EPI WATER

Evaluating Economic Policy Instruments for Sustainable Water Management in Europe

Toolbox and guidance document

Deliverable no.: D 2.2
July 5th, 2011

Grant Agreement no. 265213
FP7 Environment (Including Climate Change)

COOPERATION

Deliverable Title	Toolbox and guidance document
Filename	epi-water_DL_2-2_final.doc
Date	30 June 2011

Prepared under contract from the European Commission
Grant Agreement no. 265213
FP7 Environment (including Climate Change)

Start of the project:	01/01/2011
Duration:	36 months
Project coordinator organisation:	FEEM

Deliverable title:	[WP2. Task 2.9. Toolbox and guidance documents]
Deliverable no. :	D 2.2

Due date of deliverable:	Month 6 – June 2011
Actual submission date:	Month 6 – July 5th, 2011

Dissemination level

X	PU	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the Commission Services)
	CO	Confidential, only for members of the consortium (including the Commission Services)

Deliverable status version control

Version	data	Authors
1.0	30 June 2011	Lead authors: Pierre Defrance (ACTeon), Pedro Andrés Garzón Delvaux (ACTeon) and Verena Mattheiß (ACTeon) Other contributors: Mikael Andersen (AU-NERI), Maggie Kossida (NTUA) and Jaroslav Mysiak (FEEM) Reviewers: Gonzalo Delacámara (IMDEA) and Carlos Mario Gómez Gómez (IMDEA) Layout and editing review: Martina Gambaro (FEEM)
1.1	5 July 2011	Final review and approval by the coordinator.

Preface

Abraham Maslow's witty and satirical statement 'If the only tool you have is a hammer, you will see every problem as a nail' does not lose its appeal despite years of use. Far too often, the specific contexts under which a policy instruments operates, whether well or poorly, are sacrificed to the generality of applied tools and methodologies. Here, we don't follow this path. Instead, we explore the variety of methodological approaches, suitable to describe the performance of EPIs and best adapted to the specific needs of each case study.

The Toolbox (deliverable D2.2) is a twin deliverable to the Assessment Framework (D2.1). It consists of an **introductory paper** (Part I) and two **databases** (Part II and III). The D2.2 offers tools and methodologies to choose from when conducting the thirty or so ex-post review studies of the existing Economic Policy Instruments (EPIs) in the WP3. The Toolbox is an evolving product, collecting the advice provided for the review studies, and lessons drawn from them. The revised and enhanced version of the Toolbox will be completed in month 13 and become part of the deliverable (D2.3). Subsequently, it will be turned into a more user friendly format and completed with selected examples of how the different assessment criteria have been handled using different methodologies and tools. In this form, it will advise the conduct of the ex-ante case studies in the WP4. Before the end of the project, the final version of the Assessment Framework and the Toolbox will be connected to the WISE-RTD portal which collects research results useful for the implementation of the Water Framework Directive and other environmental policies.

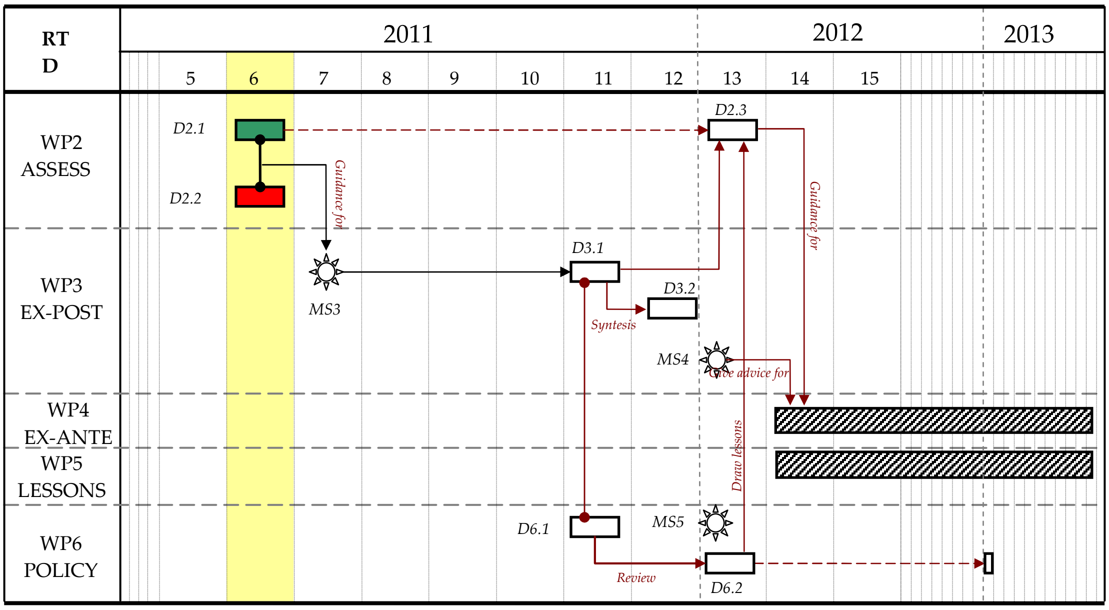

Figure 1. Road map of EPI-WATER *work packages*

Executive Summary

The D2.2 consists of an **introductory paper** (IP, Part I) and **two databases** (Part II and III). The IP provides a brief conceptual description of the toolbox, summarises what methodologies and tools have been used for similar scope in the past assessment studies (literature review), and discusses the role of the National Accounts for the policy assessment. The two databases provide an in-depth description of tools and methodologies to be applied in connection with the Assessment Framework (AF, D2.1), and offer additional details obtained from the literature review.

The Toolbox is an evolving product. It will be updated and complemented with detailed guidance documents throughout the ex-post and ex-ante assessment exercises in the WP3 and WP4 respectively. The final version document will feed into the 'Lessons learned' under the WP5.

To meet the variety of criteria introduced in the Assessment Framework (AF, D2.1), the Toolbox consists of a number of assessment methodologies and tools to choose from. Some of them are analytical and quantitative; others are qualitative, narrative-based or interpretative. The Toolbox draws on a number of European research projects and their results, offering insights and lessons learned from using the application of the methodologies and tools in different contexts and different purposes. These include projects identified previously as complementary for the scope of the EPI-WATER: CONHAZ, MEDIATION, XEROCHORE, POLICYMIX and ACQUAMONEY.

