversity of aquatic ecosystems, protection of human health through water-related exposure, lower costs for water uses (e.g. reducing treatment and remediation costs), improvement of the quality of life by increasing the amenity value of water bodies (e.g. for recreation), mitigation of impacts from climate change and security of water supplies, and creation of new jobs through sustainable uses. As with WATECO, the document reiterates that it can be challenging to estimate the monetary value of all potential environmental and social benefits, and that in some cases it may not be necessary; i.e. where it is possible to make a qualitative assessment of the benefits and weigh this against costs. The document also cites the UN Millennium Ecosystems Assessment (MEA 2003) and The Economics of Ecosystems and Biodiversity (TEEB) initiative as further sources of information for valuing non-market benefits, although no explicit detail is provided (e.g. no recognition of the ecosystem services approach). Both the MEA and TEEB are discussed in Section 3.1.

2.2.2 Relevance of economic valuation to WFD Articles

Overall there are four main aspects of the WFD where economic valuation has a potential role:

- *Article 4*: in assessing the need for an exemption based on an economic appraisal of disproportionate cost. Economic valuation can be used to provide monetary estimates for non-market costs and benefits in this assessment.

- *Article 5*: which covers the economic characterisation of river basins through: (i) assessing the economic significance of water use in a river basin; (ii) forecasting supply and demand of water in a river basin; and (iii) assessing current cost recovery associated with water services. Economic valuation can help to provide monetary estimates of environmental costs to be included in cost recovery calculations. It can also assist in understanding the importance of direct and indirect benefits derived from water bodies (e.g. understanding the importance of flood protection in a catchment) and forecasting demand for non-market goods and services (e.g. contingent behaviour surveys in relation to recreation visits and improvements in environmental quality).

- *Article 9*: which states that Member States shall take account of the cost recovery of water services, including environmental and resource costs. By 2010 Member States are required to ensure that: (i) water pricing policies provide adequate incentives for water users to use water resources efficiently; and (ii) an adequate contribution of the different water uses to the recovery of the costs of water services. Economic valuation can help to provide monetary estimates of environmental costs to be included in cost recovery calculations.

- *Annex III and Article 11*: which states that Member States shall make judgements about the most cost-effective combination of measures in respect of water uses to be included in the programme of measures. Economic valuation can be used to estimate non-market costs included in the cost-effectiveness assessment such as environmental impacts associated with programmes of measures (e.g. climate change, air quality, health, waste, land use, biodiversity, etc.).

An illustrative example of the potential role of economic valuation in the context of Article 4 and new modifications to water bodies is provided in Box 2.3. This example sets out the range of data and evidence that is needed from various assessments to address this particular WFD policy question.

Box 2.3: Example of WFD implementation and economic valuation - new modifications to water bodies

New modifications to water bodies, for reasons such as household and commercial water supply, flood defence and renewable energy supply, can give rise to adverse environmental impacts and deterioration in ecological status. Under Article 4.7 of the WFD exemptions for new modifications to water bodies are permitted if their benefits outweigh the benefits of achieving and maintaining GES. In practice cost-benefit analysis (CBA) can be applied to weigh the alternative outcomes to ascertain the net impact of the new modification. This requires that the full range of economic, social and environmental impacts are identified, and then measured in quantitative and monetary terms. If the benefits of the new modification outweigh the cost, which includes the 'foregone benefit' of not attaining GES, there is economic case for allowing the activity.

As an illustrative example, the benefits of a hydro-electricity generation scheme will include:

- Economic benefits: generation of electricity that can be sold to the distribution grid; and
- Environmental benefits: if renewable energy replaces fossil-fuel generation there will be 'carbon benefits' in terms of lower greenhouse gas emissions from the energy sector and benefits due to reductions in other air pollutants.

The costs of the hydro-electricity generation scheme will include:

- Economic costs: capital, and operating and maintenance expenditure;
- Environmental costs: deterioration in status of the water body, and
- Social costs: detrimental effects on in-stream water recreation activities.

In this example an estimate of the benefit of electricity generation would be based on (market) electricity prices. Likewise capital and operating and maintenance costs would be estimated from market data. Carbon values could be sought from market values, since carbon is a traded commodity under the EU Emission Trading Scheme. Non-market damage estimates of carbon emissions are also available and could be applied via value transfer.

Economic valuation can be applied to estimate the value of non-market benefits and costs, in this case in relation to the deterioration in water quality status and impacts on recreational uses. For instance a primary valuation study could be undertaken (e.g. a travel cost or multi-site recreation demand model for the recreation impacts) or alternatively value transfer could be applied if suitable valuations already exist.

The various estimates of market and non-market costs and benefits would input to a CBA for the exemption determination. Scientific and technical assessments would be needed to provide the basis for the economic analysis by measuring changes in ecological status, impacts to recreation activities, and quantifying expected electricity output of the scheme.

Based on illustrative policy questions that could arise under Articles 4, 5, 9 and 11 (see Table 2.1), likely evidence requirements for WFD implementation in terms of non-market costs and benefits can be broadly characterised as:

- What are the non-market benefits of achieving GES (or a less stringent objective such as GEP)?
- What are the non-market costs of not achieving GES (or a less stringent objective such as GEP)?
- What are the non-market costs of alternative means of providing the activities currently using a water body and will not be allowed if GES is to be achieved (or will continue if an exemption is applied)?
- What are the wider non-market costs and benefits of achieving GES (or a less stringent objective such as GEP); i.e. impacts in terms of climate change, air quality, health, waste, land use, biodiversity effects, etc.?

Note also though that WATECO identifies other approaches and tools that could also be used as an alternative to, or in conjunction with, economic valuation. Furthermore the generic questions listed above and more specific examples presented in Table 2.1 are not intended to represent an exhaustive and definitive list of policy questions, rather they are provided for illustrative purposes to aid exposition. Finally there are of course other (market) costs and benefits that need to be taken into account in aspects such as disproportionate cost assessments and cost recovery pricing, such as financial costs and their distribution, but these are outside of the (non-market) scope of this study.

A further point to highlight is that economic value estimates of non-market costs and benefits are 'context-specific'. Therefore while it is possible to outline generic WFD policy questions, the actual economic values that would be estimated in such instances could be very different depending on various factors related to the details of the good subject to valuation. The context-specific nature of economic valuation is discussed further in the subsequent section (Section 2.2.3).

Table 2.1: Illustrative WFD policy questions and economic valuation

	Requirements of WFD	**Possible policy questions**	**Notes**	**Examples**
Article 4 -Decisions on exemptions	Heavily modified water bodies (HWMB)[1] and artificial water bodies (AWB)[2] Designation of HWMBs and AWBs [Article 4.3] Measures for reaching good ecological potential and good chemical status for HWMBs and AWBs [Article 4.3]	Economic valuation could assist in addressing: • What are the non-market benefits of achieving GEP/a less stringent objective? • What are the non-market costs and benefits of not achieving GES (or less stringent objectives) due to HMWBs and AWBs? • What are the non-market costs of other alternative means (that provide the same benefits of HWMBs and AWBs)?	Tests of designation include consideration of: • Adverse effects on specified uses or the wider environment; and • Costs of 'alternative means' of delivering the same objective. Both can include water-related and non-water (e.g. climate change, air quality, health, waste, land use, biodiversity, etc.) related environmental impacts which could be valued in order to establish 'better' environmental options.	For example, assume that a water body is modified by flood defences. Achieving GES requires removal of the defences. Assessments could include: What are the non-market costs of removal of the flood defences to achieve GES supply?
	Time exemption - extension of the time frame in which objectives have to be achieved (beyond 2015) [Article 4.4]	Economic valuation could assist in addressing: • What are the non-market benefits of the measure(s) to achieve GES by 2015? • What are the non-market benefits of the measure(s) to achieve GES by a later date? • What are the non-market costs of the measure(s) to achieve GES by 2015? • What are the non-market costs of the measure(s) to achieve GES by a later date?	Time exemptions can be assessed in terms of disproportionate costs for - i.e. comparing total costs of measures to achieve GES by 2015 to the total benefits achieving GES. Economic valuation can be applied to estimate the value of environmental benefits and costs. This is a cost-benefit analysis interpretation of the test of disproportionate costs.	For example, assume that the policy choice is between achieving GES in 2015 and 2025. An assessment of time exemption could include: What are the non-market benefits of achieving GES in 2015? What are the non-market benefits of achieving GES in 2025? This example allows for the case that some non-market benefits that may be gained in 2015 could be lost by 2025 due to poorer status of the water body up to this time.

Table 2.1: Illustrative WFD policy questions and economic valuation

	Requirements of WFD	**Possible policy questions**	**Notes**	**Examples**
Article 4 -Decisions on exemptions	Less stringent environmental objectives due to unfeasibility or disproportionate costs of the measures required for reaching good ecological status [Article 4.5]	Economic valuation could assist in addressing: • What are the non-market benefits of achieving a less stringent objective? • What are the non-market costs and benefits of alternatives means?	An assessment could be made to determine if the environmental and socio-economic needs cannot be achieved by alternative means[3]. If alternative means are more costly than the benefit of achieving GES, less stringent environmental objectives could be justified. Non-market costs could include both water-related and non-water related environmental impacts (e.g. climate change, air quality, health, waste, land use, biodiversity, etc.).	For example, assume abstraction for public water supply from a surface water body that occurs currently (i.e. in the baseline) will be disallowed in order to achieve GES. The alternative means of meeting the same level of public water supply is construction of a new desalinisation plant. An assessment of the costs of alternative measures could include: the non-market (non-water) costs of a new desalinisation plant (e.g. carbon emissions). This is a non-market cost of GES in the surface water body.
	Exemption for new (hydromorphological) modifications and new sustainable economic activities that lead to a deterioration in water body status [Article 4.7]	Economic valuation could assist in addressing: • What are the non-market costs and benefits of alternative means (that provide the same benefits of new modifications and activities)? • What are the (net) non-market costs of not achieving GES (or achieving less stringent objectives) due to new modifications and/or activities?	Exemption could require: • Comparison of benefits of the new modification to the benefits of meeting the environmental objectives, including environmental and social water-related benefits; • Assessment of benefits foregone by failing to achieve objectives; • Comparison of non-market costs and benefits of the new modification and alternative means[3].	For example, assume that there are plans to build a hydro-electric scheme, the construction and operation of which will mean that the affected water body will not meet GES. An assessment of exemption could include: What are the non-market costs of the new modification (e.g. deterioration in water body status, loss of recreation, etc.)? What are the non-market costs of alternative means (e.g. construction of fossil fuel power station and continued carbon emissions)?

Table 2.1: Illustrative WFD policy questions and economic valuation

	Requirements of WFD	Possible policy questions	Notes	Examples
Article 9	Recovery of costs of water services including environment and resources costs and taking account of the polluter pays principle [Article 9.1]	Economic valuation could assist in addressing: • What are the environmental and resource costs of water uses? • What are the environmental and resource costs of not achieving GES on water uses? • What are the environmental and resource costs of not achieving GEP due to water services? • How are the environmental and resource costs of water uses distributed? Who imposes and who incurs these costs?	Costs here are defined as the costs imposed by one type of water use on other uses. These cost estimates can be incorporated in the design of price and financing mechanism. Such mechanisms can also be used to balance the distribution of these costs – in accordance with the polluter pays principle. But ultimately same economic valuation principles as for in Article 4 apply here.	For example, assume that groundwater is extracted which reduces the recharge of a downstream wetland. An assessment of cost recovery could include: What are the non-market costs of abstraction on the environment (e.g. loss of biodiversity)?
Article 11 and Annex III	Selection of cost-effective combinations of measures: Economic analysis of most cost-effective sets of measures *Relevant to all types of water bodies*	Economic valuation could assist in addressing: • What are the 'non-water' environmental costs and benefits of measures for achieving GES or GEP? • What are the 'non-water' environmental costs and benefits of measures for achieving a less stringent objective?	If measures have significant impacts (either positive or negative) that are not related to a water body and its services, these could be included as 'non-water' environmental and resource costs and benefits. These include impacts related to climate change, air quality, health, waste, land use, biodiversity, etc.	For example, assume that one of the measures to achieve GES is to extend the sewage collection capacity in baseline. An assessment of the cost of this measure could include: What are the non-market, non-water (emissions of greenhouse gases, other air pollutants, waste etc.) impacts? In order to answer this question an assessment of environmental impacts of the measure (construction and energy and other material uses during operation) would be required.

Notes: [1] These are surface water bodies that have been physically altered by human activity for specific uses such as navigation, hydropower, water supply or flood defence. [2] These are water bodies created by human activity. [3] 'Alternative means': in Article 4.5 this refers to alternatives to serve the environmental and socioeconomic needs served by a certain human activity, which are a significantly better environmental option not entailing disproportionate costs. In Article 4.7 the WFD indicates that it is necessary to demonstrate that the beneficial objectives served by the modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option (see European Commission, 2009c).

2.2.3 Basis for economic valuation in the context of WFD implementation

Having broadly identified policy questions that economic valuation can potentially assist in addressing, it is useful to establish the basis on which a valuation study would proceed in a given case. Referring back to Section 2.1, the process of estimating costs and benefits requires qualitative and quantitative assessment using multidisciplinary input followed by economic valuation methods that express the costs and benefits in monetary values. Note that the plural use of 'benefits' and 'costs' is intentional as water bodies provide multiple ecosystem services, each of which may be affected by WFD measures differently, and all of which should be reflected in the analysis (even if it may not be possible to monetise all).

Overall economic valuation builds on the qualitative and quantitative assessments of: (i) the good or service that will be valued; and (ii) how its provision is changed by the policy that is being analysed. The four fundamental questions this process must answer are presented in Table 2.2, together with an indication of the kind of qualitative and quantitative information that needs to be collected in the context of WFD implementation. This then provides the basis for undertaking an economic valuation study.

Note that the four questions are relevant to all economic valuation exercises, regardless of the policy context and valuation method applied. Addressing these questions requires a range of context-specific qualitative and quantitative information, which in most instances will be informed by scientific and technical assessments (see Sections 3.1 and 3.2). However, the particular good or service that is to be valued, the choice of method, the way the methods are implemented and the way estimates are interpreted will depend on the specific details of the policy question of interest. In this regard Box 2.4 illustrates how economic value evidence can be used for implementing the WFD using the example of estimating the economic value of informal recreation. It highlights the point that economic value estimates are context-specific, depending on a range of factors including location, the characteristics of the affected population, and the scale and timing of the change. Understanding the factors that define the context is a pre-requisite to not only designing valuation studies and interpreting their results, but also knowing which values from the literature are appropriate for a given analysis and what adjustments are necessary (i.e. when using value transfer).

The factors illustrated for informal recreation in Box 2.4 are amongst the most common factors that are expected to influence economic values. All these factors need to be identified and information about them needs to be collected in order to understand the physical (quantitative and qualitative) change in water bodies and resulting change in economic value. Examples of such contextual details as relevant to valuation studies are presented in Annex 1, which summarises a sample of recent economic valuation studies that are relevant to WFD implementation.

Table 2.2: Key generic questions that need to be answered for economic valuation to be possible and how these relate to WFD

Generic Questions	Answers in the context of WFD
1. What resource is affected?	Type of water body: e.g. rivers and lakes, estuaries, coastal waters, HMWB, groundwater. Also important are the services, i.e. the benefits provided by water bodies. An 'ecosystem services approach' (see Section 3.1) can help with identifying these services). The assessment should also include the substitutes of water bodies in terms of alternatives that can provide each service. Issues relating to geographical scale also need to be considered.
2. What is the expected change?	For deteriorations in environmental quality: identifying the expected impacts due to pressures on water bodies which affect both water quantity or quality or both) due to pollution, increasing demand for consumption, land development, etc. For improvements in environmental quality: identifying the expected impacts of programmes of measures; e.g. for achieving GES or GEP in a water body.
3. Where and when will the change happen?	Includes the geographic scale of change (local, regional, national) and time scale (short or long term, seasonal, permanent, temporary, etc).
4. Who will the change affect and how? (users and non-users)	For non-market costs and benefits: impacts of the change on the benefits derived by individuals. This requires data on the affected population: for both users and non-users - socio-economic characteristics; for users only - distance between residence and water body and frequency and type and frequency of use made of the resource.

Notes:

HMWB: Heavily Modified Water Body.

Users: often this population group is readily identified as it consists of those making direct use of a resource, for example all visitors to a river (so long as visit data are recorded). It also includes those deriving indirect use values, for instance in terms of flood protection benefits within a catchment. Importantly different elements of use value can be relevant at different spatial scales; recreation values may only be relevant at a local level, while others such as water quality may confer benefit on a larger regional scale.

Non-users: this refers to the population group that derives some wellbeing from a resource even though they do not make direct or indirect use of it. Instead economic values are associated with altruistic, bequest and existence value motivations (see Box 2.1).

Box 2.4: Using the economic value evidence on informal recreation for implementing the WFD

One of the range of non-market benefits provided by water bodies is informal recreation, including activities such as walking, dog-walking and in-stream activities such as paddling and swimming. For illustration here, it is assumed that implementation of WFD will lead a quality and/or quantity change in a water body, which will then result in an improvement in informal recreational opportunities and hence non-market benefit. The change in the benefit could be due to: (i) increased visitor numbers; (ii) increased enjoyment of individual visitors; or (iii) both. The 'economic value of informal recreation' refers to the marginal value of such qualitative and/or quantitative change in recreational benefits. It could be estimated via travel cost models, multi-site recreation demand models or stated preference approaches.

The economic value of informal recreational use of a water body can be used in the context of Article 4, in a cost-benefit analysis framework:

- Estimates the benefit of attaining GES (or GEP) - if informal recreation is provided and/or improved by attaining GES (or GEP). This evidence can help with assessing whether the cost of reaching GES (or GEP) is disproportionate (to benefits); or
- Estimates the cost of exemption – if, for example, informal recreation is lost or degraded by allowing a new modification to a water body. This evidence can help with assessing the costs of achieving less stringent objectives due to new modifications.

The economic value of informal recreation could also be used in relation to Article 9 to:

- Estimate a resource cost - if, say, allocation of water to abstractive uses reduces the recreational opportunities of the water body and hence the economic value of informal recreation.

Crucially, economic values are context-specific; this means that the value of a benefit or cost will vary in difference circumstances (for example between two different locations and water bodies). Hence in order to use economic value evidence appropriately it is necessary to understand the factors that influence economic values. In the context of informal recreation, economic values are typically dependent on:

- *Water body specific factors*: such as the type of water body; the baseline quality and quantity of the water body; the change in quality and quantity that will occur as a result of WFD implementation (separate to other pressures and other policies that may cause change) and the availability of substitutes to water body as far as the recreational opportunities are concerned (e.g. the environmental quality of other rivers, lakes, etc. that offer recreation opportunities).

- *Recreation specific factors*: such as the type of recreational activity and the availability of other recreational opportunities (current and future).

- *Individual user and non-user specific factors*: the characteristics of the affected population such as the proximity to the water body and other recreational opportunities/substitutes, frequency and duration of recreational visits and socio-economic characteristics such as income, education, age, gender etc.

3. ECONOMIC VALUATION – DEVELOPMENTS IN THE CONTEXT OF THE WFD

The application of economic valuation methods receives a great deal of attention from the research and policy community. A significant amount of work has been undertaken in this area as part of the implementation of the WFD and this has results in recent developments methodology and application. This section reviews a number of aspects of these developments, in not only economic valuation methods, but also relevant developments in related fields ('WFD science') and analytical frameworks which can be applied to aid policy analyses. Note however that the scope of the review is limited to the context of WFD implementation; e.g. it does not attempt to provide an account of all recent developments in economic valuation *per se*.