The **Toolbox** is organised as a database or catalogue advising the choice from among the variety of assessment methodologies and tools available, applicable for any given criterion of the AF. The list of initially included tools and methodologies is far from being complete. It will be enhanced and complemented with detailed application guidance documents. Note that the tools can be used interchangeably. They allow for flexibility needed to analyse the different EPI and the background conditions under which these are set to operate.

We pay attention to **Environmental-Economic Accounting** (i.e. National Accounts, NA) as a specific type of tool which potential for policy analysis has been insufficiently exploited. NA is relevant for addressing environmental outcomes, economic criteria and distributional effects. We aim at testing the Accounts in the context of several case studies, particularly in ex-ante assessments inWP4.

The **literature review of past assessment**, although not exhaustive, offers some useful insights and lessons learned for the implementation of the EPI-Water project. Generally, the EPI-WATER is more ambitious than most of the studies conducted so far. Only one past reference study addressed – at least to some extent– all assessment criteria included in the AF. The EPI-WATER project enters 'uncharted waters' for example by application of chronological flow chart to trace down the transaction costs, or by addressing distributional equity following the Stiglitz Commission's Wellbeing indicators.

The reviews shows limitation of the past studies in terms of the level of detail; type of the EPI and performance addressed; scope of the evaluation; data availability; time and budgetary constraints. Many assessment exercises are based on qualitative narratives, literature review, interviews or simple data analysis

Given that most of the past studies are based on piecemeal data and single assessment tools, employ only a few assessment criteria, rarely compare the EPIs with alternative policy instruments, and hardly use counterfactuals; it is expected that the EPI-WATER will significantly contribute to advancing our understanding of EPIs.

However, the literature review also shows that the revision of the Toolbox and the Assessment Framework will be essential, as some aspects (like effects on competition and competitiveness) might have been neglected so far.

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D 2.2 – Toolbox and guidance document

1. Introduction

The deliverable 2.2* describes assessment methods and tools that have been or could be applied for the assessment of Economic Policy Instruments (EPIs). As a twin deliverable to D2.1 (Assessment Framework, AF), it offers methodological guidance for the choice and application of a wide range of tools and methodologies suitable to assess different criteria against which to judge the EPIs performance.

The D2.2 is **not a report**. Rather, it is an initial version of the Toolbox scheduled to be updated and complemented with detailed guidance documents throughout the ex-post and ex-ante assessment exercises in the WP3 and WP4. The final version document will feed into the 'Lessons learned' under the WP5.

The deliverable D2.2 is divided into three parts:

Part I specifies the structure of the Toolbox (Section 2), discusses the role of the Environmental-Economic Accounts (Section 3) and summarises the insights gained by reviewing some 30 past policy assessment studies (Section 4).

The literature review offers a survey of methods and tools used in the past policy assessment exercises. It does not attempt to duplicate efforts of other research projects such as ACQUAMONEY, XEROCHORE, MEDIATION, POLICYMIX and CONHAZ. To the possible extent, we draw on the results and deliverables of these projects. Given the wide scope of the AF, the Toolbox collects available information and knowledge, and aptly complements it so as to advise the EPI-WATER research.

Particular attention is paid to Environmental-Economic Accounts (i.e. National Accounts, NA) and how these might be used (and adapted as necessary) for supporting the assessment of a wide range of EPIs. NA can be used, at least to some extent, to address EPIs from a macro perspective (i.e. whole economic sectors).

Part II contains the full detailed of the past studies (literature review) summarised in this document (Section 4).

Part III extracts the content of the initial database of the tools and methods. It contains a lengthy description of a variety of different methodologies, their strengths and recognised weaknesses, and additional information.

* The authors would like to thank Gonzalo Delacámara and Carlos Mario Gómez Gómez for their constructive comments during the review process.

PART I – EPI-WATER Toolbox: Introductory paper

2. Toolbox database

The Toolbox is designed as a database connecting the assessment criteria and tools that can be used for their evaluation. The database (see Part III) gathers the methodologies and tools suggested as relevant to answer the critical assessment questions posed by the AF. The objective is to provide the assessors with guidance as to how to address the different assessment criteria of the AF.

The tools include, *inter alia*: hydro-economic models, economic valuations methods, macroeconomic models taking into account water use (CGE), water accounting, and integrated modelling. These tools are referred to as "analytical tools". For the purpose of the Toolbox, we define tools whose application requires human and technical resources, and is supervised by trained experts, able to understand and conduct the policy analysis in a way that is functional to inform policy decision makers. For any given assessment criterion, several tools can be used interchangeably.

The initial database of tools is neither exhaustive nor final. It will be further developed and validated in the context of the ex-post (WP3) and ex-ante (WP4) policy assessment exercises. Some have broad applicability, while others are quite narrow in their scope.

The NA are a special tool particularly relevant for addressing environmental outcomes, economic criteria and distributional effects.

The Toolbox database is accessible following the link in Part III of this document.

2.1. Structure

The selected tools are described in the toolbox according their purpose, requirements, strengths and weaknesses following the structure of the Toolbox Database in Table 1.

Table 1. Structure of the Toolbox Database

"Assessment criterion"	
Subcriteria	Subcriteria considered
Approach	Broad approach
Description	General description of a family of tools
Name of the tool	Specific name of the tool
Type of tool	Experimental methods, Survey methods, Field study / social anthropology methods, Modelling, Interpretative, Critical, Participatory, Evaluative
Description and purpose	Objective of the tool
Principal steps required to implement the tool	Work flow through which the tool is being applied.

Indicators (Indicate if indicator is Direct or Proxy)	
Strengths	List strengths
Weaknesses	List weaknesses
Type of EPIs which can be assessed with the tool	All water tariffs taxes & charges subsidies tradable permits compensation mechanisms voluntary agreements & PES Insurance, finance and full cost recovery mechanism
References, handbooks and articles	Complete references of guidelines documents or relevant papers
Comments	Practical experiences from project partners with this tool, suggestions (this will be completed throughout the development of WP3 and WP4)

The toolbox also reference approaches, which could be useful for the assessment and makes the link between the tools and criteria.

2.2. Source of information

The database is based on the past assessment studies (see Part III) and expertise of the consortium partners. 2.1-2.7). In brief, the toolbox contains the following information:

- Tools identified or briefly discussed in the AF (D2.1);
- Additional references including the insights from the literature review (Section 4 and Part II).

2.3. Using the Toolbox Database: ex-ante and ex-post conditions

The main guiding principle during the assessment is to follow the critical questions described in the AF. In some cases only a coarse approach is possible or necessary while in others, a comprehensive analysis in line with the non-experimental evaluation method is preferable and feasible.

A fundamental issue to account for during the assessment is that a tool favoured for the evaluation of a given criterion for each EPI-Water case study will primarily depend on the data available for such experience. This is particularly (expected to be) true for ex-post assessments where assessors will have more limited elbowroom.

However, the contribution of the Toolbox is expected to have a larger role in the development of the ex-ante assessments. The prospective approach offer more freedom as to which approach and tool to use, although not all tools can be used in this form.

Whatever the degree of complexity, the toolbox will support the analysis of the cases with counterfactuals in mind so to control for competing explanations of perceived change not related to the implementation of the EPI.

However, given the variety of objectives and instruments, the options presented may be complementary rather than exclusive, as highlighted by Fahrenkrog et al. (2002).

3. Environmental-Economic Accounting: A focus

3.1. Introduction

As indicated by the objectives of the project, particular attention is given to Environmental-Economic Accounts (i.e. National Accounts, NA) and how these might be used for supporting the assessment of a wide range of EPIs. This potential is not developed as one of the assessment criteria in the Assessment Framework and therefore deserves some detail in this presentation of Toolbox. As such these Environmental-Economic Accounts are not an assessment criteria but rather a tool by which certain (EPIs) can be approached for assessment using physical and macroeconomic statistical records to be designed, monitored and assessed at a macro level. The macro level would entail manipulating aggregated, sector wide information. Although such the Accounts can be classified as information tools, they also offer some analytical opportunities that the project will explore. Analytical examples that this type of tool can be, for example, is that they provide criteria for prioritising a sector that could be targeted by an EPI, and also provide some level of integration of assessment criteria at this aggregated level.

As such the information provided by such macro accounts include environmental effectiveness, economic efficiency and distributional implications of potentially assessed EPIs.

These Accounts will be tested as assessment tools for a selected number of case studies. The scope of their analytical contribution will be scrutinised in WP4, after which, their place in the Toolbox will be revised. At this stage it is important to highlight that the information dimension of this tool is still under construction is not comprehensive yet and if used in the assessments, the other tools covering all the criteria are also expected to support the development of the assessments.

3.2. Accounts

According to the Global Water Partnership (2004), following an integrated water management (IWRM) approach for policy-making and planning requires:

(a) policies and priorities take water resources implications into account, including the two-way relationship between macro-economic policies and water development, management and use;
(b) there is cross-sectoral integration in policy development;
(c) stakeholders are active in water planning and management;
(d) water-related decisions made at local and river-basin levels are in-line with, or at least do not conflict with, the achievement of broad national objectives; and
(e) water planning and strategies are integrated into broader social, economic and environmental goals.

The formulation and evaluation of water related policies, such as those aiming at efficient water allocation and cost recovery of the water services, are at the heart of water management. Policy makers taking decisions on water need to be aware of the likely consequences for the economy. Those determining the development of e.g. industries making extensive use of water resources, either as inputs in the production process or as sinks for the discharge of wastewater, need to be aware of the long term consequences on water resources and the environment in general, and possess suitable tools for effectively and equitably formulating these decisions. Such tools are not adequately developed or readily available and in many cases need to be based on a uniform integrated system with common concepts, data definitions and classifications, which allows for derivation of consistent indicators across countries and over time.

BOX 1 - The System of Environmental-Economic Accounting for Water (SEEA-Water)

The SEEA-Water is a conceptual framework for the organization of physical and economic information related to water using concepts, definitions and classifications consistent to those of the System of National Accounts 1993 (1993 SNA). The SEEA-Water framework is an elaboration of that in the handbook Integrated Environmental and Economic Accounting 2003 (SEEA 2003) which describes the interaction between the economy and the environment and covers the whole spectrum of natural resources and the environment.

Source: UNSTATS (http://unstats.un.org/unsd/envaccounting/seeaw.asp)

Environmental accounting is one of the key tools for assessing environmental issues and their relation to the economy, and was claimed to be the *"best option" for integrating social and environmental considerations into EU decision making in the long* *term" at the "beyond GDP"* conference[1]. A key advantage of the accounting framework is that it offers a platform for better integrating heterogeneous information, qualifying it and, to some extent, paving the way for accurately quantified scenario analysis. The "System of Environmental-Economic Accounting for Water (SEEAW)" developed by the United Nations Statistics Division (UNSD) aims at standardizing concepts and methods in water accounting. It provides a conceptual framework for organizing economic and hydrological information permitting a consistent analysis of the contribution of water to the economy and the impact of the economy on water resources. It is linked to a full range of economic activities with a comprehensive classification of environmental resources and includes information about all critical environmental stocks and flows that may affect water resources and that may be affected by water policies.

A reference of such accounts is developed in the Toolbox Database (see Part III, Environmental outcomes & Economic Assessment criteria) and is briefly presented in Box 1 (above).

The SEEAW is a useful tool in support of IWRM by providing the information system to feed knowledge into the decision-making process assisting policy makers in taking informed decisions on (SEEAW, 2006):

- *Allocating water resources efficiently,* as it presents the quantity of water used and who is using it, and provides information about the economic values added generated by different industries. It allows thus the derivation of water efficiency and productivity indicators, and helps water managers with developing policies for competing water uses.
- *Improving water efficiency:* Water efficiency can be improved from the demand or the supply side. On the demand side, policy makers are faced with the decision of which economic instruments to put in place in order to influence the users' behaviour. On the supply side, they can encourage the efficiency of the water supply or irrigation systems as well as the reuse of water. SEEAW provides information on the fees paid for water supply and sewerage services, as well as payments for permits to access water resources, either for abstracting water or for using water resources as a sink. It also provides information on the quantity of water, which is reused within the economy that is water that, after use, is supplied to another user for further use, thus offering policymakers a database that can be used to analyze the impact of the introduction of new regulations throughout the economy on water resources.
- *Understanding the impacts of water management on all user,* and evaluating tradeoffs of different policy options on all users.
- *Getting the most value for money from investment in infrastructure.* Investment in infrastructure needs to be based on the evaluation of long-term costs and

[1] ENDS Europe DAILY (2007) Conference held in Brussels on November 19Th 2007. No. 2432, 20/11/07. http://www.endseurope.com/14171?referrer=search

benefits. Policy makers need to have information on the economic implications of infrastructure maintenance, water services and potential cost-recovery. The water accounts provide the information of current costs to maintain existing infrastructure, the service charges paid by the users, as well as the cost structure of the water supply and sewerage industries. Therefore they can be used in economic models to evaluate potential costs and benefits of putting in place new infrastructure.