The content covered in this section is based on a desk-based review of the guidance and empirical research literature since the publication of the WATECO guidelines. The search task included the following:

- An email request for literature relating to valuation within the context of WFD was sent out to leading academics and researchers in the field of economic valuation. Those who responded are recognised in the acknowledgements to this report;
- The WISE[9] database was consulted to locate information relating to the research projects being undertaken as part of WFD implementation; and
- Using the CIRCA (Communication Information Resource Centre Administrator)[10] website was used to access Common Implementation Strategy (CIS) guidance documents.

Given that this is a scoping study, the literature search and review are not exhaustive. To reiterate, the purpose of this study is not to comprehensively identify and review all relevant economic valuations studies, rather it is to draw some conclusions about the relevant developments in the areas and provide recommendations for future research. Annex 1 summarises the relevant empirical literature in terms of the methodology used, values estimated and factors affecting these estimates.

The key findings of the review can be summarised under three types of developments:

- *Analytical frameworks* (Section 3.1): there have been many developments in the approaches to the analysis of environmental goods and services. Two areas of particular note are:
    - o The 'ecosystem services approach' – which helps identify myriad of services provided by water bodies. One advantage of this is greater transparency in establishing which ecosystem services are included in cost and benefit estimates; and
    - o Use of 'spatial analysis' via Geographical Information Systems (GIS) – application of GIS in valuation studies helps better organise the locally specific data on water bodies, changes in environmental quality, availability of substitutes, characteristics of the affected population and so on. This provides a consistent basis for

[9] See: http://water.europa.eu
[10] See: http://circa.europa.eu/

accounting for the context-specific nature of economic values (as discussed in Section 2.2). GIS is also used to aid cross country scientific data collection and for socio-economic datasets.

- '*WFD Science*' (Section 3.2): as implementation of the WFD has progressed, there have been developments in scientific understanding of the links between GES, wider environmental quality and human uses of water bodies. This has mostly been driven by requirements for ecological characterisation of water bodies (Article 5), the development of monitoring networks (Article 8) and the intercalibration process. The focus of this review of developments in WFD science is their relevance to developing economic valuation practice, particular in terms of providing the qualitative and quantitative assessments that provide the basis for valuation (as discussed in Section 2.1).

- *Economic valuation methods and practice* (Section 3.3): in addition to developments of analytical frameworks and science that have benefitted economic valuation methods and practice, there have been also refinements in the methodologies themselves aimed at understanding the variation in value estimates between different contexts, influence of distance and substitutes on the values and better communicating of results. There have also been developments with regards to value transfer.

While these developments are evidenced in the research literature, this does not imply that these developments are necessarily reflected in all economic valuation studies undertaken for the purposes of WFD implementation.

3.1 Analytical frameworks

3.1.1 Ecosystem services

Concerted policy analysis and research in recent years has generated widespread attention to the 'ecosystem services approach'[11]. This refers to analyses that reflect the contribution of ecosystems and the biological diversity contained within them to individual and social wellbeing. In this sense, the term 'ecosystem services approach' has come to describe a basis for analysing how individuals and human systems are dependent upon the condition of the natural environment.

In practice there is no single ecosystem services approach framework. Numerous research initiatives have been undertaken, although it is widely recognised that the key contribution in developing a high profile systematic account of ecosystem services was provided by the UN Millennium Ecosystem Assessment[12] (MEA, 2003). The MEA set out four main categories of ecosystem services:

[11] Note this should not to be confused with the 'ecosystem approach' which is advocated by the Convention on Biodiversity as a "*strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way*". See: http://www.cbd.int/ecosystem/

[12] See: http://www.millenniumassessment.org

- *Provisioning services*: these refer to products that are obtained from ecosystems. In the context of the WFD, examples of provisioning services include:
  - Water – water for industrial use; water for agricultural use.
  - Food - commercial fish catch.
  - Renewable energy - energy from natural resources that is replaced naturally or controlled allowing for its continual use without depletion (e.g. hydro power or tidal power).

- *Regulating services*: these refer to the benefits obtained from the regulation of ecosystem processes. In the context of the WFD, examples of regulating services include:
  - Water regulation - flood prevention and aquifer recharge.
  - Water purification and waste management - filtration of water, detoxification of water and sediment to remove toxins from or purify water and/or sediment (e.g. removal of harmful chemicals or sewage).

- *Cultural services*: these refer to the non-material benefits that individuals obtain from ecosystems. In the context of the WFD, examples of cultural services include:
  - Recreation and tourism – activities that individuals do for enjoyment and business activity connected with providing accommodation, services and entertainment for people who are visiting a place for pleasure (e.g. angling, boating, swimming, etc.).
  - Aesthetic – amenity values.
  - Education – using rivers/lakes/canals etc. as an aid to teaching.

- *Supporting services*: these refer to services that are necessary for the production of all other ecosystem services. They differ from the other services in that their impacts on people are either indirect (via provisioning, regulating or cultural services) or occur over a very long time. Examples of these services include soil formation, nutrient cycling, habitat provision and primary production.

Subsequent studies to the MEA have sought to improve understanding, refine concepts and develop practical applications of ecosystem service approaches. Current major initiatives include 'The Economics of Ecosystems and Biodiversity' (TEEB)[13] and 'UK National Ecosystem Assessment' (UKNEA)[14]. Both studies are structured around ecosystem services frameworks (and include water ecosystems).

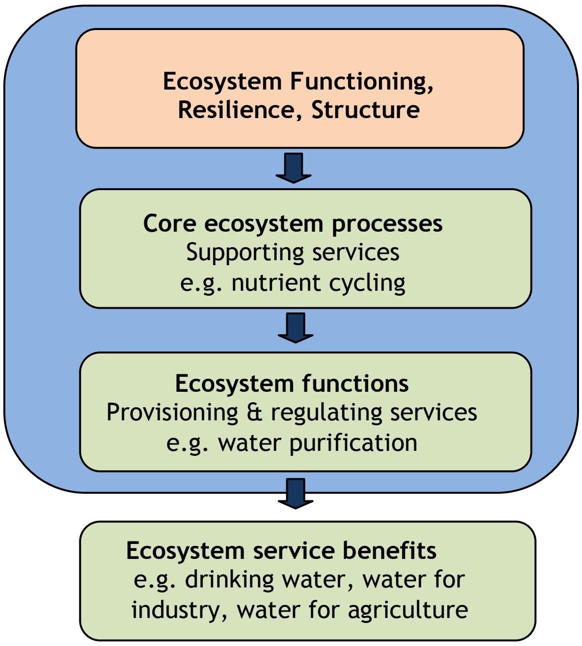
The purpose of TEEB, which is a major international study, is to draw attention to the global economic benefits of biodiversity. The TEEB approach explicitly describes the links between the TEV framework (see Section 2.1) and the different categories of ecosystems services, with particular emphasis on tracing the effects of policy changes through changes in the provision of ecosystem services to outcomes in terms of changes in TEV (see Box 3.1). The UKNEA framework also provides for an explicit account of the use of capital inputs in converting ecosystem processes into goods and services useful to humans (for example agricultural machinery that is required in the production of crops). This recognises the important role of human inputs in converting latent services to actual values (see Nicholson et al., 2009; Bateman et al., forthcoming).

[13] See: http://www.teebweb.org/
[14] See: http://uknea.unep-wcmc.org/

Box 3.1: The Economics of Ecosystems and Biodiversity (TEEB) - classification of ecosystem services

The purpose of the Millennium Ecosystem Assessment (MEA) conducted in 2005 was to determine the impacts/changes on human wellbeing as a result of ecosystem change. In this context ecosystem changes were described within four high level ecosystem service categories: provisioning, regulating, cultural and supporting services. Since the MEA further studies have developed similar ecosystem services frameworks (see for example Fisher and Turner, 2008; Mace et al., 2009).

The TEEB initiative builds on developments since the MEA. It defines core ecosystem processes and functions, and how these produce 'ecosystem benefits'; i.e. market and non-market goods and services:



Source: adapted from TEEB (2009)

The ecosystem service approach has a useful role in clarifying purpose of economic valuation - namely measuring the (human) wellbeing derived from environmental resources - and how it can subsequently input to policy analyses such as Impact Assessments and CBA (which, for example, can help inform WFD implementation). Foremost this has an advantage of broadening understanding of the purpose of economic valuation across environmental science and policy analysis disciplines. Moreover the ecosystem services approach also reinforce the 'three-stage process' for valuation described in Section 2.1, where economic valuation is reliant on sound understanding and measurement of environmental impacts (see also Section 3.2). The key point in particular is determining how changes in ecosystem processes and functions result in impacts to affected human populations in terms of (market and) non-market goods and services.

In this regard a number of recent studies have examined the nature of relationship between ecosystem services and benefits to human populations (see for example: Boyd and Banzhaf, 2006; Fisher and Turner, 2008; Luisetti et al., 2008; Bateman et al., forthcoming). Here distinctions can be made between 'final services' that provide direct value to human users in terms of (market and) non-market benefits, and 'intermediate' or supporting services which indirectly benefit human populations by supporting other direct/final services. The main implication of this for economic valuation is that these distinctions help to identify all those services that contribute to human wellbeing in a structured manner. This then helps to highlight potential 'double-counting' or 'over-valuation' risks; for example seeking to estimate the value agricultural irrigation benefits *and* water purification services from groundwater supply (water purification is a supporting service to the final irrigation service, hence to valuing both would be double-counting).

The ecosystem service approach is also intended to help establish the full range of outcomes from particular actions. In the context of implementation of the WFD, a number of aspects of Article 4 require that the full range of costs and benefits of measures, or alternative measures, be established. For example measures aimed at addressing diffuse pollution to water bodies from agricultural land uses will likely result not only in water quality improvements but a range of other environmental enhancements (see Box 3.2).

Box 3.2: Assessing the benefits of sustainable catchment management

A widely cited example of river catchment land management is the SCAMP ('Sustainable Catchment Management Programme') initiative. This is a programme led by United Utilities, the regional water and wastewater services company in the North-West of England. Over the period 2005-10 it has sought to restore and manage 20,000 hectares of upland habitats, comprised mostly of moorland farmed for sheep in order to enhance the water purification services of this land (United Utilities, 2009).

The SCAMP land is recognised as important in conservation terms and provides multiple ecosystem services to the local, national, and even global population. The most salient service is gathering and filtering water for human consumption as much of the land consists of peaty, wet soils that can retain, filter and clean rainwater. Habitat degradation, however, can seriously compromise the water functions of the land. Additionally, the peat soils store substantial quantities of carbon. Healthy peat bogs can sequester carbon, while carbon can be lost from degraded areas. Overall the most relevant ecosystem services are (eftec, 2010):

- *Provisioning services*: food, fibre.
- *Regulating services*: carbon sequestration, water quality and quantity, flood protection.
- *Cultural services*: informal recreation.

Applying an ecosystem services approach to the assessment land use management initiatives such as SCAMP, therefore permits for recognition of a much wider range of benefits than a narrow focus on water quality improvements. This can also strengthen the case for multi-objective measures particularly in light of disproportionate cost assessments under Article 4 of the WFD.

A further strength of the ecosystem services approach can be the use of services as indicators of environmental quality within the context of valuation studies. This can particularly aid the design of stated preference surveys in describing to respondents what changes in environmental quality mean in terms of final goods and services. For example, describing deterioration in the environmental quality of a lake in terms of physio-chemical indicators (e.g. biological oxygen demand, nitrogen and ammonia levels) will be virtually incomprehensible to respondents who will not have technical knowledge. Instead, describing changes in terms of impacts on final goods and services (e.g. "visitors will no longer able to use the lake for angling or swimming") communicates the implications of technical information in a simpler way. Development of water quality ladders as aids this aspect of valuation studies (see Section 3.3.1).

At present there a few examples of studies that have considered implementation of the WFD within an ecosystem services approach framework. Relevant studies include Rönnbäck et al. (2007) who sought to identify the ecosystem services of the Swedish coastline, and Birol et al. (2006) who estimated the value of benefits from for single ecosystems services such as flood protection and compared them to estimates of the value of ecosystem services in aggregate. Also, as noted in Section 2.2, the recent CIS Guidance Document on 'Exemptions to the Environmental Objectives' references the MEA and TEEB but does not provide any explicit discussion as to the relevance of the ecosystem services approach, other than stating that these are 'tools' that can assist with valuation of non-market benefits.

3.1.2 Spatial analysis of economic values using GIS

Geographic Information System (GIS) refers to any system that captures, stores, analyses, manages, and presents data that are linked to geographic location. Here computer technology makes it possible to overlay several different types of data which makes co-analysis of data easier. For example, water bodies, locations of specific recreation sites, and population density data could be overlaid to estimate visitor catchment for sites. Given this there has been increasing recognition of the role that GIS can play in practical application of all economic valuation methods (see for example Bateman et al., 2005a). There is, however, no acknowledgement of this role in current CIS guidance. In particular formal guidance on the use of GIS (Updated guidance on implementing the GIS elements, 2009) focuses on water quality mapping, while economic valuation research that has incorporated GIS has been subsequent to the WATECO and ECO2 guidance documents.

Significantly a key aspect of the context-specific nature of WFD implementation is concerned with the spatial and geographic aspects of water bodies. One area of focus is the need to understand the impacts of programmes of measures in relation to WFD Article 4 and how these may vary over spatial scales. In particular there will likely be a range of effects to consider when measures are implemented as prescribed by RBMPs. These effects will not only have an impact on the direct benefits related to the water bodies themselves, such as attaining GES, but can also have indirect beneficial or detrimental impacts elsewhere. In the case of water quality, and in particular rivers, most of the relationships between ecosystem service production areas and benefit areas is 'directional' in a downstream direction (rather than "in situ"), as conceptualised by Fisher and Turner (2008).

In some cases the beneficial effects can be spatially very remote from the area of a targeted intervention. The direct benefits (improvements in water quality for various purposes) are likely to be measurable in terms of ecological status as defined in the WFD, or in terms of compliance or non-compliance with other directives (e.g. Nitrates Directive for drinking water standards). However, considering indirect benefits of measures introduces further ecosystem-related values which can be accounted for in a 'comprehensive' valuation study. Examples include:

- Under land management interventions for reducing diffuse pollution there may be enhancements of terrestrial biodiversity (e.g. due to pollination), soil quality and erosion regulation, in addition to the water quality benefits downstream. There may be a negative impact on food production as a provisioning service.
- Under floodplain restoration/rehabilitation, floodplain and wetland function may be enhanced as well as flood control and water quality.

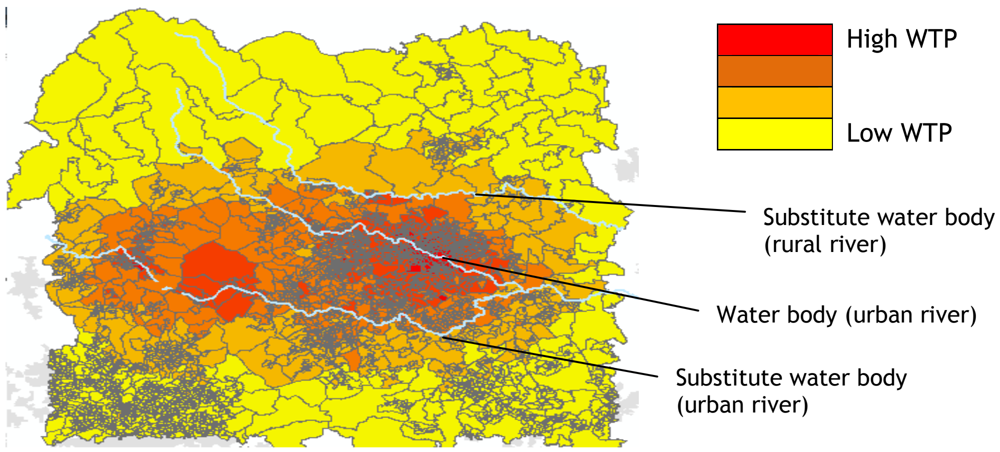
GIS also permit an account to be made for a range of physical environment factors, such as hydrology, topography, land cover, land use, etc. that will determine what impacts will occur and where they will occur at a reasonably detailed spatial scale. From a practical perspective for economic valuation studies this permits for a ready account of the affected population; i.e. the likely beneficiaries of improvements in environmental quality and/or those likely to suffer from detrimental effects, such as specialist user groups (e.g. anglers), resident households, and other stakeholders including land owners and water abstractors. Use of GIS also permits stated preference studies to much better represent aspects such as improvements in water quality, by specifying more certainly affected water bodies and sites, via the provision of maps as of part the questionnaire design (see Section 3.3.1). Some examples of economic valuation studies integrating GIS are provided in Section 3.3. Box 3.3 details potential applications for GIS in valuation study.

Box 3.3: Application of GIS in economic valuation studies

Application of GIS in economic valuation studies permits a consistent account for the spatial context of economic values. For example by:

- Identifying the location of environmental improvements and magnitude of such improvements (i.e. improvements in water quality may not be uniform across water bodies);
- Accounting for the location of beneficiaries for environmental improvements (e.g. in terms of population density);
- Accounting for spatial variation in the socio-economic and demographic characteristics of the affected population (e.g. average household income);
- Calculating the spatial area over which use values are derived from environmental goods and services (so called 'distance-decay' in economic values – see also Section 3.3.2); and
- Identifying substitutes resources (e.g. alternative water bodies and the environmental quality of these).

Use of GIS enables spatial variation in economic values to be illustrated graphically, which can be a very effective means of communicating the context-specific nature of benefits of WFD implementation. The map below illustrates how the non-market recreation benefits of a water body (a mainly urban stretch of river) vary across a spatial area.



Source: adapted from ChREAM project.

The 'basic story' illustrated by the map is that greater recreation benefit is generated in the immediate vicinity of the water body. In this particular case the water body runs through a densely populated urban area and this extenuates an observed 'distance decay effect'. As distance from the water body increases potential users have access to substitute water bodies that are closer, and hence are less likely to visit, or visit less frequently, the water body of interest. This then translates to lower economic values as distance from the water body increases.

3.2 WFD Science

As highlighted in Section 2.2 there are a series of key questions that provide the fundamental basis for economic valuation exercises (see Table 2.1). Addressing these questions requires a range of context-specific qualitative and quantitative information. In particular:

1. *What is the resource affected?* This requires a description of the water body, geographical scale, the current status or environmental baseline (e.g. information relating to current water quality), etc.

2. *What is the expected change?* This requires determination of the magnitude of the change as a result of measures implemented in terms of physical indicators of water quality and also associated biodiversity outcomes, etc.

3. *Where and when will the change happen?* (i.e. the location(s) and timing of the change) This requires determination of the areas of a water body or catchment which will be affected, the time required for improvements in water quality to be realised, etc.

4. *Who will the change affect and how*? This requires determination of the 'affected population', their characteristics, and the nature of their interaction with the water body (e.g. users, non-users).

'WFD science' is particularly relevant to 1-3 above and in general is needed to support all approaches to economic valuation (i.e. revealed preference and stated preference approaches, as well as value transfer). In addition, practical application of the analytical frameworks described in Section 3.1 is reliant on supporting scientific information, in terms understanding impacts on ecosystem service provision, while combining different types of data using GIS can greatly improve the account of spatially specific factors in WFD implementation.

The following discusses key aspects concerning 'WFD science' in terms of the relevance of applying economic valuation in WFD implementation.

3.2.1 WFD science and the requirements for economic valuation

A number of different natural science (e.g. ecology, hydrology, chemistry, etc.) research activities and initiatives have been undertaken or are ongoing with regards to implementation of the WFD. As Box 3.4 details, this includes aspects such as 'scientific knowledge and data', which relates to the general understanding of physical environment processes and outcomes, such as the impact of measures to attain GES[15]. In addition, formal requirements under WFD implementation of intercalibration and monitoring are also relevant to the use of economic valuation. The relevance of the research types and activities summarised in Box 3.4 for the use of economic valuation in WFD implementations is discussed subsequently, in terms of the key questions that need to be addressed for any valuation study (as listed above).