- *Linking water availability and use.* Improving efficiency in the use of water is particularly important in situations of water stress. For the management of water resources, it is important to link water use with water availability. The SEEAW provides information on the stocks of water resources as well as all changes in stocks due to natural causes (e.g. inflows, outflows, precipitation) and human activities (e.g. abstraction and returns). Further, water abstraction and returns are disaggregated by industry, thus facilitating its management.
- *Providing a standardized information system which harmonizes information from different sources and is used for the derivation of indicators.* Information on water is often generated, collected, and analysed by different agencies. The individual datasets might be collected for different purposes, use different definitions and classifications and show overlaps in data collection. A SEEAW based water account allows for disparate information to be integrated

At this stage it is important to highlight that there is as yet no developed approach for how to integrate quality issues in environmental accounts. Thus this reason the present sub-task will take a methodological orientation and explore feasibility of progressing from monetary appraisal of water quality attributes to evaluation of economic policy instruments. The method applied for monetary valuation is catchment-specific. EPI-Water allows applying the method to more catchments as well as for the first time exploring implications of applying economic policy instruments. This can be done within a welfare economic framework informed by the benefit estimates arrived at.

3.3. The dimension of quality

The modelling framework will be calibrated to provide catchment specific benefit estimates. The extension activities would include checking on the agricultural data feeding the nutrient loss modelling framework. The extension activities would result in updated estimates for the external costs that are to be addressed by policy instruments. Using up-scaling matrix it is possible to infer from catchment level characteristics.

The utilisation of Accounts would entail that the criteria against which EPI's should be assessed include environmental effectiveness, economic efficiency and distributional implications.

Environmental effectiveness follows directly from the integrated water quality modelling referred to. Economic effectiveness will require a broader welfare economic framework within which to place EPI's and their effects.

For ex-ante assessment, a baseline scenario can be defined comprising business-as-usual activities and existing policy instruments. A reference scenario need then to be defined for each economic policy instrument to be explored, these reference scenarios may also include adjustments in existing national level policy instruments as a policy-maker would see fit. When analysing quality issues, emitters' adjustment to modulations in EPI's will be gauged from elasticity estimates available in literature. A sector input-output model will be selected to estimate how the impacts of the EPI's will come through.

Note that the possibilities offered by EPI and on basis of a programmed ex-ante case study, it could be possible to outline an extension of the UN framework for environmental accounts (SEEAW) which addresses the quality aspects.

3.4. The dimension of quantity

3.4.1. Water asset accounts

These accounts focus on the quantitative assessment of the stocks and the changes in stocks. Such changes occur during the accounting period and link information on the abstraction and, discharge of water with information on the stocks of water resources in the environment. In particular, the attempt will be to represent:

- Opening and closing stocks which are the stocks level at the beginning and end of the period of time
- Increases in stocks which include those due to human activities (i.e. returns) and natural causes (e.g. inflows, precipitation)
- Decreases in stocks, which include those due to human activities (i.e. abstraction) and natural causes (e.g. evaporation/evapotranspiration, outflows etc.)
- Additional information on the exchange/flow of water between water resources

3.4.2. Water supply and use accounts

The compilation of the water supply and use per source and sector can describe three types of flows (from the environment to the economy, within the economy, and from the economy to the environment) allowing for:

- The assessment and monitoring of the pressure on water quantities exerted by the economy;
- The identification of the economic agents responsible for abstraction and discharge of water into the environment; and
- The evaluation of alternative options for reducing the pressure on water.

In combination with monetary information on value added, indicators of water use intensity and productivity can be calculated.

3.4.3. Hybrid and economic water accounts

The objective of these accounts is to study the economy of water, that is to describe in monetary terms the use and supply of water-related products and to identify:

- The costs associated with the production of these products,
- The income generated by their production,
- The investment in water-related infrastructure and the costs to maintain them,
- The fees paid by the users for water-related services as well as the subsidies received.

Economic instruments to manage water, namely taxes on the use of the resource and permits to access it, could also to be incorporated. This type of accounts is considered to be more challenging, nevertheless using the hybrid accounts in economic models permits the analysis of possible trade-offs between alternative water policies and economic strategies.

The following specific accounts are included in the Hybrid and economic accounts:

a. Hybrid accounts for supply and use of water

They provide information by industry on the output produced, including water-related output, the intermediate consumption, including the costs of purchasing water and sewerage services and value added. It forms the basis for the calculation of a consistent set of hydrological-economic indicators.

b. Hybrid accounts for water supply and sewerage for own use

They explicitly identify the intermediate costs and output of water-related activities when households and industries they are carried out for own use. To assess the contribution of water-related activities to the economy, the costs of these activities need to be separately identified. Hybrid accounts for own use are compiled for the following activities: Water collection, treatment and supply (ISIC 36), Sewerage (ISIC 37) Remediation activities related to water (part of ISIC 39) could also be carried out for own use. They, however, are not included in the simplified standard tables because they are usually small.

c. Government accounts for water-related collective consumption services

For analytical purposes and, in particular for compiling the table of financing, it is useful to develop economic accounts for government expenditures on water-related services. These are classified according to the Classification of the Functions of Government (COFOG) (UN, 2000b). COFOG is a classification of expenditures by the government according to purpose: it classifies transactions such as outlays on final consumption expenditure, intermediate consumption, gross capital formation and capital and current transfers by general government according to the function that the transaction serves. The following functions classified in COFOG are relevant for water: Wastewater management (COFOG 05.2), Soil and groundwater protection (part of COFOG 05.3), Environmental protection not elsewhere classified (n.e.c.) (related to water) (part of COFOG 05.6), Water supply (COFOG 06.3.)

d. National expenditure accounts and financing accounts for (i) wastewater management, (ii) the protection and remediation of soil, groundwater and surface water

The national expenditure and financing accounts for water-related activities above are classified by purpose. They are based on environmental protection expenditure accounts (EPEA). Information from the hybrid and economic accounts presented in the previous sections provide inputs to these tables. The National Expenditure accounts aim at recording the expenditure of resident units and financed by resident units in order to get a total that corresponds to the effort a nation is making out of its own resources. They are compiled for environmental protection related to water, namely Wastewater management and Protection and remediation of soil, groundwater and surface water as well as for Water management and exploitation. Users of water-related products do not always bear the entire costs of production. In the case of water, it is not uncommon for users to receive transfers from other units (generally the government). These transfers include subsidies on the production of water-related products, investment grants and other transfers that are financed either from government expenditure or from specific taxes. The National Financing accounts describe the financing of national expenditure by identifying the financing sector (e.g. which sector is providing the financing) and the beneficiaries (e.g. which units benefit from the financing), as well as the amount being financed

e. Economic accounts supplementary information:

They provide information on labour input (number of workers, total hours worked) by industry

Please refer to the Toolbox Database (*National Accounts*) in Part III. Annex I provides detailed examples of what the SEEWA tables have to offer.

4. Assessing Economic Policy Instruments (EPIs): A review

In order to gain insights into which tools and assessment methods have been used in the past to evaluate EPIs, a literature review has been conducted. This exercise allows grasping, to a certain degree, whether the tools identified and linked to the assessment criteria of the Assessment Framework (AF) and consequently catalogued in the toolbox have already been used for the evaluation of EPIs beforehand, giving in this way legitimacy to a number of approaches. At the same time, the literature review provides references representing sources of ideas for those making the evaluations and helps to ensure that evaluation work during the EPI Water project will be built on previous knowledge, by making the best out of other research projects' outcomes. This task can also be helpful to identify tools which are not yet included in the toolbox but which might be so after revision at a later stage, following the development of the ex-post assessment of 30 case studies in both Europe and beyond.

The literature review of past assessment exercises also sheds light on the type of criteria and indicators used in past evaluation studies. Likewise, this may be handy to check whether the Assessment Framework of this project has covered all the important criteria or whether additional aspects should be subsequently included.

This task has been accomplished through a screening of documents, which evaluate economic policy instruments applied in the field of water resources. Far from being exhaustive, the attempt has been made to cover a broad variety of different instruments and locations (examples from different countries within Europe as well as some studies from beyond). Emphasis has been placed on more recent studies. Literature sources considered are (almost) exclusively written in English, so they can easily be looked up as a reference during the evaluation of the EPI Water case studies. Although no distinction has been made during the selection of the literature sources concerning the level of detail of analysis, documents that only provided descriptive comparisons of existing EPIs without assessment were excluded.

In order to facilitate comparison of the different sources, a review Table has been developed and filled in during the screening exercise. The elements included are shown in Table 1. It indicates the type of EPI regarded, the tool used for the evaluation and the criteria and/or indicators, which have been assessed.

Table 2. Review table template used for the literature screening

Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	Full reference of the study	Comments

4.1. What has been the trend in assessing EPIs?

A total of 38 relevant documents have been screened. They cover a wide variety of different economic policy instruments applied in the water sector, including amongst others water pricing schemes (household, irrigation), taxes on pesticides and fertilizers, water markets, water effluent charges and payments for environmental services (see table below for the type of EPIs evaluated in the different documents). The list of literature sources includes both quite "short" evaluations) as well as in-depth studies of individual EPIs (e.g. Neverre et al., 2010). Several documents provide comparisons of different EPIs (e.g. Bernstein, 1997). Most sources present ex-post evaluations, only some studies have been found which have been carried out ex-ante (e.g. Swedish Environmental Protection Agency, 2009).

The details of the analysis can be consulted in Part I.

Concerning the kind of **tools** used for evaluation of water-related EPIs, several aspects are worth mentioning. Basically, the tools that have been used depend on the detail of the evaluation (in-depth or not) or on whether only one specific criterion has been assessed or rather several have. A number of studies are mainly based on a literature review and provide an evaluation in the form of a qualitative narrative. This includes a description of the effects of EPIs, also in the form of numbers (e.g. amount of revenue collected), but without using a specific tool. In some cases, the authors themselves have developed evaluation tools. This includes for example evaluation questionnaires (ECOTEC et al., 2001) and evaluation matrixes (e.g. Mattheiß et al., 2009)).

Counterfactual approaches to evaluation have explicitly only been used in four of the screened documents. This includes both counterfactuals in terms of comparisons between two scenarios in the same area (present-day situation compared to the introduction of an EPI – e.g. Swedish Environmental Protection Agency, 2009) as well as in terms of comparisons with other geographical areas (with and without the EPI introduced – e.g. Hoffman, 2008).

Several studies use modelling for evaluation purposes. Examples can be found for General Equilibrium Models (e.g. van Heerden et al., 2008 on water taxation or Brouwer et al., 2008, on emission permit markets) as well as “simpler” models adapted to the specific evaluation purpose (e.g. Zinnes et al., 1999).

Surveys administered to inhabitants or stakeholders have been carried out in one case amongst the reviewed sources (Zheng & Zhang, 2006). Glachant (*after* 1999) uses the description of historical evidence in order to address the institutional setting of EPIs.

However, not all types of tools used for evaluation might be evident directly from the literature. It is, for example, not always clear whether information has been gathered by interviews, or if another data collection process has been used.

Concerning the kind of **criteria** assessed within the literature sources reviewed, most of the evaluations consider economic impacts and environmental outcomes, followed by the institutional set-up and equity aspects. Several sources look also at transaction costs and questions of policy implementability, respectively. Uncertainty is explicitly considered only in a few cases (e.g. Lenouvel & Montginoul, 2009).

It is noteworthy that, although one of the just mentioned criteria has been addressed during the evaluation, authors often focus on selected aspects. Regarding the assessment of economic criteria, studies concentrate for example on the assessment of the effect on land use values and third party effects (Libecap & Shaw, 2005) or the cost-recovery function of EPIs (Berbel et al., 2008).

A few examples of evaluation studies of water-related EPIs could be found which cover nearly all evaluation criteria developed under the assessment framework of the EPI water project, although in varying detail (e.g. MacDonald et al., 2004). None of the documents screened covers all criteria.

Two sources have been screened which focus amongst others on the impact of EPIs on competition and competitiveness (e.g. Speck et al., 2006), an issue which is only slightly addressed by the current EPI Water assessment framework.

4.2. References and guidance

This section is still under construction and will be the part that is expected to evolve the most just during the development of WP3 and WP4.

The next step in the literature review consists in completing the cross referencing of the references gathered with i) the EPI to which they apply and ii) the assessment criteria that they analyse.

Table 3. Type of instruments evaluated by the references in the Review of Literature.