[15] As part of the WFD implementation process there have been a number of different projects across Europe that seek to model chemical and ecological processes within different water bodies throughout Europe including: AQEM, Aquaterra, Cityfish and COMET etc. (see: www.wise-rtd.info for details of projects)

Box 3.4: WFD implementation and science

In examining the role of economic valuation in implementation of the WFD, three areas of scientific research and activity are of interest:

- ***Scientific knowledge and data***: economic valuation represents the final stage of a process that is dependent on sufficient information being available on the resource of interest (i.e. the water body and its services) and the (quality or quantity) changes to that resource are described. In the context of the WFD, this is primarily informed by the scientific data and understanding of environmental dose-response or damage functions through the use of models of varying complexity, which describe the relationship between the impacts of programmes of measures and water (and broader environmental) quality. For instance this may require data on nitrate, orthophosphate and ammonium concentrations in rivers, lakes and coastal areas throughout Europe, along with the number of water bodies at risk of not meeting GES, and also ecological assessments. Largely scientific data availability is driven by the river basin management planning process, with characterisations of river basin districts made available in 2003, and RBMPs published in 2009. RBMPs in particular define current status, objectives for improvement and measures to achieve objectives for each river basin district. The Water Information System for Europe (WISE) provides a summary of past and current research projects that determine the impact(s) or change(s) associated with the implementation of WFD (although these projects are not all exclusively focused on scientific work).

- ***Intercalibration***: this is the process of ensuring that the definition of GES is comparable between any pair of water bodies in Europe. There may however be differences between the baseline conditions and GES for the same type of water bodies depending on their location and associated characteristics. The initial intercalibration exercise took place during 2004 – 2006 and helped identify where gaps within scientific data existed. Significant differences were identified for transitional waters, while some ecological data were missing altogether. The next deadline for a complete set of quality elements is 2011 for application in the second round of RBMPs (for 2015). The intercalibration of GEP as relevant for designations as HMWBs is not included in this timetable. Out of necessity, intercalibration has progressed in some cases where monitoring systems to provide the driving data are still incomplete or under development.

- ***Monitoring***: Article 8(1) of the WFD requires that Member States establish monitoring programmes for the assessment of the status of surface water and of groundwater in order to record water status within each river basin district. These monitoring programmes were to be operational by 22 December 2006. Following the establishment of WISE, Member States have been able to report the results of monitoring in a standard electronic format, which has been checked by the European Environment Agency for compliance based on 20 indicators. As detailed in the 2009 Implementation Report (European Commission 2009f), 24 Member States have reported on their monitoring programs in accordance with these requirements. WISE has largely been a success with the number of monitoring stations in use across Europe in the region of 50,000 for both surface and ground waters (European Commission 2009f). However, the quality of the data provided varies widely across countries with Austria, Czech Republic, Hungary and the Netherlands being recognised as the best examples.

Establishing the details of the resource affected - the 'good to be valued'

Scientific information is required on water bodies to understand and determine the baseline conditions in physical terms, using chemical, biological and other data as necessary. For example, to establish nitrate concentrations, identify plant communities present and so on.

The key source for such data is the WFD implementation monitoring requirements. Ideally all necessary indicators such as chemical concentrations and ecological characteristics would be monitored for different water bodies, providing accurate information on the 'baseline' status of water bodies across Europe. Monitoring data input to the process of water quality mapping[16] and this should represent the starting point for a economic valuation study. In most instances for economic valuation, information relating to physio-chemical information needs to be linked to ecological measures (e.g. high-level measures such as fish and plant communities) to enable a comprehensive baseline assessment to be made. This can then be linked to specific non-market costs and benefits that affect human populations (e.g. recreation benefits, improved environmental amenity, etc.). Note that this assessment can be aided by use of an ecosystem services approach, as described in Section 3.1.1, which provides a formal framework for linking changes in ecosystem processes and functions to effects to human populations.

Current data availability provides some scientific evidence for determining the current status of water bodies. However data are usually not available for all quality indicators which can present difficulties in terms of establishing an appropriate baseline for valuation studies. Also data are mainly limited to large scale water bodies in terms of Europe-wide maps. In particular surveillance monitoring[17] is only mandatory at sites draining over 2,500 km^2, or sites of significant volumes (e.g. lakes), or at points that cross national boundaries, and is only carried out once during a six year RBMP cycle (although there is no minimum period stipulated for groundwater quality elements). For the next RBMP cycle, however, operational monitoring[18], targeted to the most sensitive constituent elements to the classification, is to be established at sites at risk of non-compliance. This will provide data in greater detail for these sites. Furthermore monitoring of groundwater resources is more stringent with several core parameters (including oxygen content, pH value, conductivity, nitrate and ammonium) that must be reported at least once during each six-year planning cycle (European Commission 2009a).

In general current variance in monitoring means that information on different physio-chemical indicators may not be available for a particular site, or where available measures/indicators may not have been sampled at the same time. Moreover at present there is little systematic information available in relation to the ecological status of water bodies in terms of the plant, fish and bird communities. This latter point is potentially the most problematic issue since such

[16] See for example EEA interactive water quality maps: http://www.eea.europa.eu/highlights/take-a-look-at-the?&utm_campaign=take-a-look-at-the&utm_medium=email&utm_source=EEASubscriptions

[17] Surveillance monitoring is used to provide an assessment of surface water status within a catchment/sub-catchment in a river basin district and accounts for the risk analysis carried out under Article 5 in 2004. Its main focus is long-term changes in natural conditions and human activities (European Commision 2009a).

[18] Operational monitoring is used to provide a targeted approach to assess the ecological and chemical status of water bodies at risk of failing to meet environmental objectives. Monitoring frequency is chosen by Member States to provide sufficient data for reliable assessment (minimum standards are provided for specific indicators) (European Commision 2009a).

information is important to establishing the non-market costs and benefits that affect human populations. Overall this implies that in some cases economic valuation studies may face challenges in establishing all details of the resource affected. However, this may not prevent a valuation study from being undertaken. In particular involvement of scientific experts means that the 'most can be made' of limited data and evidence, with expert judgement informing in the design of studies. Indeed recent progress in valuation studies that is reviewed in Section 3.3 details the development of 'water quality ladders' that link physio-chemical and ecological indicators to impacts on human populations in the face of the limitations in available scientific evidence.

Determining the magnitude of the change – the improvement in water quality and non-market benefits

Specifying the expected change in the quality or quantity of resource is also reliant on the available scientific and technical understanding of physical processes and the impact of measures, as well as data availability, in relation to physio-chemical and ecological indicators. Again, where available evidence is limited the design of valuation studies can be informed by expert judgement.

One aspect of the required evidence that is ordinarily readily available is the definition of GES or GEP for water bodies. This is central to many of the potential valuation questions outlined in Section 2.3; i.e. valuing the benefits of attaining GES in the contexts of WFD Article 4 and disproportionate costs and exemptions. Where a sound understanding of GES is available – defined in terms of physio-chemical and in some cases ecological indicators – the impact of measures can be established, provided that the baseline status is also understood to a reasonable degree. In these circumstances it is possible, therefore, to specify the improvement in water quality (or other environmental impacts of interest) in the design of a valuation study.

The intercalibration process is also a potential aid to valuation studies, particularly in cases where they are conducted across countries or international river basins. Specifically intercalibration should allow the translation of any country's results (in terms of chemical and ecological data) into a standard set of categories measuring GES. If this is then linked to 'tools' such as water quality ladders a consistent framework for undertaking valuation studies is possible. As demonstrated by the Aquamoney project[19], the advantage of a consistent framework for valuing improvements in water quality means that a better understanding of the range of factors across Member States that influence the economic value of water quality improvements is possible. These factors include the scale of the improvement ('scope'), the availability of substitutes, and the socio-economic characteristics of the affected population (see Section 3.3 for further discussion).

Intercalibration is also potentially useful in the application of value transfer. Again this may simply be in terms of comparing estimated values between countries and understanding the key factors that should influence values, or more formally transferring values to estimate benefits in the absence of country-specific results (see also Section 3.3.3) where adjustment can be made to account for differences in the scope of improvement in order to avoid potential 'transfer error'.

[19] See: http://www.aquamoney.ecologic-events.de/

In practice, however, there is no formal example to date of the use of outcomes from intercalibration in economic valuation studies. As with other aspects of 'WFD science' there are gaps in certain environmental quality indicators. The initial intercalibration process revealed gaps particularly in ecological measures (e.g. fish and macrophytes for rivers, macroinvertebrates and phytobenthos for lakes), implying that translation of quality indicators between countries is limited to mostly physio-chemical data.

Determining the location and timing of the change

Information needed for valuation studies in terms of the location and timing of the change builds on the data available for the resource affected and the expected change. Hence limited evidence or understanding will also present a challenge to this aspect of valuation studies. Establishing the timescale for and location and spatial extent of improvements in water quality is dependent on understanding of the impact of measures on highly complex hydro-morphological processes. At present WFD science is mostly reliant on modelling and even though techniques are increasingly reliable at predicting the change in chemical indicators in response to measures, effects to ecological indicators are typically not accounted for. Again it is the case that in most instances expert judgement will be required to inform valuation studies, rather than reliance on outcomes of formal models. For example if the water body of interest is 'small' and with a low flow regime, it may be assumed that the improvements will take effect at concurrent with implementation of measures. However, where larger scale water bodies (e.g. faster flowing rivers or coastal tidal areas) are considered further information relating to the changes seen in different parts of the water body is needed, which may or may not be available via monitoring data.

3.2.2 Implications for economic valuation studies

As highlighted in Section 3.2.1 a key challenge for economic valuation studies in the context of implementation of the WFD is relating different scientific indicators to each other; in particular determining effects on ecological indicators such as changes in plant communities and fish species due to changes in underlying physio-chemical and hydro morphological processes. In part this issue was recognised in De Nocker et al. (2007) who identified the need for improved understanding of dose-response relationships between changes in water quality and the provision of non-market goods and services. However, the further distinction to be made is that this understanding is dependent on two types of information: (i) physio-chemical indicators that are largely the subject of WFD monitoring; and (ii) high level ecological indicators, for which monitoring data are typically not available[20]. Furthermore it is largely the high level ecological indicators to which non-market benefits are more readily linked; e.g. biodiversity, recreation (both in-stream such as angling, and more informal activities such as walking), visual and general environmental amenity, etc.

At present there are a number of issues relating to methods that have been used to measure high level ecological indicators and link these to indicators of GES (see Hime et al., 2009). For

[20] The data currently available through the European Environment Agency are mostly related to chemical measures, in particular the level of nitrates, orthonophosphate and total phosphorous. See http://www.eea.europa.eu/themes/water/dm#c1=Data&c1=Graph&c1=Map&c11=all&c0=10

example no Member State has provided complete information on the level of confidence and precision of the approaches developed[21]. Furthermore only four Member States monitor all biological indicators, and few international river basin districts use the international coordination mechanisms that are in place. However refinements to ecological quality elements and indicators are ongoing, with the aim to better predict the outcomes of measures identified in RBMPs. As more information becomes available it may become easier to establish the relationships between physio-chemical factors and ecological indicators. This will provide a more substantive basis for economic valuation studies in describing the resource affected and the outcomes associated with implementation of the WFD in terms of non-market benefits and costs. Further challenges for economic valuation studies will however likely remain. For instance the 'scale of the data' for most monitoring is high-level and while data are available for individual monitoring stations there may be relatively few measurements (e.g. one every six years, meaning that baseline conditions may only be based on very few results). This has potential implications if valuation studies are aimed at local and small scale water bodies.

Despite these issues, as Section 3.3 reveals, various economic valuation research and studies have been undertaken in the context of WFD implementation in recent years. This implies that while challenges exist in terms of establishing the scientific basis for valuation studies, they are most likely to have helped to improve and refine methods, particularly in terms of improving inter-interdisciplinary understanding and coordination. Moreover, the practical application of economic valuation has largely helped identify gaps in WFD science which are key to policy-making and implementation.

3.3 Economic valuation methods and practice

The role for (non-market) economic valuation in the implementation of WFD is discussed in Section 2. Recent methodological developments are presented here together with empirical examples illustrating the approaches and results (Section 3.3.1), aggregation (Section 3.3.2), developments in value transfer (Section 3.3.3) and the implications of these developments for future economic valuation (Section 3.3.4). Summary information about the referenced studies can be found in Annex 1.

3.3.1 Recent developments in economic valuation methods

Developments in economic valuation methods since WATECO have mainly been responses to the challenges faced in empirical experience and the need to refine the methods to better reflect the context-specific nature of economic values (as discussed in Section 2.2). These can be summarised as:

- Better presentation of uncertain and complex scientific information, such as the outcomes that result from improvements in water quality (as discussed in Section 3.2), so that the

[21] A particular issue with the lack of information on the confidence and precision of monitoring results is the difficulty in consistently identifying water bodies that are at risk of failing to achieve environmental objectives. Therefore although current data has been used to produce maps relating to scientific measures across Europe (http://www.eea.europa.eu/data-and-maps), the data available are not full proof and vary according to each water body. According to the 2009 Implementation Report (European Commission, 2009f) approximately 25% of operational monitoring did not start by the deadline specified (which was the end 2006) (European Commission, 2007).

resource and change can be defined more clearly to respondents (or better taken into account in the data analysis involved in revealed preference studies or value transfer). In addition to the use of scientific information for communication an increasing amount of literature highlights the importance of integrated approaches such as hydro-economic models (Heinz, 2005), or land use modelling (Morris, 2004) when considering the implications of WFD related policies;
- Better design of valuation studies so that the resulting economic value estimates are sufficiently sensitive to the scope of environmental change; i.e. the magnitude and scale of improvements in water quality. Such sensitivity is integral to the validity of value estimates;
- Better account of the influence of the availability of substitutes of a water body on the economic value of that water body – with the implication that water bodies with many substitutes within a given area will have a lower value than water bodies with few or no substitutes;
- Better testing of the influence of income – which is a key determinant of economic value in terms individuals' WTP for environmental quality. All else being equal, economic theory predicts that those with higher income would be willing to pay more to secure an improvement or to avoid degradation. Results in line with prior expectations provide a firm basis for the validity of economic value estimates and also can be an input to the discussions of affordability of measures as well as cost-benefit analysis related to issues such as disproportionate costs;
- Better sampling strategies, larger sample sizes and better data analysis to ensure that spatial variation in economic values, for example via distance-decay relationships, is captured. Distance-decay is a relationship between the distance of an individuals' residence to the water body analysed (and other substitute water bodies) that implies that the further away someone is located from a water body the less likely they would be willing to pay for its improvement (see Section 3.3.2 on aggregation; and also Box 3.3 in Section 3.1); and
- Overall improved design of questionnaire based stated preference methods so that the influence of the design (wording, visual aids and so forth) of the questionnaire itself on the economic value estimates is minimised. Such influence is also known as procedural variance – with smaller variance being preferable.

Further detail and some examples from the literature reviewed are provided below with further details in Annex 1.

Presenting uncertain and complex scientific information

Recent revealed preference studies demonstrate how data on physio-chemical and ecological indicators (see Section 3.2) can inform input to analyses. Here as data availability improves there is scope to reflect an increasing set of scientific factors to understand how they could potentially influence economic value estimates. For example, two recent UK travel cost studies utilise data on chemical classifications along with ecological descriptions of river classification (see Hime et al., 2009) and a habitat modification score[22] (see Johnstone and Markandya, 2006), which can be used as a measure of physical disturbance of rivers.

[22] This describes the extent of physical modification of a river channel (see Raven et al. 1998).

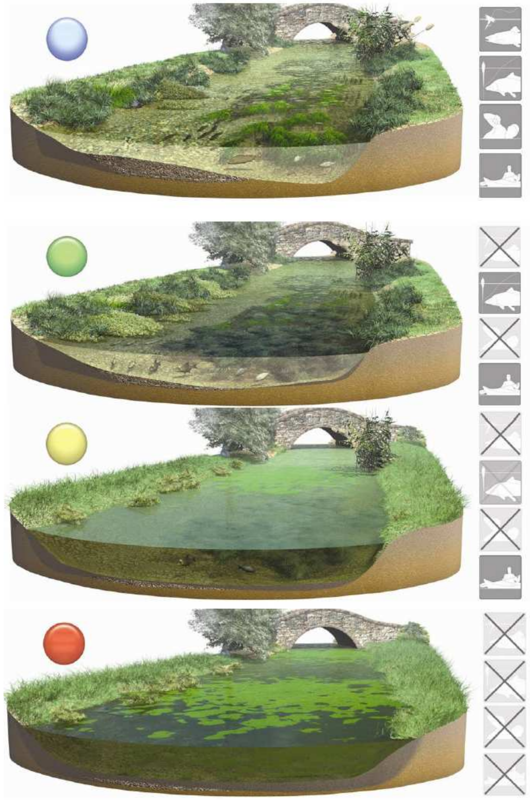
In addition a number of recent stated preference studies have explicitly addressed the challenge of representing changes in physio-chemical and ecological indicators to impacts on human populations; i.e. describing how improvements in water quality affect non-market benefits. The general approach presents survey respondents with information in a combination of formats, for example:

- Presenting summary and/or detailed text descriptions of water quality;
- The use of 'water quality ladder' (see below) and other visual aids; and
- The use of maps to show the location of changes in water quality.

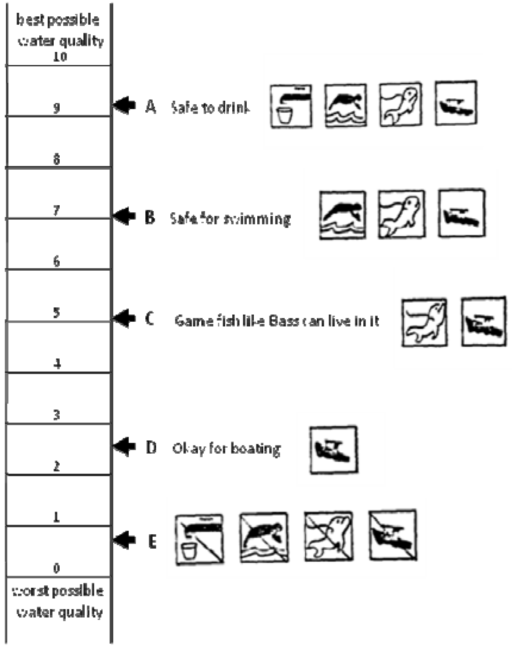
Coupled with this there is an extensive literature in relation to stated preference studies that emphasises the merits of visual as opposed to textual or numerical provision of information to respondents. (e.g., Peters et al., 2005a,b; Fagerlin et al., 2005; Zikmund-Fisher et al., 2005; Bateman et al., 2009b). Specifically these articles argue that supplementing conventional numerical representations with images significantly reduces the susceptibility of respondents to rely on heuristic rules of thumb when formulating answers, resulting in a reduced rate of anomalous responses; i.e. results that are inconsistent with prior expectations.

Use of visual approaches is still relatively new within the field of WFD valuation. However, a series of recent studies have developed water quality ladders to depict the impact of measures (e.g. Brouwer et al. (2009), QUALIWATER Project (2009), Hime et al. (2009), and Brouwer et al. (undated b). A number of these are presented in Figure 3.1. Studies that use visual aids typically rely on a multi-disciplinary approach, with much closer involvement of specialists from hydrology, ecology and engineering subject areas.

Figure 3.1: Examples of different water quality ladders used within different valuation within the context of the WFD.



Source: Reproduced from Hime et al. (2009). Used within Aquamoney and ChREAM



Source: Resources For the Future (RFF) water quality ladder reproduced from (Vaughan, 1986; Mitchell and Carson, 1989; Carson and Mitchell, 1993).

	Option A	Option B	Current situation
Flood frequency	Once every 25 years	Once every 25 years	Once every 5 years
Water quality	Good	Very good	Moderate
Increase in water bill	€ 3	€ 10	€ 0
I prefer:	Option A ☐	Option B ☐	Neither ☐

Source: Reporduced from Brouwer et al. (undated).

Source: Example of options reproduced from QUALIWATER Project (2009).

Hime et al. (2009) provide a particular example of the task of translating the scientific detail of water quality improvements (in terms of technical parameters of water quality including BOD, ammonia levels, flow, ecological indicators, etc) to 'condensed' descriptive information that can be presented in stated preference questionnaire to respondents. Box 3.5 details the scientific basis that underlies the water quality ladder developed by Hime et al.

The issue of scientific content versus the use of simple information as a description of environmental attributes is also considered by Hasler et al. (2009). This acknowledges the helpfulness of using a water ladder approach but also identifies the difficulties of relating information back to scientific indicators. In addition, the engagement with stakeholders at an early stage of a valuation study design process is also noted as beneficial for such studies (Rinaudo, 2008).

Visual prompts in questionnaires also include maps. Here the growing availability of GIS (see Section 3.1) has enhanced the way in which environmental goods and changes in their provision can be communicated to respondents. The use of maps as part of economic valuation studies within the context of the WFD is important given the issues that have been faced with regard to the aggregation of WTP estimates across populations, but also because these maps effectively communicate the exact location of where an environmental change is expected (e.g. Rinaudo, 2008; and Sėmeniene, 2007). Other studies have used such maps to illustrate the locations of water bodies that are either at risk of not meeting GES, or where the areas that may be improved to GES are situated (e.g. ChREAM project; NERA and Accent, 2007; and Hasler et al., 2009b). Figure 3.2 shows examples of the map based illustrations that have been used by some recent non-market valuation studies in the context of WFD implementation.

Box 3.5: Characterising river water quality for a stated preference study (Hime et al., 2009)

Hime et al. (2009) define four levels of river water quality based upon chemical, physical, flora and fauna characteristics. While it is recognised that to some considerable degree the pathways linking pollution to ecological impact is still the subject of ongoing research (UKTAG, 2007), the study contends that this does not prevent the use of stated preference studies from valuing certain states of the world on the assumption that ongoing research will indicate how such states might subsequently be attained.

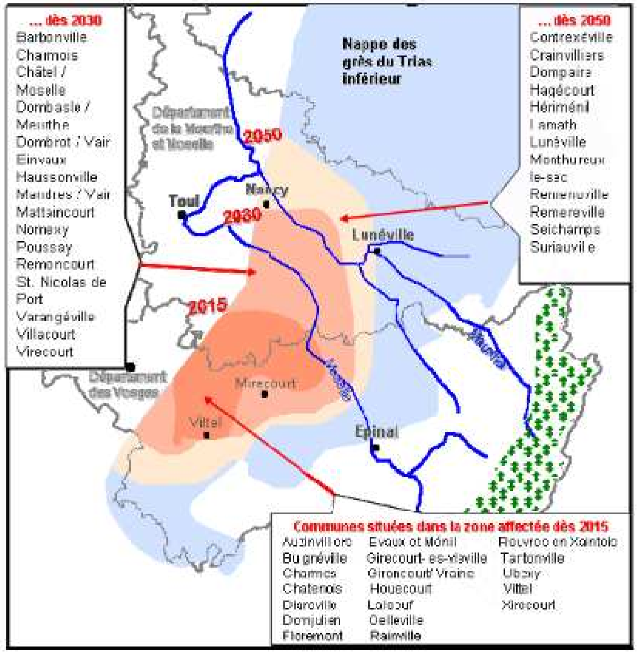
Characterisation of river water quality			
Highest quality BLUE	GREEN	YELLOW	Lowest quality RED
	Chemistry		
BOD Limit < $4mgl^{-1}$	BOD Limit >= $4mgl^{-1}$ and < $6mgl^{-1}$	BOD Limit >= 6 and < $8mgl^{-1}$	BOD > $8mgl^{-1}$
Freshwater fish directive limit game BOD Limit = 3 mgl^{-1}		Freshwater fish directive limit BOD Limit = 6	
Ammonia < 0.6 $mgNl^{-1}$	Ammonia < 1.3 $mgNl^{-1}$	Ammonia < 2.5 $mgNl^{-1}$	Ammonia > $2.5mgNl^{-1}$
	Assumed physical state		
Patches of faster flow	Lower flow rate; no fast patches	Low flow rate	Very low flow rate
Gravel / pebble substrate; No algae on rocks	Small gravel and sand substrate; little algae on rocks	Mud; algae on rocks	Mud; algae on rocks
	Aquatic plants		
No algae; Water plants (described below); Good clarity	Greater amount of aquatic plants taking up more of the open space; Slight increase in water turbidity	Less aquatic plants with increases in algae; Further increase in turbidity and green hue to the water, Small number of algal mats	Large degree of siltation; Turbid water with a brown hue; Algal mat covering the substrate
Vegetation cover= 50%	Vegetation cover= 60%	Vegetation cover= 70%	Vegetation cover= 85%
Rhynchostegium riparoides (20); *Myriophyllum alterniflorum*[1] (20); *Leptodictyum (Amblystegium) fluviatile* (10); *Fontinalis antipyretica* (10) *Ran. penicillatus ssp. Pseduofluitans*[1] (4); *Pellia endiviifolia* (2); *Apium nodiflorum* (3); *Cal. hamulata*[1] (10); *Leptodictyum (Amblystegium) riparium* (3);*Rorippa nasturtium-aquaticum* (3); *Callitriche platycarpa*[1] (5); *Callitriche stagnalis*[1] (2); *Potamogeton*	*Apium nodiflorum* (20); *Leptodictyum (Amblystegium) riparium* (20); *Potamogeton crispus* (10) *Rhynchostegium riparoides* (15); *Myriophyllum alterniflorum*[1] (10); *Leptodictyum (Amblystegium) fluviatile* (5); *Fontinalis antipyretica* (5) *Callitriche hamulata*[1] (2); *Callitriche stagnalis*[1] (8);	*Apium nodiflorum* (5); *Leptodictyum (Amblystegium) riparium* (50); *Potamogeton crispus* (5) Algae *Cladopora etc. (40)*	algae *Cladopora etc.(100)*

Characterisation of river water quality			
Highest quality BLUE	GREEN	YELLOW	Lowest quality RED
crispus (2); *Potamogeton natans*[2] (6)	*Potamogeton crispus* (5)		
Fish - general assessment			
Game and coarse	Same or higher coarse numbers, few game fish	Lower coarse fish, no game fish.	Very few fish
Fish - species breakdown			
Brown trout (mid) central area fastest flow	-	-	-
Minnow (high)	-	-	-
Vendace (mid)	-	-	-
Barbel (mid)	-	-	-
Chub (mid)	-	-	-
-	Bream	Bream	-
-	Common Carp (mid) mid-water	Common Carp (low) Whole area - not edges (silt)	-
-	Perch (less) mid-water	-	-
-	Roach (mid) mid-water	Roach (high) Whole area - not edges (silt)	-
-	Rudd (mid) mid-water	Rudd (low) Whole area - not edges (silt)	-
Pike (v. low)	Pike (v. low) mid-water	Pike (v. low) Whole area - not edges (silt)	-
-	-	Stickle Back (mid) edges as small fish, not where there is too much silt	-
Uses			
Game fishing	-	-	-
Coarse fishing	Coarse fishing	Restricted coarse fishing	-
Swimming	Swimming	-	-
Canoeing & boating	Canoeing & boating	Canoeing & boating	-
Bird watching	Bird watching	Bird watching	Restricted bird watching

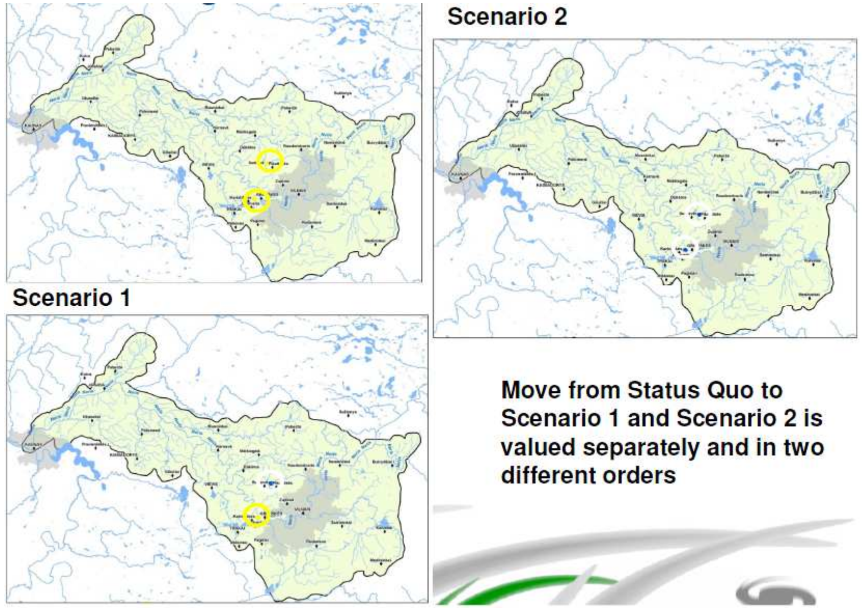
Source: adapted from Hime et al., (2009)
Notes: Biological oxygen demand (BOD) and ammonia levels from UKTAG (2007) and EA (2007a,b). Aquatic plant frequency and species from Holmes et al., (1999) and JNCC (2005)
1 = Aquatic plant species which occur at up to 0.5m depth (EA, 2007c,d,e);
2 = Aquatic plant species which occur at 0.5 - 1.5m depth (EA, 2007c,d,e).
Numbers in parentheses to the left of plant community composition show the percentage breakdown of the total vegetation cover. Physical assessments and fish species information from EA (2007f,g).

The complexity of information given in the characterisation is too high to reasonably allow its unadjusted use as survey information. It does however provide the basis for the generic water quality characteristics that are represented on the water quality ladder shown in Figure 3.1 that is used within the Aquamoney and ChREAM research projects.

Figure 3.2: Examples of map based illustrations used within non-market valuation studies within the context of WFD

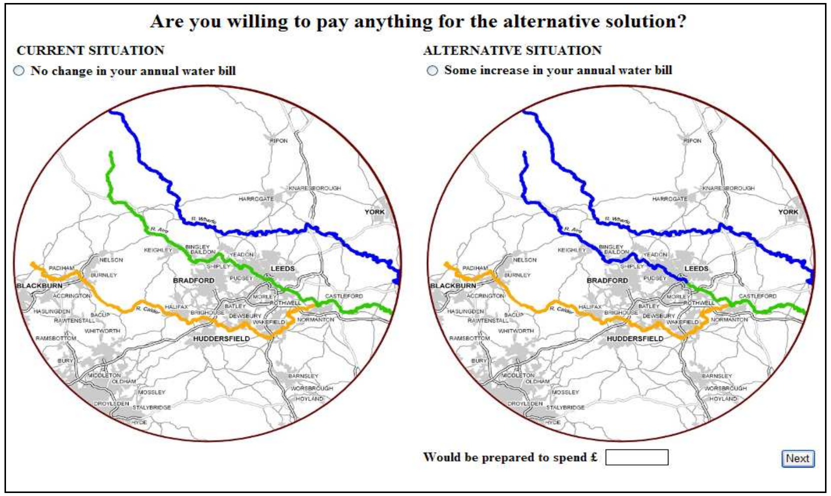


Source: Reproduced from Rinaudo (2008)

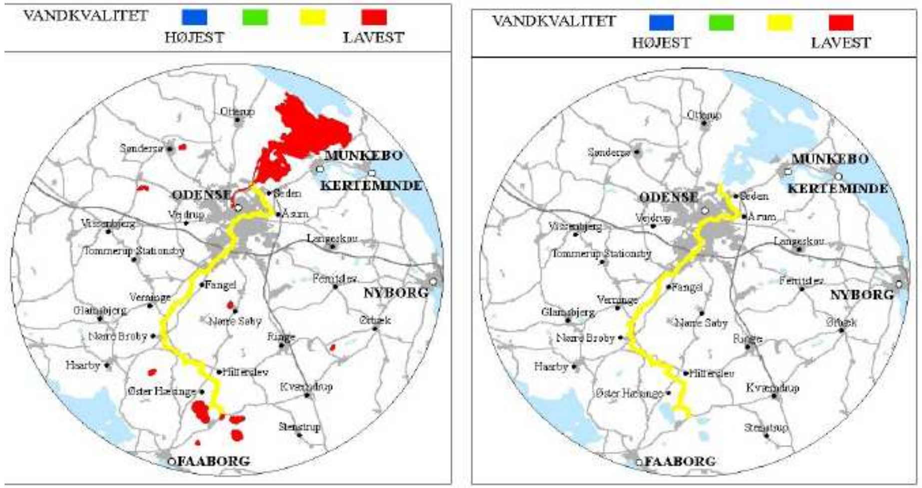


Source: Reproduced from Semeniene (2007)

Figure 3.2: continued



Reproduced from eftec (2010a)



Reproduced from (Hasler et al. 2009)

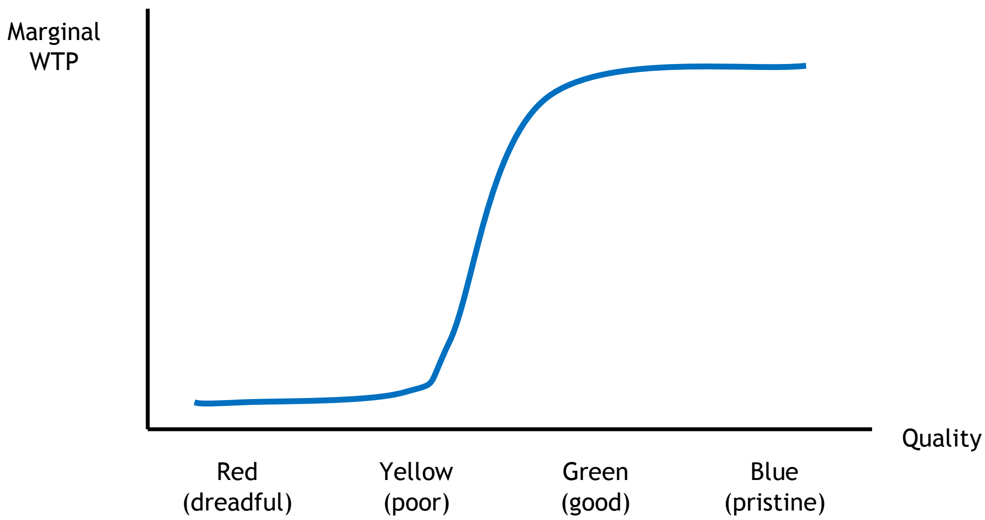
Scope

A key aspect of validity testing of valuation studies is the assessment of scope sensitivity; i.e. that larger improvements in environmental quality, all else equal, should give rise to larger WTP. Both the Aquamoney and ChREAM[23] projects explore this issue in some detail in the context of the WFD implementation. They highlight that there are very few environmental resources for which there are prior expectations regarding the *degree* of increase in WTP that might be reasonable. Indeed, given that individuals may become satiated with environmental goods (e.g. it might be reasonable for a respondent to think that once they had access to one nearby clean river they were not willing to pay anything for a second), the only definite expectation that economic theory provides is that marginal WTP should not be negative for an increase in provision of a good (see Box 3.6).

Box 3.6: Relationship between marginal WTP and scope of environmental improvement

The ChREAM project highlights that a key need for valuation studies focussed on implementation of the WFD is to estimate marginal valuation functions. This permits investigation of the relationship between marginal values and the scope of the good, which in turn should inform validity testing assessments of the results of studies.

The basic premise is that as the scope of the environmental improvement increases so the cumulative value of that change should also increase. However, there is no reason to suppose that this will be described by a linear relationship, and assumptions of linear relationships in this context can often be gross simplifications. In fact it may be expected that the marginal value is a function of both the baseline quality and also the size of provision change. The figure below provides a stylised illustration of the suggested non-linear relationship.



[23] See: http://www.uea.ac.uk/env/cserge/research/relu/index

Box 3.6: continued

Initial results from the ChREAM project indicate that there is indeed empirical support for the suggested non-linear relationship, although this is subject to further testing. This shows that marginal WTP is low for moving from very poor quality ('dreadful') to poor quality ('poor'), reflecting that in either of these states water bodies offer very few opportunities to human populations to derive use (and non-use) values. However marginal WTP is much higher for the change from poor to good. The curve then indicates that further improvements in quality from good to pristine does not result in significant changes in WTP, reflecting a satiation point with environmental quality.

In instances where a linear relationship is assumed - because a valuation study is not explicitly designed to test for the scope sensitivity - use of constant marginal WTP values could lead to error in estimating aggregate environmental benefits. For example if the linear relationship is approximated on the change from poor to good quality, this will likely result in over-estimates of aggregate values of improvements from very poor to poor quality, and also from good to pristine quality.

The ChREAM project also highlights that other factors will influence marginal values, including the availability of substitutes and complements (see below). Since these typically vary across locations, marginal value functions have to be spatially explicit; i.e. they will change between different locations and geographical areas. Therefore the marginal value of an additional kilometre of river achieving GES will not be a constant across a regional the national level.

Substitutes

Similar to issues of scope sensitivity, valuation studies should also control for the influence that substitutes can have on valuations. Here accessibility measures can also determine whether the WTP for an improvement in quality at a water body should decline as the availability of suitable substitutes rises. A practical issue here concerns the definition of substitutes that has been examined by recent studies. Reliance upon respondents' assessment of substitutes involves some challenging questions for survey respondents, along with the assumption that respondents are aware of substitutes (Powe et al., 2004) and generates variables which are not available for subsequent value transfer analyses. Johnstone and Markandya (2006) advocate the use of GIS to help determine local substitute sites while Jones et al. (2010) use GIS to calculate distances to multiple potential substitutes. Similarly, ChREAM (2007-2010) determined the number of substitute sites available to respondents by considering all access points along the main river within the case study area and determining their distance from an individual respondent via GIS. Rinaudo (2008) identifies that the presence of substitute resources (for the production of drinking water) has a negative effect on the WTP for protecting groundwater resources in the Rhine River Basin District. The same result is prevalent in Hasler et al. (2009), where, as distance to the coast (considered to be a substitute) increases, WTP for river water quality also increases. Bateman et al. (2009) report a joint analysis of the valuation data from all Aquamoney water quality valuations and show that this type of substitution distance decay effect is highly significant across all.

Income

While a variety of socio-economic and demographic variables may empirically influence economic values, theoretical expectations emphasise the role of income in terms of the budget constraints it may impose on WTP. It is therefore plausible that (all else being the same) those with higher incomes will have higher WTP. Income is a standard predictor variable and is almost always included within valuation studies. An illustration of the impact of the income variable is most noticeable in valuation studies that cover respondents from different countries with a high variance in the average income. This is particularly true within the Aquamoney project (see Brouwer et al. undated a). In addition, Ready et al. (2002) show that WTP for environmental and water quality increases as income increases for respondents in Latvia. Furthermore a number of authors stress the importance of considering the affordability of proposed options both in terms of householders and industry (for example Interwies et al., 2005).