Type of instrument		Reference number of the literature review analysing this type of instrument
Taxes and charges	Water tariffs (pricing)	1, 2, 3, 5, 6, 7, 8, 21, 23, 25, 26, 27, 28, 30, 35, (38)
	Environmental tax	2, 11, 13, 15, 21, 24, 28, 29, 31, 32, 34
	Environmental charge	1, 2, 7, 15, 16, 21, 23, 24, 25, 27, 30, 38
Subsidies	Subsidies on Products	7, 24, 29, 30
	Subsidies on Practices	1, 11, 20, 24, 25, 29
Markets for environmental goods	Tradable permit for pollution	2, 7, 10, 12, 13, 23, 24, 29, 33, 36
	Tradable permit for abstraction	2, 8, 9, 14, 17, 19, 22, 24, 25, 28, 30, 36
	Compensation mechanisms	2, 24, 37
Voluntary agreements		(2), 18, 24, 37
Other		2, 7, 23, 24, 27, 29, 30, 38

Note: See Part II to identify the references corresponding to the different reference numbers.

In addition to Table 3, an updated selection of the relationship between references and the type of EPI has been formulated based on the Review and the Toolbox in addition to additional references[2]. Note that by following each EPI type, according to the Assessment Framework (Table 2, section 1.1) and used in Table 3 here, it is not possible to be exhaustive as because this branch of knowledge is rapidly growing. However, a more comprehensive presentation is possible by presenting key authors, best practices worldwide, main assessments, and related surveys. This review is to be expanded subsequently:

a) On **taxes and charges**, Stavins (2001) provides a clear view. Some examples of specific studies, which could also serve as a benchmark, are Molle (2009) on water pricing for scarcity management, Rey et al. (2010) on charges in the industrial water sector, and Ward and Pulido-Velazquez (2009) on incentive pricing.

b) On **subsidies**, Millock and Nauges (2010), on household adoption of water-efficient equipment, might be relevant.

c) On **water markets**, a pretty updated and comprehensive review was produced in the US NBER (Grafton et al., 2010). Further to that (and this is valid for other EPI types), it might be advisable to build on the project consortium knowledge to provide the most relevant references for those countries in which each EPI has been implemented in a deeper way. Regarding water use right markets, one may refer, therefore, to the Western states of the USA (Basta and Colby, 2010; Easter, 2009; Hadjigeorgalis, 2008; Brewer et al., 2007); Chile (Donoso et al., 2004; Bauer, 2005, 2010; Cristi and Díaz, 2008); or Australia (Brook and Harris, 2008; Grafton et al., 2009; Young, 2010).

d) On **voluntary agreements**, Colby (2011) is an excellent reference on conflict resolution and negotiated agreements. D'Estrée and Colby (2000) is a guidance document to evaluate success in environmental conflict resolution, and builds upon previous references by B. Colby on negotiated transactions as a water conflict resolution mechanism.

e) On **insurance**, Glenk and Fischer (2010), for instance, have recently provided a good reference to deal with uncertainty and risk. The study is aimed at analysing how social agents evaluate policy options that aim at climate change adaptation and, more specifically, to reduce the risk from flooding and low flows.

[2] These will be more fully reviewed and introduced in the final Bibliography (i.e. References section of the document)

f) On **cost recovery**, François et al. (2010) also provide a very recent reference for the water and sanitation sector, but methodologically strong references on a wider perspective can also be found: i.e. Schoengold and Zilberman (2010).

With respect to the assessment criteria, it is also possible to follow a similar presentation. Note that The Review of Literature related each reference to the type of assessment criteria in Part I and in the Toolbox in Part II. However, the guidance could also be approached as:

a) On **institutional analysis**, both Coase (1998) and Hodgson (1998, 2006) provide a conceptual reference on institutional economics. Ménard (2011) provides a survey, mainly based on water management. Vatn (2010) produced an institutional analysis of payments for environmental services. Authors like Saleth and Dinar (2004, 2008) or Blomquist et al. (2010) have been regularly publishing on this field.

b) On **environmental outcomes**, relevant references can be found under Task 2.1 of D 2.1, which provides a very detailed bibliography. Yet, to provide an example, Harou et al. (2009) includes a very thorough survey of selected hydro-economic modelling applications., which might be of help for EPI assessment.

c) On **transaction costs**, one may expect to find at least Crals and Vereeck (2005) or one of the three recent papers by K. Krutilla on transaction costs, such as Krutilla and Krause, 2010, 2011). Other interesting references on transaction costs are Pérard (2009) or Olmstead (2010).

d) On **social equity and acceptability**, the basic conceptual papers are relevant but out-dated (Rawls, 1971) or Elster (1992). However, more recent references linked to water management are Hannigan (2011), and McDonald et al. (2011). A further step linking social equity with EPIs could be Giannoccaro et al. (2010) or Schoengold (2010).

e) On **economic assessment criteria**, a relevant set of references can be identified starting from the WATECO Guidance Document no. 1 for the WFD implementation. Joyce and Convery (2010) also shed light on the economics of the WFD (including EPI assessment). Brouwer (2008, ed.) provides a good reference on CBA and water management, and this is far from being the only one. Tol (2009) also provides a useful reference, with strong methodological foundations, on economic modelling.

f) On **uncertainty**, beyond the references on the "pedigree analysis" on Task 2.7 of D 2.1, should anyone want to explore for EPI assessment purposes, other aspects of uncertainty, Brouwer and De Blois (2008) address modelling risk and uncertainty, Hughes et al. (2008) focus on price and investment policy for urban management under uncertainty, Luo et al (2007) studies water trading under uncertainty, and Koundouri et al. (2006) deals with irrigation technology under production uncertainty.

4.3. What lessons for the EPI-WATER project

Although keeping in mind that the literature review is not exhaustive, some conclusions for the EPI-WATER project can be drawn. One major outcome is that the project will provide an evaluation of economic policy instruments applied on water resources, which is more comprehensive (in terms of criteria assessed) than past evaluation exercises (See Part I for the screening of each study and the assessment criteria scrutinised). Only one reference could be found which addresses – at least at the margin – all of the assessment criteria identified in the assessment framework of the EPI Water project (see Grafton et al., 2010, on water markets). The project will furthermore be innovative in terms of the tools it will use for the evaluation of EPIs. One example is the evaluation of transaction costs through their mapping in the form of a chronological flow chart[3]. Another option to highlight is the assessment of distributional equity following the Stiglitz Commission wellbeing components, which are proposed in the toolbox of the EPI-WATER project.