Procedural invariance

As stated above economic theory indicates that individuals should have well formed preferences, conforming to standard assumptions and robust against what theory would see as irrelevant issues, such as the way in which a given question was framed. Within the context of the WFD there has been little work to determine whether WTP values are affected by different valuation techniques as these tend to be the focus of general academic research on environmental economics. However, research (e.g. Ariely et al., 2003; Kahneman, 2003; Bateman et al., 2005b, 2007) has found results in stated preference studies that sometimes suggest individuals may determine their assessments of certain goods by inferring information from the manner in which a question is framed, and not solely by reference to what might be recognised as their economic preferences. Such issues should be considered by future applications of stated preference studies in relation to the WFD implementation.

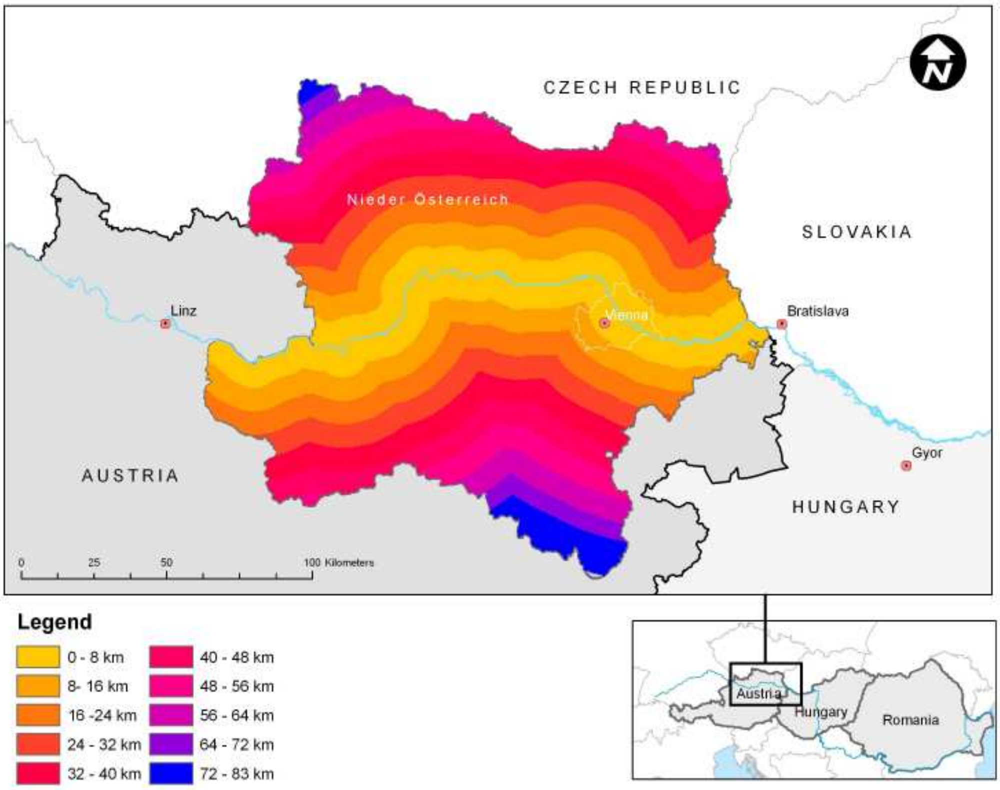
3.3.2 Aggregation of economic values

Use of economic valuation in the context of Article 4 of the WFD and estimating environmental benefits of attaining GES for disproportionate cost assessments requires the estimation of total values aggregated over the population of interest (i.e. affected users and non-users). Aggregation is not necessarily a straight-forward process and there is as much potential for error in estimating aggregate benefits as there is in estimating unit economic values. In particular there are two interlinked considerations that stem from the expectation of spatial sensitivity in economic values for non-market goods and services associated with improvements in water quality:

i). Whether it is valid to assume a constant unit value across the affected population or whether it is necessary to account for variation in unit values (per person or household) in aggregation – or whether benefits (and hence values) decline with distance from a water body (known as distance decay and is illustrated in Box 3.3 above in the context of using GIS and Figure 3.3 below); and
ii). The relationship between the provision of the good and the extent of the affected population; i.e. do improvements in water quality increase the beneficiary population?

These considerations draw together a number of the factors addressed in Section 3.2.1. These points are also addressed in a series of studies that have been undertaken in relation to WFD implementation; particularly Aquamoney and ChREAM.

Figure 3.3: Illustration of distance-decay effects for good water quality in Austria



Source: Reproduced from (Brouwer et al. undated a)

Specifying the affected population

Economic valuation studies must identify the affected population and whether and how the affected population may change with changes in the provision of the good to be valued (e.g an improvement in water quality). In considering the extent of the affected population for the purposes of aggregation it is important to distinguish between the administrative jurisdiction, concerning some political administrative area, and the economic jurisdiction incorporating all individuals who benefit from the provision of the good, in terms of those who hold non-zero economic values (i.e. positive willingness to pay). Ordinarily the administrative and economic jurisdictions do not match well when aggregating at the local or regional scale. Assessments at the national level generally limit valid population for aggregation to the national population and therefore encompass within them the valid economic jurisdiction for the assessment (i.e. national residents).

Issues with the use of administrative jurisdiction

The use of the administrative jurisdiction for the purposes of aggregation will not be appropriate in cases where not all individuals within that spatial area have a positive economic value for the change in provision of the good. This is especially important where a distance decay relationship is detected[24]. The risk here is that a unit value from some subset area is used as the basis for estimating aggregate values for the entire jurisdiction.

In principle the use of a sample mean WTP value need not necessarily lead to biased estimates of aggregate values. If a representative sample is drawn from the entire economic jurisdiction (or indeed some larger sample area) then multiplying the sample mean WTP by the population of the sampled area should give an accurate estimate of aggregate values in that sampled area. In addition, given that Member States report statistical information annually for the Eurostat database[25] it is relatively easy to consider administrative jurisdiction. For the UK study by NERA and Accent (2007) several thousand respondents across different river basin districts in England and Wales were asked their value for water quality improvements across *all* rivers in England and Wales. Here the use of the total population of England and Wales for the calculation of aggregate values was appropriate for the context of the valuation.

Furthermore other studies have sought to correct for the presence of zero WTP values by adjusting population estimates. Eggert and Olsson (2004) undertook a choice experiment with residents from the Swedish west coast to estimate the economic benefits of improved coastal water quality. The total benefits were calculated for the study area population, i.e., 20% of the total population of Sweden, and adjusting for the fact that non-respondents (40% of those surveyed) were assumed to have zero WTP.

Establishing the economic jurisdiction for the benefits of WFD implementation

Within the context of WFD implementation there are now a growing number of studies that account for the distance of individuals from resources in aggregation of benefits, including: Bateman et al. (2006); Bliem et al. (2009); Brouwer et al. (undated a); Hasler et al. (2009). In Bateman et al. (2006) data are taken from a face-to-face contingent valuation survey of WTP for water quality improvements to the River Tame in Birmingham, UK. In addition to determining respondent WTP, GIS was used to calculate distances from each respondent's home address to the River Tame to determine the boundary of the economic jurisdiction (the point at which WTP falls to zero).

In Bateman et al., the analysis was then used to provide a spatially sensitive estimate of aggregate benefits for the economic jurisdiction that was compared with the approach to estimating aggregate benefits for an administratively defined jurisdiction (i.e. multiplying those households which live within the relevant local water company area by the sample mean WTP). The population within the economic jurisdiction is substantially smaller than that of the administrative jurisdiction suggesting immediately that the latter is liable to lead to over-

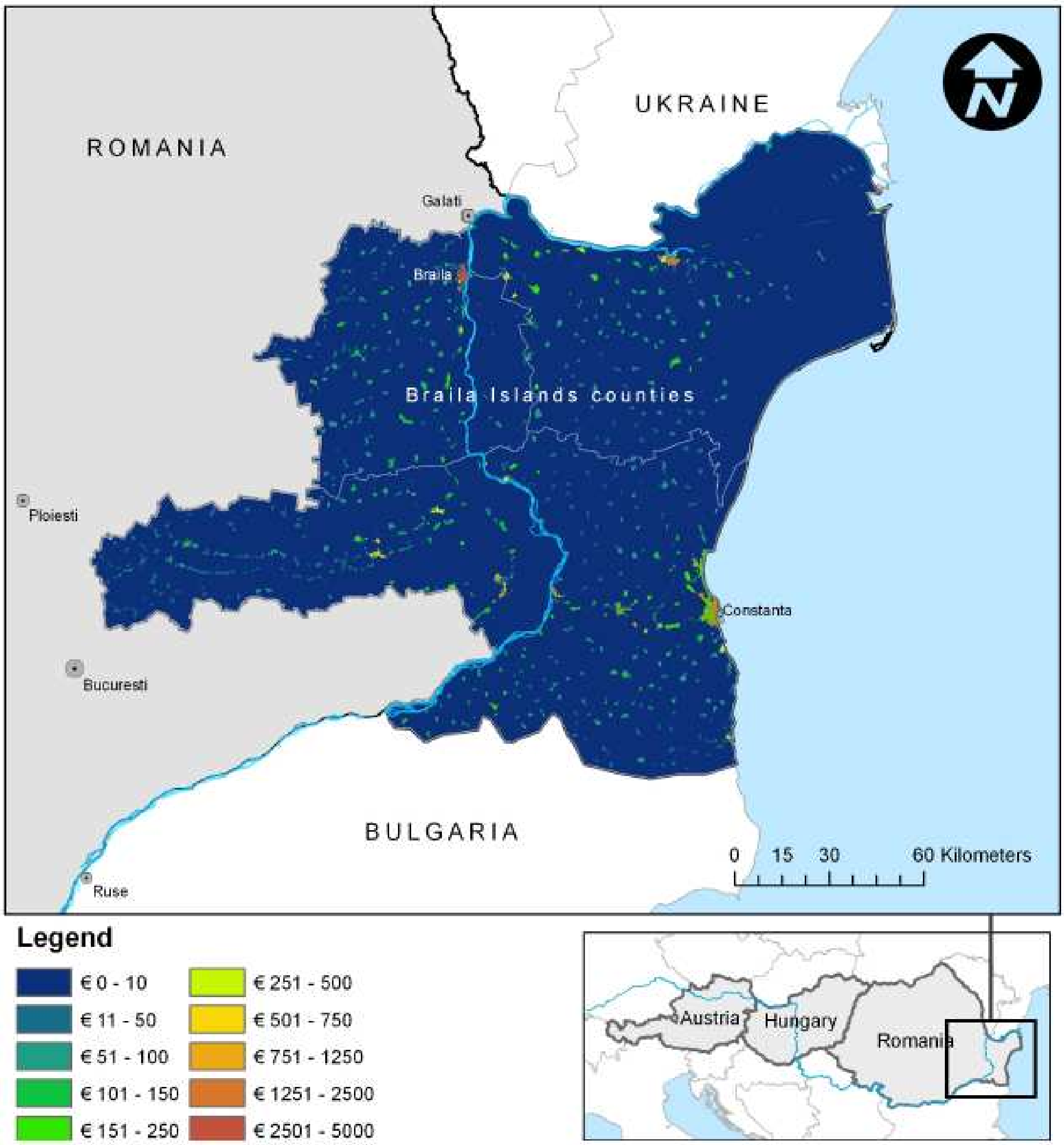
[24] Distance decay relationships may not always be significant. For example Šceponaviciut et al. (2010) found that distance was not significant in their Lithuanian study of water quality improvements while Aulong et al. (2006) found that WTP did not differ between those that lived near to and further away from a groundwater resource.

[25] See http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/

estimation of aggregate benefits as it includes households for which WTP is zero. Here the administrative jurisdiction method led to estimates which were just over double that for the economic jurisdiction for the large improvement and more than two and a half times too high for the small improvement. These errors dwarf those due to uncertainty in the estimate of mean WTP which range from 17% for the large improvement to 20% for the small improvement.

More recently Aquamoney (Brouwer et al., 2009) provide guidelines as to how to account for distance decay relationships within valuation models. Several case studies that account for the effect of distance on the calculation of aggregate values are presented, including: Bliem et al. (2009) who account for the distance of respondents from an Austrian river as part of their valuation to determine the preferences for river restoration; and Hasler et al. (2009) who include distance decay within a study to determine the benefit of improved surface water quality for the Odense river in Denmark. For the latter case study WTP did not fall to zero within the boundary of the case study site. However Hasler et al. were able to calculate this boundary as 144km. Finally, Brouwer et al. (undated b) use a GIS to determine the economic jurisdiction for the beneficiaries of improved water quality in the Danube River across three countries. As demonstrated by Bateman et al. (2006), Brouwer et al. (undated b) compare the total value calculated by aggregating the sample mean WTP across the population associated with administrative areas, to the total value calculated when accounting for differences in socio-economic factors and distance decay. As with Bateman et al. (2006) the final results show that aggregating mean values over the administrative jurisdiction results in the total value of water quality improvement across the Danube was over-estimated by 30% on average (max by 50% in Romania). Figure 3.4 shows the estimated TEV of river restoration to very good water quality for Romania. Distance decay is accounted for by multiplying the estimated distance-decay factor by the distance of each grid cell from the river (kms) and then multiplied by the number of people.

Figure 3.4: Value of very good water quality in Romania adjusted for distance-decay



Source: Reproduced from Brouwer et al. (undated b)

3.3.3 Developments since WATECO - value transfer

A number of recent studies have provided guidelines for undertaking value transfer – to help balance the practical advantages of value transfer with it limitations – with a strong focus on valuation of water quality improvements. These include the Danish Environmental Protection Agency (Navrud, 2007), Defra in the UK (eftec 2010a; 2010b), and also the Aquamoney project (Brouwer et al. 2009). In addition, several studies have attempted to test the validity of value transfer for specific case study sites by collecting primary data relating to WTP values for all sites and applying the economic value functions across sites and comparing these results to those obtained from primary research[26]. For example Hanley et al. (2006) reject the use of value transfer due to the level of transfer errors and issues relating to site equivalence. However, the need for the use of value transfer as a tool for valuation within the context of the WFD is acknowledged in Meyerhoff and Dehnhardt (2007) and Hime et al. (2009), with the need for 'minimum' transfer errors also suggested in Bateman et al. (2009).

Analysis undertaken for the Aquamoney project includes a comparison of the two main approaches to value transfer – unit value transfer and value function transfer – in the context of valuing water quality improvements arising from implementation of WFD in five European countries (Belgium, Denmark, Lithuania, Norway and the UK)[27]. In particular the standard expectation - see for example Pearce et al. (1994) - has been that more sophisticated approaches (i.e. value function transfer) that allow the analyst greater control over differences between the policy good and study good context should yield lower transfer errors than the more basic approach (i.e. unit value transfer).

Outcomes from the Aquamoney analysis add two important qualifications to the standard expectation, namely that: (i) any value function which is to be used for transfer purposes should be carefully specified to focus on factors which are generic across the study and policy good contexts; and (ii) value function transfers, even when using well specified functions, may still not outperform unit value transfers if conducted for changes and contexts which are very similar to those given in source studies. In particular when transferring between similar contexts and goods then unit value transfer can yield lower transfer errors than function transfer, but when transferring between relatively dissimilar contexts the variation within study source and/or policy contexts means that the value function transfer can yield lower errors than unit value transfer (Bateman et al., 2009a). Moreover the analysis shows that when value function transfer is more appropriate, it is important to use a function specified for transfer purposes. The use of models that give the best statistical fit to the study context may yield higher transfer errors than a model specified to only contain those factors which are likely to be of generic importance to both the study and policy contexts; i.e. the scope of the change in provision of the good, the distance from resource being valued, the availability of substitutes and income as detailed in Section 3.3.1.

A further aspect of the Aquamoney project is the presentation of the results of value transfer on maps in order to communicate the spatial distribution of benefits derived from improvements in water quality. The approach applied by the Aquamoney project is to use a meta-analysis function[28] and GIS (see Section 3.1.2) to estimate benefits of changes in ecosystem services provided by water at the level of individual beneficiaries (i.e. households). A proposed methodology for spatial value transfer is provided:

[26] A key issue is the degree of transfer error that arises from value transfer. This is the extent to which economic value estimates differ between those that would be applied via value transfer and results that would be obtained from a primary valuation study. This can be tested via specifically designed studies which estimate economic values for a range of sites and then estimate the degree of transfer error when the value(s) for one site are transferred to the other sites.

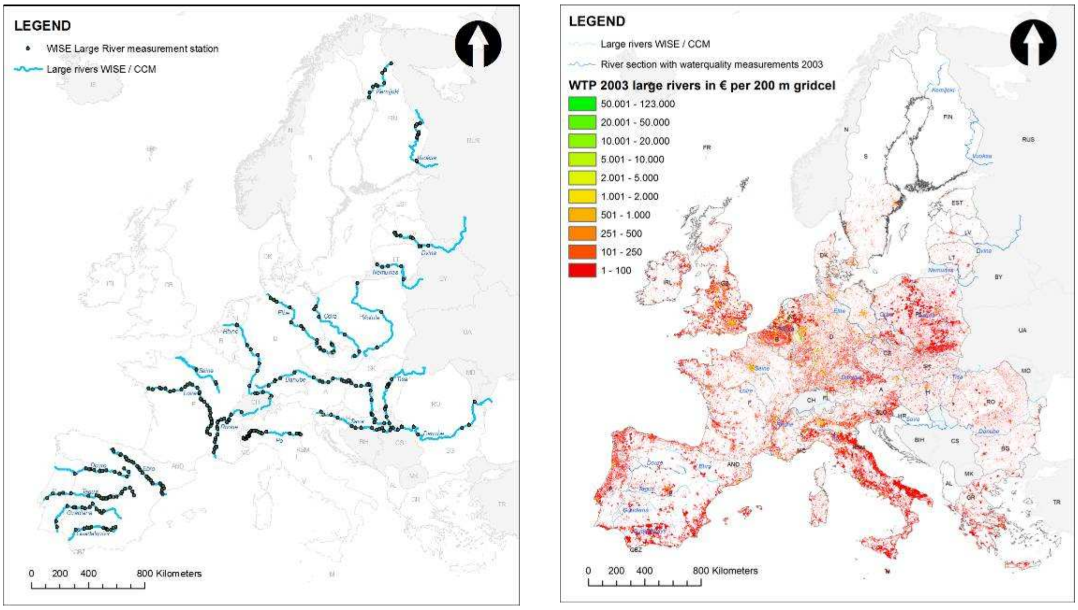
[27] See eftec (2010a) for further detail on different approaches to value transfer, including unit value transfer and function transfer.

[28] Meta-analyses collate information from multiple studies, providing a quantitative synthesis of existing literature. In the context of economic valuation studies, this enables the investigation of the range of economic value estimates from different studies to identify key factors that influence estimated values. For further detail see Brander et al. (2008).

1. Use a meta-analysis of existing water quality valuation studies to estimate a value function that relates the value of water quality improvement to variables for the site (initial water quality, change in water quality) and affected population (income, distance to water body);
2. Use GIS to specify a scenario for water quality improvement in the water bodies that are of policy interest;
3. Combine the GIS and estimated value function to estimate the mean value of water quality improvement for households located in each grid cell in the geographic area of interest; and
4. Aggregate across all households in each grid cell to estimate of the total value of benefits (or costs) resulting from the described water quality improvement. This information can be mapped to represent the spatial distribution of welfare effects of water quality improvements.

The Aquamoney project illustrates this methodology in a case study valuation of achieving GES water quality in the 20 largest European rivers. The selection of these rivers is based on the WISE definition with catchments larger than 50,000 km^2. The value function employed in this analysis uses a 10-point water quality index, with GES assumed to have a value of nine. The value function includes a distance decay effect in order to adjust values for the distance between beneficiaries and the nearest water body included in the analysis. Information on water quality for segments of the 20 rivers included in the case study is obtained from the WISE river monitoring stations shown in Figure 3.5(a). The results of the analysis (Figure 3.5(b)) show naturally a high correspondence between the density of beneficiaries (i.e., in urban areas) and the spatial distribution of values associated with water quality improvements. It also shows that values are in general higher when beneficiaries are closer to the selected rivers and when changes in water quality are large.

Figure 3.5: Aquamoney example of spatial value transfer



(a) WISE River measurement stations of European Large Rivers

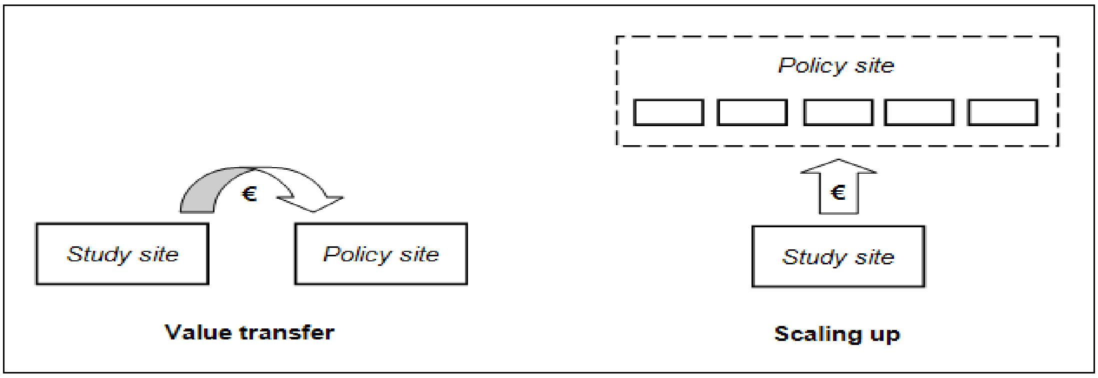
(b) Value map for water quality improvements in Europe

Scaling-up ecosystem service values

The term 'scaling-up' is used to emphasise that existing value data, which are generally for small scale geographic settings (e.g. one water body), are used to estimate values at a larger geographic scale, for instance at the regional, national or global scale. Recent research for the European Environment Agency (Brander et al. 2008; Ghermandi et al., 2008) has addressed whether and how existing data on the economic value of ecosystem services can be 'scaled-up' to assess the value of changes in the provision of ecosystem services that occur at large geographic scales (e.g. the benefits of improved water quality at a regional level).

Scaling-up builds on the methods that have been developed for value transfer, and can be seen as an extension of value transfer. Value transfer is usually applied on a case-by-case basis, but in a scaling-up exercise, economic values from a particular study site (or sites) are extrapolated to a larger geographical setting (see Figure 3.6).

Figure 3.6: Scaling-up versus value transfer



The key additional consideration in scaling-up values, as compared to value transfer, is that changes in many water bodies in a region will affect the scarcity and therefore value of all other water bodies in that region. In other words, it is necessary to control for non-constant marginal values across the stock of a water body. In general at the margin, a small change in a water body (e.g. the loss of a small area) will not affect the value of services from other ecosystem sites. Non-marginal changes in a water body, however, will affect the value of services from the remaining stock of water bodies. If this effect is not accounted for, it is likely that value transfers will under-estimate the total value of a negative change (or conversely over-estimate the value of a positive change). Appropriate adjustments to marginal values to account for large-scale changes in ecosystem service provision therefore need to be made.

The European Environment Agency project proposes an approach to scaling-up ecosystem service values that combines the use of meta-analysis of primary valuation studies with a GIS. This approach allows the effect of ecosystem scarcity to be taken into account as well as other important spatially defined factors, including the size of each ecosystem site and the proximity and purchasing power of (potential) beneficiaries of ecosystem services. Value estimates are produced at a site specific level, which can then be aggregated to the relevant geographic scale of analysis. This approach has been illustrated in a case study valuation of change in ecosystem services from European wetlands and is shown to be practicable for valuing very large numbers of ecosystem sites and to enable the adjustment of transferred ecosystem service values to reflect variation in important site-specific and context-specific factors.

4. CONCLUSIONS AND RECOMMENDATIONS

This final Section concludes the report with a summary of findings with respect to the study's objective (Section 4.1) and presents recommendations for the future use of (non-market) economic valuation in relation to implementation of the WFD (Section 4.2).

4.1 Developments in economic valuation and other contributing fields such as environmental sciences since the WATECO guidance

Implementation of the WFD requires a multi-disciplinary approach to develop River Basin Management Plans. The role for economic valuation within this process is primarily concerned with the assessment of costs and benefits, and in particular valuing in monetary terms non-market environmental and social costs and benefits. The main aspects of the WFD which may require consideration of non-market costs and benefits are Article 4 in relation to exemptions and disproportionate costs, and Article 9 in estimating environmental and resource costs in cost recovery assessments. Economic valuation may also be a useful input to assess the cost-effectiveness of programme of measures under Annex III and Article 11, by providing an account of wider environmental impacts of measures (e.g. climate change, air quality, health, waste, land use, biodiversity, etc.). There may also be scope for applying economic valuation to Article 5 and the economic characterisation of river basins in terms of highlighting the significance on non-market outcomes.

Practical application of economic valuation methods builds on qualitative and quantitative assessments of environmental impacts, which are informed by scientific and technical studies. Economic value estimates are context-specific and this requires that these studies provide the basis for valuation by establishing the details of the resource to be valued and the change in its provision; for example by documenting the baseline status of a water body and determining how implemented measures will improve the ecological status, including the location(s) and timing of improvements, and the effects to various uses and non-market outcomes.

Recent developments in terms of the ecosystem services approach (for example the MEA and TEEB) highlight the complex functioning of ecosystems and how market and non-market benefits derived by human populations are reliant on underlying ecosystem services. While to date there has been little 'integration' of the ecosystem services approach into WFD implementation, it does offer a framework for future application, particularly in terms of systematically establishing the range of environmental outcomes from particular actions. Article 4 of the WFD in particular requires that assessments of exemptions for aspects such as HMWBs, AWBs and new modifications be based on a full account of costs and benefits of measures or alternative means of achieving the same uses of water bodies. Likewise measures to achieve GES or GEP may also have wider environmental effects and these may not necessarily be limited to aquatic ecosystems (e.g. potential climate change, air quality, health, waste, land use, biodiversity, etc. impacts).

In general adopting an ecosystem services approach should not imply greater qualitative, quantitative and monetary evidence assessment needs. Implementation of the WFD should mean that the need for such data and information is already recognised. Rather the approach further establishes the multi-disciplinary requirements of WFD implementation. In turn this can imply greater transparency in the assessment of costs and benefits, providing explicit acknowledgement of gaps in evidence and helping to avoid the risk of double-counting in policy analyses such as Impact Assessments and CBA which apply the results of economic valuation studies.

Review of recent developments in 'WFD science' suggest that the key challenges for economic valuation lie primarily in linking changes in physio-chemical and hydro morphological processes and indicators that result from WFD measures, to changes in ecological indicators, and ultimately the provision on non-market benefits. Underlying this there are gaps in both scientific understanding of processes and data, although these are being addressed by continuing modelling and monitoring initiatives. However, as recent economic valuation studies have demonstrated, these challenges can be overcome, demonstrating the importance of multi-disciplinary collaboration. This has resulted in developments such as 'water quality ladders' which link economic values to 'measurable' indicators of ecological status and also, for stated preference studies, improved the way in which typically complex information on water quality improvements is presented to respondents.

Use of economic valuation in WFD implementation can also be improved by application of GIS. This provides a consistent basis for accounting for the context-specific, and in particular, spatial variation in economic values. Recent research projects such as Aquamoney and ChREAM in particular demonstrate the 'state-of-art' in valuation in this regard, highlighting how the benefits of attaining GES vary according to the scope of environmental improvement, the availability of substitutes and the proximity to and socio-economic characteristics of affected populations. This has key implications for aspects such as disproportionate cost assessments under Article 4 and the estimation of total benefits (or costs) of measures, indicating that great care is required in aggregation of economic values to avoid, in particular, over-estimation of benefits.

Finally, recent developments in economic valuation have also sought to improve the scope for the use of value transfer. A number of studies have highlighted the importance of refining value transfer applications since, from a practical perspective, it represents the most feasible approach to estimating the value of non-market costs and benefits in the context of WFD implementation, where valuations are required for numerous water bodies and sites across MS. The Aquamoney project in particular demonstrates 'good practice' for value transfer, with the explicit objective of assisting WFD implementation.

Overall, the scope for using economic valuation in the context of WFD implementation relates to a distinct set of policy questions that are explicitly concerned with the monetary valuation of non-market costs and benefits. This role was established in WATECO and in general subsequent guidance has not expanded upon this. In part this is because WATECO provides a fairly high-level interpretation of WFD requirements. While specific case studies are used to highlight principles, the recognised context-specific nature of economic values implies that it is not possible for a guidance document to identify each individual case where valuation could be used. Rather emphasis is placed on outlining general principles. Developments in economic valuation since WATECO show how methods have been refined particularly in terms of addressing key methodological and practical issues. The following recommendations are intended to help inform future application of economic valuation to assist implementation of the WFD.

4.2 Recommendations for future use of economic valuation in WFD implementation

The following recommendations are based on the review of the relevant developments since the WATECO guidelines. They are largely generic and may need to be tailored according to the policy context, information needs, research resources and institutional capacity in each Member State. In addition, as with the review process that gave rise to these recommendations, they are focused on the role of economic valuation in implementing the WFD. They should be interpreted as suggestions for improving the application of economic valuation, if it is determined that valuation is required in a particular instance of WFD implementation. Interactions with other related policies (e.g. CAP, CFP) are not considered but should be taken into account in the wider context of policy making. Note also that the recommendations relate to the assessment of non-market costs and benefits; market costs and benefits also need to be considered in implementation of the WFD.

The six recommendations for the use of (non-market) economic valuation in the implementation of the WFD in future are:

1. Use spatial analysis tools;
2. Make better use of multi-disciplinary expertise;
3. Provide better and more appropriate scientific information;
4. Apply economic valuation where it provides the most 'added value' to policy making;
5. Develop value transfer tools, and
6. Improve communication.

The recommendations are relevant to all of the WFD policy questions identified in Section 2.2. In addition the recommendations are 'medium-term' and can help inform continued implementation of the WFD over the next 2-5 years; for example, in determining the scope of valuation evidence needs for the next round of RBMPs. Future use of economic valuation beyond this will require further review of developments in science and economics, given the rapid rate of development in both fields.

Recommendation 1: Use spatial analysis tools for economic valuation

How can spatial analysis improve economic valuation?

A key theme throughout this report is that the economic value of water is dependent on the context-specific factors. These factors include the characteristics of the water body, changes to its quality and quantity depending on the WFD programme of measures, socio-economic characteristics of the affected population, their proximity to the water body and substitute sites and so on.

Geographic Information Systems (GIS) which can integrate multiple layers of location specific data are being increasingly used in valuation studies (see Box 4.1 for the basics requirements). Integrating GIS into economic valuation studies provides a consistent basis for reflecting 'local characteristics' of economic values. The main advantages of using GIS are twofold: (i) allowing better representation of the impacts of WFD implementation at the design stage of a valuation study; and (ii) reflecting the spatial distribution of economic values – rather than assuming uniform values - in (a) the estimation of aggregate benefits (and/or costs) and (b) examination of distributional impacts.

Box 4.1: Basic data requirements of integrated spatial analysis - economic valuation studies

Developing and undertaking valuation studies requires spatially referenced information and data (e.g. GIS datasets) on the following:

- The baseline level information including the location and environmental quality of water bodies.
- An assessment of how the quality of water bodies will change as a result of measures or pressures.
- The location and environmental quality of all other water bodies.
- The locations and quality of all substitutes and complements, including both natural and man-made attractions.
- The location and socio-economic characteristics of populations.
- The proximity of populations to water bodies and accessibility to these (e.g. the available transport network and its quality).

Studies designed to capture such data will enable analysis and results to better account for:

- Sensitivity of the scope of the environmental change on the economic value of water bodies;
- The influence of the availability of substitutes on the economic value water bodies; and
- Distance decay relationships.

What is the policy relevance?

To date economic valuation studies using GIS have been largely driven by academic research. As a result, currently greater effort and resources are required to undertake this more sophisticated analysis than simpler study designs that generate regional or national value estimates. However, as GIS become more accessible to a larger number of users and data on environmental quality and change and other WFD-related factors become more available, incorporating spatial analysis within valuation studies will become more feasible.

Despite the current higher cost, GIS should be considered as its use does generate unit and aggregate estimates with greater confidence. This will likely be a significant issue when decision-making requires a high degree of accuracy in evidence. For example in cases of disproportionate cost assessments where programmes of measures can entail costly investments (e.g. in wastewater treatment) or significant impacts to certain stakeholder groups (e.g. the impact of land use management measures on agriculture). Where accuracy requirements of decision-making are lower (in other words, greater uncertainty in evidence is acceptable or there is less need for economic value evidence), then the need for approaches to valuation that integrate GIS is likely to be lower.

Integrating economic valuation and GIS is also beneficial for future value transfer applications. It will make it easier to design primary valuation research studies that incorporate all factors that may need to be adjusted in subsequent value transfer applications (see Recommendation 5).

Finally, combining GIS and economic valuation also permits examination of the distribution of costs and benefits, which are likely to be unevenly distributed and a consideration within disproportionate cost assessments. For example agriculture may bear the brunt of costs associated with the changes in land use necessary to deliver water quality improvement, whereas it may be urban populations who capture the majority of benefits. Spatial analysis tools provide a means of 'targeting' policies that can alter this (e.g. undertaking analysis to maximise aggregate benefits given a resource budget, or to redistribute benefits to focal disadvantaged groups).

Overall, while a common understanding across Member States in recognising the need for the appropriate use of spatial analysis would be helpful in relation to economic valuation, in the main the onus will be on individual Member States to determine the scope of further analysis that will need to be implemented.

Recommendation 2: Make better use of multi-disciplinary expertise for economic valuation

How can multi-disciplinary expertise improve economic valuation?

Economic valuation is underpinned by qualitative and quantitative assessments of the change in the quality and quantity of water bodies. These assessments require multi-disciplinary input from hydrology, ecology and other environmental science specialists. More specifically the input is needed to: (i) specify the baseline status and changes in environmental quality that provide the basis for valuation studies; (ii) develop water quality ladders and similar representations of changes due to the implementation of WFD; (iii) implement ecosystem service approaches to assess the welfare implications of these changes; and (iv) integrate spatial analysis tools and economic valuation (see Recommendation 1).

What is the policy relevance?

Economic valuation represents the 'final step' in the qualitative – quantitative – monetary assessment process. For a consistent evidence base to be developed, the scope of each individual component should be viewed in this wider context. This requires dialogue between policy makers, scientists and economists to establish the requirements for decision-making, so that current evidence needs are fulfilled and future gaps in evidence can be addressed. For example the feasibility of implementing a future valuation study may be dependent on sufficient availability of the type of water quality monitoring data that are suitable for economic valuation (see Section 3.2). This also implies that a multi-disciplinary approach requires better communication from economists as to the scientific information inputs that are required for valuation studies, and that scientist understand the role of economic valuation in informing policy making (see also Recommendation 6).

The robustness of valuation studies – particularly stated preference studies – is in part dependent on the accurate depiction of environmental impacts associated with WFD implementation. Tools such as water quality ladders that provide visual depictions of the changes to aid respondent understanding (and the hence reliability of studies) are being increasingly applied, and require input from scientist to help link technical understanding of impacts to outcomes perceived by respondents.

Ecosystem services approaches represent a framework within which multi-disciplinary inputs to WFD implementation can be organised. From a policy perspective this can help establish the range of impacts and associated costs and benefits that need to be accounted for in decision-making, along with where key gaps and uncertainties lie. This also provides for a transparent process for establishing estimates of economic values, included accounting for potential risks of double counting by requiring that qualitative and quantitative assessments work towards identifying 'final' services that provide the market and non-market goods that confer economic value to affected populations. Again this point emphasises role of economic valuation as the final step of a multi-disciplinary process.

Overall, the need for multi-disciplinary analysis is recognised in relevant guidance (e.g. WATECO). However specific practices that have developed in recent years, such as the ecosystem services approach and closer collaboration between economists and environmental scientists in undertaking valuation studies, could usefully be highlighted – for example via case studies – to demonstrate the benefits in terms of aiding WFD implementation. Such examples of practical application would also provide useful updates to those currently outlined in the WATECO and ECO2 guidance documents.

Recommendation 3: Provide better and more appropriate scientific input for economic valuation

How can improved science improve economic valuation?

Building on Recommendations 1 and 2, undertaking economic valuation requires good quality data particularly on water quality status, along with good understanding of the links between GES, ecological indicators, better environmental quality and human wellbeing outcomes. Challenges faced by early valuation studies focussing on implementation of the WFD included uncertainty associated with the definition of GES and availability of data and indicators of water quality.

More recent (and future) studies should benefit from improved scientific knowledge and data availability so that: (i) specification of baseline environmental status is reflective of the current status of water bodies; and (ii) changes in environmental quality presented to respondents (particularly in stated preference studies) are representative of the outcomes from ecological changes resulting from programmes of measures or pressures on water bodies. Gaps and uncertainties in evidence are likely to remain, emphasising the need for expert judgement from science and technical experts to inform the design of valuation studies. Some of these uncertainties could be reflected in the design of the economic valuation studies and preferences about these can be estimated. However, others will have to be taken into account in decision-making as separate factors.

What is the policy relevance?

As scientific understanding of complex and dynamic water systems improves along with improving data availability on the monitoring of water quality and indicators of GES, policy questions faced by decision-makers are likely to evolve. For example the effectiveness of particular measures will become better understood as practical experience of their implementation increases; this will set the context within which implementation of further measures should be assessed. Consequently the scientific information that inputs to valuation studies in this context should also account for this improved understanding, to ensure that valuations are based on an appropriate baseline and therefore consistent with the policy question faced.

In addition, valuation studies require some degree of expert judgement in interpreting scientific evidence to link the change in the water bodies from baseline status to GES in physical terms (e.g. using chemical, biological data) to impacts on human wellbeing. These assessments also underpin tools such as water quality ladders (see also Recommendation 2). Improved scientific knowledge can lead to future refinement of these aspects of valuation studies or their wider application; for example specification of water quality ladders for other water body types (e.g. HWMBs, wetlands, coastal waters) which would help to expand the potential scope of using economic valuation in WFD implementation.

In the main the onus will be on individual Member States to determine the scope of further scientific and economic valuation analysis that will need to be implemented. Where the need for future scientific research is identified this could usefully determine whether results can contribute to further (or ongoing) valuation studies.

Recommendation 4: Apply economic valuation where it provides the most 'added value' to policy making

How can targeting the use of economic valuation assist policy making?

As set out in Section 2.3, (non-market) economic valuation is applicable to a distinct subset of policy questions that arise from relevant Articles of the WFD. These give a fair amount of scope for applying economic valuation to support implementation of the WFD. However constraints on resources available for analysis to inform decision-making imply that it is not feasible to apply economic valuation in every instance where it could theoretically be applied. As noted in Recommendation 1 resource implications of economic valuation studies should be weighed against the accuracy requirements of decision-making.

Targeting the use of economic valuation means that it is applied in instances where it provides the most 'added value' to policy making; for example in cases where qualitative and quantitative assessments alone cannot provide sufficient evidence to help determine policy decisions. In other instances however, it may be the case that improved implementation of the

WFD will result from concentrating effort on improving scientific information rather than undertaking economic valuation. Robust scientific information is, in any case, a prerequisite for better economic valuation.

What is the policy relevance?