Yet, the review also shows that the revision of the toolbox and the assessment framework at a later stage will be important, as some relevant aspects (like effects on competition and competitiveness) might have been neglected so far.

Finally, past evidence also shows that the level of detail of the evaluation of EPIs as well as the type of impacts assessed may vary depending on the purpose of evaluation, the type of EPI assessed, data availability and of course time and budgetary constraints. Evaluation consisting in qualitative narratives which are based on literature review, interviews and a "simple" analysis of data might be sufficient to evaluate certain impacts of EPIs in specific circumstances.

However, given that the majority of available studies is mostly based on scattered, *ad hoc* or partial information, makes use of a single analytical tool, considers a limited number of decision criteria (when not just one), only exceptionally compares EPIs with alternative instruments and uses counterfactuals only as an exception, it can be expected that the evaluation work undertaken by the EPI-WATER project will contribute significantly to an improved knowledge base necessary for informed decision making processes regarding EPIs on water resources.

[3] However, see also Crals & Vereeck (2005) which suggest a selection of chronological transaction costs.

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Note: Specific references indicated in the Toolbox can be found in Part III.

PART II – Literature review screening table

The xls version of literature review reference table is available at the following link:
http://www.feem-project.net/epiwater/docs/epi-water_DL_2-2_annex1_literature-review.xlsx

No.	Name of the study	Type of EPI assessed	Global approach OR Tool(s) used	Criteria / Indicators assessed	Which criteria are assessed? 2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
1	Andersen (2001) Economic instruments and clean water: why institutions and policy design matter	Economic instruments for water pollution control (charges, subsidies for the construction of sewage plants, pricing)	Comparative analysis Analytical narrative	Institutional set-up as a precondition for economic instrument implementation (Cost-effectiveness, transaction cost) - only mentioned				X	X	X		Economic instruments for control of water pollution in four OECD countries -- Denmark, France, Germany and the Netherlands -- from 1970-1990
2	Asian Development Bank (2011) Market-based instruments for water pollution control in the People's Republic of China	* Fee-based instruments (environmental taxes, pollution levies, and wastewater treatment tariffs) * Allowance-based instruments (emissions trading markets - e.g., water pollutant discharge permit trading, watershed water rights trading, and ecological and environmental compensation) * Input-based instruments (Public Private Partnerships, public finance) * guaranteed deposits; and subsidies and incentives	Litterature review and lesson learned from international experience for: (1) Water Quality Trading, (2) Water Pollution Taxes and Levies, (3) Water Resource Extraction Taxes and Fees, (4) Wastewater Taxes and Fees, (5) Public–Private Partnerships, (6) Wastewater Treatment Fee	Global narrative assessment of instruments	X			X	X			
3	Bartolini et al. (2010) Water management and irrigated agriculture in Italy: multicriteria analysis of alternative policy scenarios	Water pricing	Methodology is based on the multicriteria analysis (of indicators) of water and agricultural policy scenarios. Applies the analysis to the outcome of the simulation by Bartolini et al. (2007)	Indicators used: Farms profit, farms contribution to GDP, farm employment, genetic diversity, water use, nitrogen balance, pesticide risk	X					X		
4	Bate (2002) Water – Can Property Rights and Markets replace Conflict?		Literature review	Social aspects (pre-conditions, contraints, impacts)			X					

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
5	Bazzani et al. (2005) The sustainability of irrigated agricultural systems under the Water Framework Directive: first results	Pricing instruments	The methodology relies on scenario analysis combined with farm level mathematical programming models. Indicators are designed to fit the general framework represented by the DPSIR (Driving forces-Pressures-State-Impact-Response)	Selected indicators: For economic balance: Profit; net income; public support; value added For social impact: Farm employment For nutrients and pollutants: Energy balance; nitrogen balance; pesticide risk For landscape and biodiversity: Soil cover For water use: Water quantity used	X		X	X		X		
6	Berbel et al. (2008) Water Pricing and Irrigation: A Review of the European Experience	Irrigation water pricing	Literature review, qualitative narrative	Cost recovery, incentives for conservation and efficient water use	X			X				Compares different pricing schemes in Europe
7	Bernstein (1997) Economic instruments	All type	Qualitative narrative	Cost-effectiveness, administrative and financial feasibility, consistency with other objectives, equity, transparency, flexibility		X			X	X		No in-depth analysis of one instrument. The approach considers how to choose an adequate instrument.
8	Blanco et al. (2009) Groundwater development and wetlands preservation: assessing the impact of water conservation policies	Water pricing schemes (water use quota system) water rights market	Aggregated non-linear Mathematical Programming Model of constrained optimization cost-effectiveness analysis	Farmers' behaviour confronted to different policy scenarios (stakeholder-driven and policy-driven) under the uncertainty of climate and market variations / Farmer strategies groundwater consumption Income and risk (objective function) Policy, technical, economic, social (constraints)	X			X			X	

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
9	Booker & Young (1994) Modeling intrastate and interstate markets for Colorado River water resources	Market transfers	A monolinear optimization model was developed to estimate impacts of alternative institutional scenarios, river flows and economic demand levels. To estimate benefits of moving from existing allocations to those allowing transfers from expanded consumptive use markets	Quantity and quality dimensions are considered. The model links river flows, salinity concentrations and demand sectors across river locations. Annual consumptive use benefits, hydropower benefits, and cost and benefits of salt discharges are incorporated as integral model components	X	X		X				
10	Brouwer et al. (2008) General equilibrium modelling of the direct and indirect economic impacts of water quality improvements in the Netherlands at national and river basin scale	Emission permit market	Applied General Equilibrium Model (consisting of 27 production sectors, extended to water through the inclusion of substitution elasticities between labour, capital and emissions to water in the sectors' production funtions)	Water pollution	X			X				

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
11	Cai et al. (2003) Integrated hydrologic-agronomic-economic model for river basin management	Tax and subsidy systems to induce efficient water allocation	This paper presents the development of a new integrated hydrologic-agronomic-economic model in the context of a river basin in which irrigation is the dominant water use and irrigation-induced salinity presents a major environmental problem.	The modeling framework includes the following components: (1) flow and pollutant (salt) transport and balance in the river basin network, including the crop root zone; (2) irrigation and drainage processes; (3) crop production functions, including effects of both water stress and soil salinity; (4) benefit functions for both instream-water and offstream uses, accounting for economic incentives for salinity control and water conservation; (5) tax and subsidy systems to induce efficient water allocation, improvement of irrigation-related capacities, and protection of the environment; (6) infrastructure improvement with consideration of investment; and (7) institutional rules and policies that govern water allocation.	X			X				
12	Collentine (2005) Setting permit prices in a transferable discharge permit (TDP) system for water quality management	Transferable discharge permits	Supply curves calculation for abatement measures (modeled loss reductions) Composite market model	Quantify the effect of agronomic practices on nutrient losses	X							