All policy making has to establish a balance between the evidence requirements and the constraints of time and resources. This means that the role for using economic valuation in the context of the WFD needs to be viewed in broader context of all policy questions that arise from implementation and the associated evidence needs (e.g. economic characterisation of river basins, assessing financial cost recovery for water services, etc.). Therefore policy makers need to prioritise evidence needs, which in part should be based on the understanding of how different aspects of scientific and economic analyses can help to improve WFD implementation. The role of economic valuation should be communicated clearly within this prioritisation of evidence needs (see also Recommendation 6).

Where there are opportunities to undertake valuation studies, the scope of all potential outputs that can assist policy making should be assessed (subject to not compromising the attainment of the primary objectives of study). For example, while more expensive, studies combining GIS and economic valuation (Recommendation 1) offer potentially rich datasets that can address various evidence needs, providing spatially sensitive benefit estimates of attaining GES, data on visitation and use of water bodies, and also permitting for analysis of distributional outcomes. Appropriate design of such studies can also provide value transfer tools that can permit much more cost-effective future use of economic valuation.

Policy makers should also make better use of current and ongoing research studies. Much of the literature reviewed for this report is from European Commission and Research Council funded projects, rather than directly by Member State Government Agencies. While there may seem to be a 'disconnect' between academic research projects and the practical needs of policy making, there is plenty to learn from such projects and also scope for policy makers to influence research agendas for more directly relevant results.

Overall it will be for individual Member States to determine if economic valuation evidence is required for continued implementation of the WFD and where and how.

Recommendation 5: Develop value transfer tools

How can the development of value transfer tools improve economic valuation?

Following from Recommendation 4, which highlights resource constraints, implementation of the WFD could be improved by the development of value transfer tools that permit wider use of economic valuation evidence generated by primary studies. This would give a consistent basis for undertaking valuation of non-market benefit and costs of WFD implementation across regional and national scales, where it is not practical to undertake primary valuation studies in every decision-making instance.

What is the policy relevance?

The geographical scale – covering all water bodies in Europe – implies that value transfer represents the only feasible way in which large scale use of economic valuation can support the WFD implementation in a sustained way. However use of value transfer has to be able to reflect the local characteristics that are known to affect economic values (see Recommendation 1). In light of these considerations, past applications of value transfer have been limited and not provided sufficient account of such factors, implying the reliability of results is likely to be questionable – although reliability is partly relative the accuracy of evidence required in a given decision-making context (see also Recommendation 1).

Implementation of the WFD provides an opportunity to undertake well-specified and targeted valuation studies that will provide value transfer tools to address the most pressing policy questions for which valuation evidence is needed (see also Recommendation 4). While these should be designed to estimate transferable results – such as transferable value functions – they should also provide tests of transferability so that levels of 'transfer error' can be established, which can be reflected by the use of evidence in decision making. A particular opportunity exists to develop value transfer tools from studies combining GIS and economic valuation in order for value transfer to effectively account for the 'local context' of WFD implementation.

With an increasing evidence base of economic valuation studies concerning implementation of the WFD, there will also likely be opportunity to develop meta-analysis studies. This can also provide a basis for developing value transfer tools (i.e. estimating a transferable value function). In addition meta-analysis can also provide a comparative examination of the results from multiple valuation studies undertaken in different regions and across Member States, which are likely to feature methodological differences. Results from such a meta-analysis can help understanding of methodological factors that are likely to influence results and improve future practice of valuation studies in the context of WFD implementation.

Overall, while a common understanding across Member States in recognising the role for value transfer would be helpful in relation to economic valuation, in the main the onus will be on individual Member States to determine the scope of further analysis that will need to be implemented.

Recommendation 6: Improve communication

How can better communication improve economic valuation?

The previous recommendations highlight the fact that economic valuation is part of a multi-disciplinary process that is addressing implementation of the WFD. Economic valuation is reliant on input from other disciplines to ensure that the analysis that is undertaken meets the needs of policy makers. Achieving appropriate use of valuation and robust results that usefully inform decision-making also requires good communication from all involved in the implementation process. In particular that: (i) the potential role for valuation; (ii) information requirements for undertaking good quality studies; and (iii) the limitations of valuation are understood; i.e. that policy makers and scientists recognise what can and cannot be achieved.

What is the policy relevance?

Better communication should ultimately lead to more helpful use of valuation in addressing policy issue concerned with the WFD. For example, recognising that data from valuation studies extend beyond providing 'just numbers' and that can also assist in analysing distributional issues and help identify locations where measures can generate the greatest net benefits.

Improved understanding of the role of economic valuation can also facilitate improvements in both science and valuation as a result of multi-disciplinary collaboration, resulting in better decision-making. For example the demands of information inputs to valuation studies may help develop scientific understanding; e.g. in linking ecological outcomes to impacts on human populations. It may also give rise to better recognition of where requirements of the WFD not directly related to economics can actually help improve economic valuation; for example intercalibration can assist with studies that compare and transfer valuation results across countries.

Overall, a common understanding across Member States is needed to improve communication and understanding of the role of economic valuation in WFD implementation, particularly in terms of the scope of policy questions it can assist in addressing and the information, data and resource requirements of the practical application of methods.

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GLOSSARY

Adjusted unit value transfer	Transfer of a mean average (or median) value estimate for a study good that is adjusted to account for some factor (or factors) to estimate the value of policy good.
Affected population	The population of the users and non-users that are affected by the change in the provision of a market or non-market good or service. See also '*economic jurisdiction*'.
Altruistic value	Non-use benefit derived from the knowledge that contemporaries are able to enjoy the goods and services related to natural resources.
Benefits transfer	See '*value transfer*'.
Bequest value	Non-use benefit associated with the knowledge that natural resources will be passed on to future generations.
Choice experiment	A form of choice modeling in which respondents are presented with a series of alternatives and asked to choose their most preferred.
Choice modelling	An umbrella term for a variety of stated preference techniques that infer willingness to pay or accept indirectly from responses stated by respondents (as opposed to directly asking as in a contingent valuation survey). Includes choice experiments, contingent ranking, contingent rating and paired comparisons.
Consumer surplus	The difference between price paid and the maximum amount an individual is willing to pay to obtain a good; this reflects the additional benefit that is gained by consumers in consumption of a good or service.
Contingent ranking	A form of choice modelling in which respondents are presented with a number of scenarios and asked to rank them individually on a semantic or numeric scale.
Contingent valuation	A stated preference approach to valuing non-market goods and services where individuals are asked what they are willing to pay (or accept) for a change in provision of a non-market good or service.
Cost-benefit analysis (CBA)	A decision-making tool that compares costs and benefits of a proposed policy or project in monetary terms.
Cost-effectiveness analysis (CEA)	A decision-making tool that compares the cost of different options for achieving the same or similar outcomes.
Cultural services	A category of ecosystem services that relates to the non-material benefits obtained from ecosystems, for example through recreation.
Decision making / policy context	This is relates to the wider policy or project objective that is subject to appraisal and for which economic valuation evidence is required. It covers the issue under consideration and the rationale for intervention, the objective and the intended effects of intervention, and the policy

	or project options that are to be considered.
Direct use value	Economic value associated with use of a resource in either a consumptive manner or non-consumptive manner.
Discounting	The process of expressing future values in present value terms. This allows for the comparison of flows of cost and benefit over time regardless of when they occur.
Distance decay	Pattern of declining unit values for a non-market good or service as distance from it increases.
Economic jurisdiction	The spatial area over which some positive economic value is associated with the use of a resource and the services provided or supported by it.
Economic value	The monetary measure of the wellbeing associated with the change in the provision of some good. For market goods this is ordinarily measured by market price; for non-market goods this ordinarily measured by willingness to pay (WTP) or willingness to accept (WTA).
Economic value evidence	Economic values, value functions and other empirical evidence available from existing (primary) studies that provides the source of evidence for value transfer. Previous value transfer analyses may also provide evidence for current applications.
Ecosystem services approach	A term that is used to describe a framework for analyzing how human populations are dependent upon the condition of the natural environment. The approach explicitly recognizes that ecosystems and the biological diversity contained within them contribute to individual and social wellbeing.
Evaluation	Retrospective analysis of a policy, programme or project to assess how successful or otherwise it has been, and what lessons can be learnt for the future. The terms 'policy evaluation' and 'post-project evaluation' are often used to describe evaluation in those two areas.
Existence value	Non-use value derived from knowing that a resource continues to exist, regardless of use made of it by oneself or others now or in the future.
Geographic information system (GIS)	An information system that captures, stores, analyzes, manages, and presents data that is linked to geographic location.
Hedonic pricing method	A revealed preference valuation method that estimates the use value of a non-market good or service by examining the relationship between the non-market good and the demand for some market-priced complementary good (e.g. property or land prices).
Indirect use value	Economic value associated with the services supported by a resource as opposed to the actual use of the resource itself; e.g. key ecosystem services such as nutrient cycling, habitat provision and climate regulation.
Marginal change	An incremental change (ordinarily a 'unit change') in the provision of a market or non-market good or service.

Market goods	Goods and services traded in formal markets.
Market price	The value of the provision of goods and services that may be directly observed from markets.
Market price methods	Approaches to economic valuation that provide proxy estimates - which may be observed directly from actual markets - for use values that arise in relation to the provision of goods and services.
Mitigation costs	A market pricing approach that considers costs incurred to mitigate against particular outcomes associated with the degradation of a resource.
Meta-analysis	An empirical study that collates data from multiple valuation studies on a particular good, with the purpose of identifying the key factors that influence estimated economic values.
Non-market goods and services	Goods and services that are not traded in markets and are consequently 'un-priced' (e.g. environmental goods and services).
Non-use value (passive use value)	Economic value not associated with any use of a resource, but derived altruistic, bequest and existence values.
Non-users	Population group(s) that derives economic value from a resource even though they do not make direct or indirect use of it (i.e. non-use value).
Opportunity cost	The value of the next best alternative use of resource.
Option value	Benefits associated with retaining the option to make use of resources in the future.
Policy good	A value transfer term. The good or service for which monetary valuation evidence is required. It could be a physical commodity and market good (e.g. timber), it could be a non-market amenity (e.g. recreation) or service (e.g. water quality), or environmental impact (e.g. a reduction in water quality, an increase in air pollution).
Political jurisdiction (administrative jurisdiction)	The national, regional or local boundary of the decision-making context.
Present value	A future value (cost or benefit) expressed in present terms by means of discounting.
Producer surplus	The difference between the minimum amount a seller is willing to accept for a good and the actual price received; this reflects the additional benefit in exchange gained by the producer.
Production function approach	A production input method which relates the output of a given good (e.g. agricultural products) to its factor inputs (e.g. the quantity or quality of water).

Provisioning services	A category of ecosystem services which relates to products obtained from ecosystems, such as food, fibre and fuel, natural medicines and genetic resources.
Public good	A good or service that is non-rival and non-excludable. Consumption of the good by one individual does not reduce availability of the good for consumption by others, and that no one can be effectively excluded from using the good.
Quasi-option value	A use value related to option value, which arises through avoiding or delaying irreversible decisions, and where technological and knowledge improvements can alter the optimal management of a natural resource.
Regulating services	A category of ecosystem services which refers to the regulation of ecosystem processes such as climate regulation, air quality regulation, water regulation (e.g. flood control), water quality regulation (purification/detoxification) and erosion control.
Revealed preference methods	Economic valuation methods that estimate the use value of non-market goods and services by observing behaviour related to market goods and services (e.g. travel cost method and hedonic pricing method).
Shadow price	The opportunity cost to society of some activity, relating to situations where market prices do not reflect the scarcity value (i.e. opportunity cost) of the use of a good or service.
Shadow project costs	A market pricing approach that focuses on the cost of compensating for the loss of an environmental resource at a particular site by assessing the cost of providing an equal resource at an alternative site.
Stated preference methods	Economic valuation methods that use questionnaire surveys to elicit individuals' preferences (i.e. willingness to pay and/or willingness to accept) for changes in the provision on non-market goods or services.
Study good	A value transfer term. The good or service for which economic valuation evidence is available.
Supporting services	A category of ecosystem services which are necessary for the production of all other ecosystem services, such as soil formation and retention, nutrient cycling, water cycling and the provision of habitat.
Total economic value (TEV)	The economic value of a resource comprised of its use and non-use values.
Transfer error	The difference between predicted policy site WTP and observed policy site WTP as estimated by studies assessing the accuracy of value transfer.
Travel cost method	A revealed preference and survey based valuation method that uses the cost incurred by individuals traveling and gaining access to a recreation site as a proxy for the recreational use value of that site.
Unit value	Transfer of a mean average (or median) value estimate for a study good

transfer	to estimate the value of policy good.
Use value	The economic value that is derived from using or having potential to use a resource. It is the net sum of direct use values, indirect use values and option values.
Users	Population group(s) that composed of individuals making direct use of a resource or indirect use of a resource.
Value function transfer	A statistical relationship between the value of a study good and a set of explanatory variables that is transferred to estimate the value of the policy good.
Value transfer (benefits transfer)	Process by which readily available economic valuation evidence is applied in a new context for which valuation is required.
Welfare (wellbeing)	A measure of satisfaction or 'utility' gained from a good or service.
Willingness to accept compensation (WTA)	The monetary measure of the value of forgoing a gain in the provision of a good or service or allowing a loss.
Willingness to pay (WTP)	The monetary measure of the value of obtaining a gain in the provision of good or service or avoiding a loss.

ANNEX 1: ECONOMIC VALUATION STUDIES, WATER QUALITY IMPROVEMENTS AND WFD IMPLEMENTATION

The following table summarises the valuation studies that have taken place since 2003 however, the review is not comprehensive. The table below shows the main details of each valuation study including the valuation techniques used, how the change in the environmental good, in this case water, was defined, whether scientific data was used to aid this definition, along with the identification of the affected population and the location of the study.

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Aqua-money (2009)	Po Case Study Fact Sheet	CV (OE) and CE	• River basin • Agriculture (46%), industry (20%), hydropower (18%). • The household use only 16% of total water use in the basin.	Estimate the environmental value of quantitative water uses and the willingness to pay to reduce the risks of water shortages (common design in water scarcity group). The environmental improvement for the CV study was WTP to prevent household water restrictions and for the CE it was WTP for three levels of environmental improvements (sufficient, good and very good) as well as WTP to prevent water restriction.	None	Users and nonusers of the local area	North West Italy Po River Basin
Atkins, J. P.; Burdon, (2006);	An initial economic evaluation of water quality improvements in the Randers Fjord , Denmark	CV	• Estuarine and coastal waters, • Recreation, Future uses, responsibility (stewardship), Commercial fishing, Landscape, Agriculture/industry, Biodiversity value, Drinking purposes, Aesthetic value, Research/education, Human health.	Water quality improvements arising from reduced eutrophication by 80% and 50%	N/A	Regional (Arhus County) user and nonuser	Denmark Randers Fjord

[29] VT: Valuation technique

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Atkins, et al. (2007)	An application of contingent valuation and decision tree analysis to water quality improvements	CV	• Estuary, • Recreation	Eutrophication described to the respondent, algal mats; foaming; fish kills; reduced water clarity;	Not provided	Random sample of households within the county	Denmark Randers Fjord
Aulong, et al. (2006).	BRIDGE Background criteria for the Identification of Groundwater thresholds: Assessing the costs and benefits of groundwater quality improvement in the Upper Rhine valley quaternary aquifer (France)	CV	• Aquifer, • Drinking water	Reducing pollution with chlorinated solvents in Ground water quality: (1) drinking water quality; and (2) natural ground water quality. Considering distinct levels of “improvement of groundwater quality”, definition is based on three elements: (i) a description of the environmental improvement targeted by the scenario; (ii) a description of the impacts of that improvement on their utility and (iii) information on the technical measures which could be implemented to achieve the targeted environmental improvement.	Chemical data on pollution with four major chlorinated solvents: nitrates, pesticides, chloride, VOCs (TCE, PCE, III TIR, PAH and oils).	User and nonuser municipalities: located above main aquifer (rural/urban); and those located outside main aquifer.	France, upper Rhine valley
Bateman, et al. (2009)	Making benefit transfers work: Deriving and testing principles for value transfers for similar and dissimilar sites using a case study of the non-market benefits of water quality improvements across Europe	VT	• Rivers and large lakes • Recreation and biodiversity	See Hime et al. For details on the water quality ladder used	See Hime et al.	Yes	UK, Lithuania, Norway, Denmark, Belgium. UK: Bradford, Leeds; no additional site level detail available on the other countries

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Bateman, et al. (2006)	The aggregation of environmental benefit values : Welfare measures , distance decay and total WTP	CV	• Rivers, • Flooding; Biodiversity and Recreation	Dependent on the case study (The Tame study is described in that reference in this list); the Broads study looked at the threat of saline flooding	No	Different populations for different case studies - local populations for both	England River Tame, Birmingham; and Norfolk Broads
Beharry-Borg et al. (2009)	An Analytical Framework for Joint vs Separate Decisions by Couples in Choice Experiments: The Case of Coastal Water Quality in Tobago	CE	• coastal waters • Recreation: Boats - Number of recreational and fishing boats; Biodiversity; Water Quality; Coastline development; Health risks; Water clarity and litter	Attributes and levels[30]: Boats: (up to 7) Up to seven boats allowed near coastline/(up to 2); Park (fishing) A marine protected area where one can (tour, swim, snorkel, dive) and fish, Park (no fishing) A marine protected area where one can (tour, swim, snorkel, dive) but no fishing; Development (75) Up to 75% development allowed on the coastline and (25); Infect: Increased chance of getting an ear infection from swimming in polluted water, Reduced chance of getting an ear infection from swimming in polluted water; Clarity: (up to 10 m) Vertical visibility of up to 10 m, (up to 5 m); Plastics (up to 15p) Up to 15 pieces of plastic per 30 m of coastline, (up to 5p); crowding (up to 15) Up to 15 snorkelers per group or per instructor, (up to 5); Coral (45) Up to 45% coral cover, (15); Fish: (60) Up to 60 fishes, (10) Up to 10 fishes.	None	Users of Tobago beaches (tourists/locals)	Tobago

[30] The choice task faced by each respondent in the survey included two beach alternatives which differed on the basis of nine attributes relating to coastal water and beach quality plus the access fee to the beach.

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Birol, E. And Cox, V (2009)	Using choice experiments to design wetland management programmes: The case of Severn Estuary wetland, UK	CE	• Estuary • Recreation, irrigation, biodiversity	Wetland management options. 4 attributes: wetland area - 100, 200, 247, 300 and 347 km2; otter hol creation - yes, no; protected bird species - 14,24,34; irrigation related employment - 100 jobs more, no change, 100 jobs less than current levels of employment; water rates £0, £5, £10, £25, £100 (one-off increase)	Not given	Local users and non-users	UK Severn Estuary
Bliem, et al. (2009)	Temporal stability of individual preferences for river restoration in Austria using a choice experiment Temporal stability of individual preferences for river restoration in Austria using a choice experiment.	CE	• River, • Flooding, water quality	Flood return period Once every 5 years; Once every 25 years; Once every 50 years; Once every 100 years. Water quality: Moderate, Good, Very good. Cost Euros/household/yr: 0, 3, 10, 30, 50.	Austrian Ministry of the Environment's water quality assessment	The sample for both surveys was segmented between people living in the Austrian federal states of Vienna and Lower Austria.	Austria Danube River between the Austrian capital of Vienna and the border to the Slovak Republic (approx. 50 kms)
Brouwer et al. (2008)	The potential role of stated preference methods to assess whether the Water Framework Directive is disproportionately costly.	CV(DC)	• All water bodies and rivers in WFD • improved water quality, nature conservation, recreation and biodiversity, health (use value), bequest values	A general description and photographs were used to illustrate the expected impact on water-based recreation and wildlife in and near water. The valuation scenario was developed with the help of RIZA water quality experts.	N/A	Netherlands users and non users	Netherlands random selection of Dutch households.

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Brouwer, et al. (2009)	Economic Valuation of Environmental and Resource Costs and Benefits in the Water Framework Directive : Technical Guidelines for Practitioners	All	• All waters impacted by WFD legislation, • Table 1 within the document shows the classifications of water use outcomes - shows all water uses, but not explicit to any one	WQ Ladder by Hime et al. As an example, with some information about previous ladders	See Hime et al.	N/A	Not related to a specific area
Brouwer, et al. (undated)	Ecosystem Service Valuation from Floodplain Restoration in the Danube River Basin: An International Choice Experiment Application.	CE	• River, • The water quality ladder categorises water quality into recreational uses such as 'swimmable', 'boatable' and 'fishable', and • Illustrates levels of biological diversity of aquatic life.	Ecological floodplain restoration: Flood returns once every 5 years, once every 25 years, once every 50 years, or once every 100 years; water quality is moderate, good or very good.	N/A	Regional (3 countries) user/nonuser populations	Austria, Hungary, Romania Danube River

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Cooper, et al. (2004)	The structure of motivation for contingent values : a case study of lake water quality improvement	CV	• Lake, • Water quality and biodiversity	Respondents were provided with a structured, illustrated presentation regarding three nested schemes for improving water quality in the lake: - Scheme F–Filter runoff water from the UEA campus into the lake. - Scheme P–Scheme F plus the planting of reed beds around the lake. - Scheme D–Scheme P plus the dredging of sediment from the lake. The results of the schemes were described in terms of increasing populations and diversity of species with increasing water quality and the visibility of these effects.	No	UEA students 200	UK Norwich University Lake
Eggert, H.; Olsson, B.J. (2004)	Heterogeneous preferences for marine amenities: A choice experiment applied to water quality	CE	• Coastal waters, • Recreation - angling	Attributes, fish stock level, bathing water quality, and biodiversity level. Bathing water quality (%) Fraction of west-coastal sites violating the quality standard 12, 10, 5 Biodiversity Biological diversity or ecosystem balance, where today's level is medium. Low, Medium High Cod stock (kg) Catch per trawling hour with a research vessel. 2, 25, 100 Cost (SEK) The total cost for an individual for each alternative 0, 120, 240, 600, 960, 1800	Not given	Residents on the Swedish west coast	Sweden W. Coast of Sweden

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Ferrini, et al. (2008)	Valuing spatially dispersed environmental goods: A joint revealed and stated preference model to consistently separate use and non-use values	CE, CV	• Rivers and large lakes • Recreation and biodiversity	See Hime et al.	See Hime et al.	Local population of users and non users	England, Bradford, Leeds;
Gurluk, S. and Rehber, E. (2008)	A travel cost study to estimate recreational value for a bird refuge at Lake Manyas, Turkey	TCM	• Lake • Recreation	No t given details relating to the travel cost associated with visiting the wetland presented to respondents any details relating to quality not included within model summary.	Internationall y important bird species, plants and habitat, quality information	Visitors to the wetlands	Turkey Lake Manyas
Hanley et al. (2005)	Price vector effects in choice experiments : an empirical test	CE	• River, • Biodiversity	Attributes Ecology; Aesthetics; Bankside condition;	Focus group input from locals and EA officers	Local users	England River Wear in County Durham
Hanley, et al. (2006)	Estimating the economic value of improvements in river ecology using choice experiments : an application to the water framework directive	CE	• River, • (Improved) recreation (a water use), (improved) habitats and biodiversity (a water use).	Improve status of polluted urban rivers, in terms of: ecology, aesthetics, river bank, e.g. Type/extent of fishing, plants and wildlife; boating and swimming	N/A	Local users	UK River Wear, County Durham; River Clyde in Central Scotland;

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Hime, et al. (2009)	A transferable water quality ladder for conveying use and ecological information within public surveys	VT	• Rivers and large lakes, • Recreation and biodiversity	4 different levels of water quality based on ecological changes associated with eutrophication: fish, macrophytes and algae, recreational activities, habitat immediately touching the river/lake, BOD and ammonia	EA and UKTAG chemical classifications along with ecological descriptions of river classification and Hatton et al.	N/A	England and and EU - generic ladder for use at many river sites
Holmes et al. (2004)	Contingent valuation , net marginal benefits , and the scale of riparian ecosystem restoration	CV	• River • Restoration benefits are described in terms of five indicators of ecosystem services: habitat characteristics and biodiversity.	Baseline: no small streams protected, no new river restoration; and all indicators abundance of game fish, water clarity, wildlife habitat, allowable water uses, and ecosystem naturalness = LOW, with MODERATE and HIGH scenarios also described.	No	Local use/non-use	USA. Macon County, Western North Carolina, Little Tennessee River - 35 projects in the study area
IVM (undated)	HydroVal - Evaluation of Hydropower Energy Development in Austria: Exploring the Energy-Water Nexus using Public Choice Models	N/A	• River • Hydropower	The scientific approach to assess the trade-offs between clean energy demand and water conservation objectives. However, this specific document is only an informational flyer and does not illustrate the study methodology or results.	None	Austrian users and non users	Austria
Johnstone, C.; Markandya A. (2006)	Valuing river characteristics using combined site choice and participation travel cost models	TCM	• Rivers, • Recreation suitability (swimming, fishing, boating) and ecological quality (birds, plants etc.)	Number of fish species, BOD, Ammonia, DO, HMS, Flow, fish per $100m^2$, Orthophosphates, Nitrates, ASPT, Ntaxa – These variables are not shown to the respondent but used in the models.	Habitat modification score	Anglers in England and Wales	England several English rivers[31]

[31] Berkshire and Marlborough downs - Rivers Kennet, Lambourne; Exmoor & Quantocks -Exe, Bray, Mole; Midland clay pastures - Avon, Nene; Midland plateau - Severn, Stour, Tame; South chalk - Itchen, Test, Cuckmere; South Devon - Avon, Tavy, Plym, Dart; Southern Pennines - Aire, Calder, Wharfe; The fens - Ouse, Cam, Witham, Lark; Yorkshire Dales - Wharfe, Ure, Ribble.

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Kontogianni, et al. (2003)	Social Preferences for Improving Water Quality : An Economic Analysis of Benefits from Wastewater Treatment	CV	• Coastal waters, • Water quality	WTP question based on water quality improvements: talks of the waste water loads in Thessalonica as well as agricultural run-off see footnote for full question.	None	Residents and visitors to Thessaloniki	Greece, Thermaikos Bay, which is adjacent to Thessaloniki.
Koundouri (2004)	The use of non-market valuation techniques in water resources policy making: A review.	Various	• water resources (aquifers, wetlands, marine or coastal ecosystems, river basins) • Irrigation for agriculture Domestic and industrial water supply Energy resources (hydro-electric, fuelwood, peat) Transport and navigation, Recreation/amenity, Wildlife harvesting, Indirect use values, Nutrient retention, Pollution abatement, Flood control and protection, Storm protection, External eco-system support, Micro-climatic	Summary of different case studies relating to the valuation of ground water, wetlands and surface waters	None	Various user and non user	European Union All EU waters with a chapter providing a summary of the major literature on valuing water resources services. Valuations studies implemented in Europe and worldwide are classified by specific goods and services generated by water resources and all valuations have been converted to 2008 Euros.

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
			stabilisation, Reduced global warming, Shoreline stabilisation, Soil erosion control, Option values, Potential future uses of direct and indirect uses Biodiversity Cultural heritage Bequest, existence and altruistic values				
Laitila, T.; Paulrud, A. (2006)	A Multi-Attribute Extension of Discrete-Choice Contingent Valuation for Valuation of Angling Site Characteristics	CV	• River, • Recreation (angling)	Each hypothetical site was described using 8 characteristics: river (fixed), type of fish (fixed), car-road, bag-limit, catch per day, distance from residence, congestion, fee.	N/A	National user (anglers)	Sweden, Jamtland
Luisetti et al. (2008)	Testing the fundamental assumption of choice experiments: Are values absolute or relative?	CE	• Estuary • Recreation and Biodiversity	The area of new salt-marshes to be created (acres, 25, 74, 173); Bird species observable (number of protected species 2,3,4,5); Distance from respondent's home to the nearest site (miles) - 'Near sample': 2, 12, 22, 32 miles; 'Far sample': 42, 52, 62, 72 miles; Whether the created salt-marsh would be open-access or not; Increase in the respondent's annual local (council) tax to pay for the option (£ per household per annum £2, £6, £10, £14).	No	Local users and non-users	UK - Essex Blackwater estuary catchment area

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Martin (2005)	State dependence and heterogeneity in fishing location choice	N/A	• Coastal waters • Commercial sea urchin divers	This article is not so much about environmental change but about behavioural change in fishermen. This is a reduced-form model for the influence of past choices on future ones has substantial explanatory power and provides a significant improvement over previous discrete fishing location choice models.	No	Commercial sea urchin divers: Californian user population	California Sea urchin fishery
Massey et al. (2006)	Valuing water quality changes using a bioeconomic model of a coastal recreational fishery	N/A	• Coastal bays • Recreational fishing	Bioeconomic model of a coastal recreational fishery for estimating the value of water quality changes. A variety of information sources and datasets were used to specify a biological model of summer flounder population dynamics and to estimate a count regression model of catch rates and a mixed logit recreation demand model. The models were combined in a bioeconomic framework and calibrated to baseline conditions using historic recreational harvest levels from both in and out of Maryland's coastal bays and commercial harvest levels for the entire fishery.	biological model of summer flounder population	Local users	Atlantic Coast summer flounder fishery Maryland's coastal bays
Meyerhoff, J. and Dehnhardt A. (2007)	Directive and Economic Valuation of Wetlands : the Restoration of Floodplains along the River Elbe	CV(OE)	• River basin, riparian wetlands • WTP for preservation of endangered species and habitats	Value the management options along the Elbe river: Regaining 15oooha of riparian wetland by dike shifting, reducing the impact of current land use management (less fertilisers), improving conditions for migratory fish.	Nutrient retention	Elbe river basin users and nonusers	Central Europe River Elbe

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Meyerhoff, J. and Dehnhardt (2007)	The European water framework directive and economic valuation of wetlands: The restoration of floodplains along the river Elbe	CV and RC	• River and flood plains • Biodiversity	Three different management scenarios focusing on the preservation of biodiversity including fish and habitat	Statistical model for the effect of nitrogen reduction	Local users and non-users	Czech republic and Germany River Elbe catchment
Milon, J.W.; Scrogin, D. (2006)	Latent preferences and valuation of wetland ecosystem restoration	CE	• Wetlands, • Restoration of wetlands and therefore potentially all services.	Attributes included: (a) functional ecosystem attributes, (b) structural ecosystem attributes, (c) annual cost to households, (d) indoor and outdoor water use restrictions, (e) conversion of farmland to wetland. A full list of all attributes levels is not given explicitly. An example of the levels is shown below: Lake Okeechobee percent of historic level (60%, 75%, 90%); Water Wetland species percentage of historic level (20%, 50%, 80%); Annual cost $25 over 10 years? No other specific values listed; Water restriction 1- outdoor uses lim. to 1 day per week and 25% decrease in indoor use consumption; Decrease in farm acreage in (000's) e.g. reduce by 10,000 acres or 15% etc.	Scientific papers relating to the Everglades ecosystem	Representative sample of the general population	USA Everglades
NERA & Accent published by Defra (2007)	The Benefits of Water Framework Directive Programmes of Measures in England and Wales	CE	• Rural and urban rivers, lakes and estuaries/coastal waters • Biodiversity and Recreation	High quality described as a diverse and natural range of plants, insects, fish, birds and other animals. Water will generally have the right degree of clarity, no noticeable pollution, and generally be suitable for contact activities. Medium quality is described as having	N/A	Users/non users; National/local;	UK

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
				plants, insects, fish, birds and other animals, but there will be some fish and other wildlife missing. Water will be slightly murky or discoloured in parts, and there will sometimes be visible pollution in some places, and some algal blooms. Water will be suitable for contact activities in some areas but not others. Low quality is described as limited or no plants or wildlife, or the water may be dominated by a single plant species. Water will generally be murky or discoloured, and may sometimes be bad-smelling in some places. There may also regularly be visible pollution in some places, and frequent algal blooms. Water will be unsuitable for contact activities. These descriptions are modified for different types of water body and accompanied by drawings and maps.			
Palma, C.R. and Monteiro, H. (2008)	Pricing for Scarcity - WORKING PAPER	N/A	• The paper discusses residential water supply and tariffs not a specific water body • Residential water use	The paper develops a model for water scarcity and tariffs. The impact of scarcity on price schedule.	N/A	Users: Portuguese residential water users	Portuguese tariffs for the residential sector Portugal

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
Paulrud, A.; Laitila, T. (2004)	Valuation of Management Policies for Sport-Fishing on Sweden's Kaitum River	CE	• River, • Recreation suitability (swimming, fishing, boating) and ecological quality (birds, plants etc.)	Change in fishing characteristics at the river; attributes used were paired across five blocks within a CE. The attributes and there levels were: Catch per day of Grayling 30 cm: 0, 7, 15 Catch per day of Grayling 30–40 cm: 0, 4, 8 Catch per day of Grayling 40 cm: 0, 1, 3 Catch per day of Brown Trout 30 cm: 0, 7, 15 Catch per day of Brown Trout 30–40 cm: 0, 4, 8 Catch per day of Brown Trout 40 cm: 0, 1, 3 Bag-limit per day of Grayling: 0, 1, 3 Bag-limit per day of Brown Trout: 0, 1, 3 Extra fee per day (SEK): 0, 200, 400 (year 2000); 0, 400, 800 (year 2001 and 2002)	Attributes and levels were decided on the basis of a background survey within the Region, not scientific information.	The CE survey was mailed in three separate letter surveys in 2001 and 2002. The addresses for the surveys were collected by address-collectors walking along the river in the summers of 2000, 2001 and 2002. The address-collectors gathered samples3 of sizes 64 (2000), 105 (2001) and 37 (2002). The sample contained Swedish anglers only.	Sweden, Kaitum River
Powe et al. (2005)	Mixing methods within stated preference environmental valuation : choice experiments and post-questionnaire qualitative analysis	CE	River, groundwater, reservoir Household services: i.e. drinking, hosepipe; non-use: i.e. wildlife and biodiversity.	Level of service received by households: *Average likely occurrence of a hosepipe and sprinkler ban (lasting no more than 1 year) and is also an indicator of pressure and the possibility of supply interruption = 1 every 10 years [BASE], 1 every 2 years, 1 every 5 years, 1 every 50 years; *Landscape and wildlife impact on woodland, fields and environmentally sensitive agricultural land due to reservoir construction or enlargement: No	None	USE: Southern water customers	South of England Southern water

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
				change [BASE], Minor decrease, Moderate decrease, Moderate improvement, *Landscape and wildlife: impact on wetlands due to changes in the level of abstraction: No change [BASE], Minor worsening, Moderate worsening, Moderate improvement. *Landscape and wildlife impact on rivers and streams due to changes in the level of abstraction: No change [BASE], Minor worsening, Moderate worsening, Moderate improvement, *Change in what your household pays in annual water charges (not including wastewater/sewerage): No change [BASE], o10 less per year, o10 more per year, o20 more per year			
QUALI-WATER Project (2009)	A Comparative Benefits Transfer Study of the Monegros Wetlands and the River Zadorra.	VT, CE	• Rivers and wetlands, • Water for use in agriculture (irrigation) and water quality	See Table 3.1 above for an example of the attributes used. Attributes included: River banks, Ecology and Water level each with their own quality ladder.	No	Not explicit seems to be the residential population. (users, non-users)	Spain river Zadorra is a tributary of the river Ebro that runs its course through the Basque region, and Monegross wetlands
Ready, R.C.; Malzubris, J. (2002)	The relationship between environmental values and income in a transition economy : surface water quality in Latvia	CV	• River • Drinking water, water quality and recreation	For the Gauja River, respondents were asked a series of questions about their perceptions of water quality in the Gauja River and their use of the river. They were then asked to consider a project consisting of modernization of sewage facilities in Sigulda, as part of a larger program	No	Resident population 200 sample	Latvia, the study site was Sigulda, Latvia, a medium-sized town (11,800 inhabitants) located 50 km northeast of

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
				conducted in all small and medium-sized towns. Respondents were told that the local impact of the program would be to improve water quality in the Gauja River to the point where the river would be suitable for swimming and fishing, but not for direct consumption.			Riga.
Rinaudo, J. D. (2008)	Assessing the benefits of groundwater protection A Case study in the Rhine district, France	CV	• Ground water • Drinking water, agricultural and industrial uses	Description of the over exploitation of the groundwater resource see footnote for full environmental description used		Local residents	France Rhine basin district.
Rinaudo, J.D. Görlach, B. (2003)	Economic assessment of groundwater protection - Executive summary	CV, HP	• Aquifer, • Drinking water; economic sectors using groundwater; Recreation;	Three case studies of groundwater restoration: (1) Highly polluted area of the upper Rhine valley alluvial aquifer - pollution comes from tailings produced by the potash ore processing plants. (2) Intensive agriculture in the alluvial plain of the Alsace region, France, has resulted in increasing nitrate concentrations in the upper Rhine valley alluvial aquifer; and (3) a small sandy aquifer in the North Jutland Region of Denmark. Aquifer polluted by agricultural: pesticides & nitrate.	N/A	All local users and nonusers	EU w/case studies in Fabce, Denmark and Germany Alsace and Dastrup
Šceponavic iut et al. (2010)	NERIS CASE STUDY - Lithuania	CV	• River basin • The main water users in the Neris river sub-basin are households, industries and fisheries. Water	In order to reflect sensitivity to scope, a two-step scenario assessment was performed, and the questionnaire consisted of two major parts – one related to the clarification of the respondent's willingness to pay for water quality	Not provided	users and nonusers national (Lithuania)	Nemunas River Basin District in Lithuania. Neris river sub-basin

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
			needs in agriculture are not very high, Water use for recreation is gaining increased importance in general in Lithuania; Commercial fishing has been banned. The scale of hydro energy production in the Neris River basin is not very broad. Number of cultural and historical sites, valuable landscapes and meandering rivers can be found in the basin; therefore several protected areas exist in the region.	improvement and the other one related to the respondent's willingness to pay for water quality improvement and the achievement of good ecological status, i.e. river re-meandering. The scenarios included: 1) Biodiversity value (plant, animal species) 2) Landscape value (aesthetical view) 3) Recreational value (swimming, boating, fishing opportunities) 4) Quality level increase from yellow to blue (two levels)			
Semeniene (2007)	Environmental Benefit Valuation in Lithuania	mostly CV	• Rivers and coastal areas depending on case study • Not stated	Ecological water quality in most cases, but no details available on this was described, apart from in maps for the Neris Case study area.	No detail available	Local users and non-users	Baltic Several different case studies, in the region
Toivonen et al. (2004)	The economic value of recreational fisheries in Nordic countries	CV(OE)	• All river and coastal fishing areas • Recreational fishing	Regression models were used to identify demo-graphic characteristics, types of fishing patterns and differences in the countries' management regimes	None	Use and non-use of recreational fisheries on 5 countries	five Nordic countries Denmark, Finland, Norway, Sweden

Author/ Year	Reference title	Val. Tech [29]	Water body type & non market good/service(s)	Details of physical change	Scientific data	Affected population	Country & site locations
				that can explain both actual fishing expenditure and willingness to pay for the non-market benefits by persons participating in fishing or enjoying the benefits derived by it. Net benefit, i.e. willingness to pay over and above actual expenditure was highest amongst those fishing.			and Iceland