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
13	Crals & Vereeck (2005) Taxes, Tradable Rights and Transaction Costs	Environmental taxes, tradable emission rights	(Literature review) Analysis of a selection of chronological transaction costs	Transaction costs (differentiation between ex-post and ex-ante)								The analysed EPIs are not specifically water related. However, the document has been included as the analysis can also be applied on water-related taxes and permits.
14	Donoso (2006) Water markets: case study of Chile's 1981 Water Code	Water markets	Literature review, qualitative narrative	Economic benefits, institutional framework, performance, transaction costs, uncertainty, availability of information	X	X		X	X		X	
15	ECOTEC et al. (2001) Study on the Economic and Environmental Implications of the Use of Environmental Taxes and Charges in the European Union and its Member States	Taxes and charges for water abstraction, waste water, pesticides and fertilizers	Evaluation questionnaire	Revenue and use of revenue, organisational roles and administration, complementarity within portfolio of policy instruments, environmental impacts, impacts on costs and prices, impacts on competition, competitiveness and trade, impacts on employment, effects on producers, impact on consumers, equity and distributional effects	X		X	X				The evaluation questionnaire used is available here: http://ec.europa.eu/environment/envec o/taxation/pdf/annex2.pdf
16	Glachant (after 1999) The Political Economy of Water Effluent Charges in France: Why Are Rates Kept Low?	Wastewater effluent charges	Description of historical evidence, simple economic modelling	Institutional setting; impact of the water charge on pollution abatement; relationship between the tax rate and the subsidy rate	X				X			

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
17	Grafton et al. (2010) An integrated assessment of water markets: Australia, Chile, China, South Africa and the USA	Water markets	Integrated framework developed by the authors. Many of the criteria/indicators used are qualitative measures derived from primary or secondary data, but some economic efficiency criteria are quantitative. Qualitative scores have been given by four ordinal rankings.	Institutional underpinnings, economic efficiency, equity and environmental sustainability. Each criteria is divided in several sub-criteria which are analysed separately. The framework can be used amongst others: to track performance over time; to identify ways in which water markets might be adjusted by informed policy makers to achieve desired goals; to identify strengths and limitations of water markets.	X	(X)	X	X	X	X	(X)	Transaction costs are mentioned, but not a specific focus of the analysis. The uncertainty is included in the aspect of "adaptive management".

No.	Name of the study	Type of EPI assessed	Global approach OR Tool(s) used	Criteria / Indicators assessed	Which criteria are assessed? 2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
18	Hoffman (2008) Watershed shift: Collaboration and employers in the New York City Catskill/Delaware Watershed from 1990-2003	Watershed collaborations	Creation of statistical data through the agglomeration of zip coded Department of Labor data + analysis of data; comparison of the case study data with control areas (counterfactual approach)	Effect of the instrument on the economy in the case study area: Employer units, employment and wages; indicators of employer investment and employee economic welfare: • Investment: % change in number of units • Hiring: % change in number of employees Indicators of employee economic welfare • Jobs: % change in number of employees • Wages:% change in average wage per employee • Wages: % change in real average wage per employee • Wages: Real average wage as a% of the self sufficiency wage				X				
19	Howitt et al. (2010) Economic Modeling of Agriculture and Water in California using the Statewide Agricultural Production Model	Benefits from a politically viable water market during drought	Positive Mathematical Programming [Statewide Agricultural Production Model (SWAP)]	Evaluation of the economic benefits and costs of water policies and/or other external shocks and changes of the system. Water quality	X			X		X		

No.	Name of the study	Type of EPI assessed	Global approach OR Tool(s) used	Criteria / Indicators assessed	Which criteria are assessed? 2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
20	Lavee (2010) The effect of water supply uncertainty on farmers' choice of crop portfolio	Subsidies (to wastewater treatment)	Define a model to estimate the value of uncertainty of water supply, test the model with data from Israel, and attempt to determine the "cost of uncertainty".	Water supply uncertainty Wastewater reuse for agriculture	X			X		X	X	
21	Lenouvel & Montginoul (2009) Assessment of groundwater management instruments in a conjunctive use system: A linear programming approach	Direct instruments (Tax and fees, quotas) Indirect instruments (Surface water pricing)	Comparison between four management tools and their impact on farmers' behaviour. Development of a microeconomic framework to model the irrigation decision process in a multi-resource context through linear programming methods	Aggregate income Acceptability Predictability (ability of an instrument to reach as close as possible a targeted level of abatement) Durability (cost recovery) Implementability (information needed for instruments' enforcement is available at an acceptable cost)	X		X	X			X	Comparison of instruments is developed through a matrix summarizing the results for the 5 criteria
22	Libecap & Shaw (2005) Rescuing Water Markets: Lessons from Owens Valley	Water markets	Analysis of land values, use of counterfactuals, qualitative narrative	Effect on land values, transaction costs, conflicts, institutions (bilateral monopoly), third party effects		X		X	X			
23	MacDonald (2004) The use of economic instruments for managing water quality	Price-based instruments (Environmental charges, Tendering, Compensated covenants, Land leasing) Quantity-based instruments (Transferable permits and Environmental offsets)	Literature review Diagram showing which instruments are feasible in which context Defintion of segments of society (allowing to chose between various EPI)	Institutional determinants of feasibility, Cost reduction, Social equity	X		X	X	X	X		The report offers a framework for the assessment of alternative instruments that will assist decision makers to identify which instruments can most appropriately be applied to a particular water quality problem.

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
24	Mattheiß et al. (2009) Which role for economic instruments in the management of water resources in Europe?	Charge on water abstraction, subsidies for substitution reservoirs, tradable permits for abstraction, charges and emission permits, pesticide tax, voluntary agreements, tradable pollution permit, compensation payment, accounting system, bonus on products, subsidies linked to storm water runoff, income tax reduction for rainwater harvesting, subsidies on land practices, charges linked to storm water runoff	Qualitative assessment matrix developed by the authors	Transaction costs / difficulties of implementation; acceptability		X			X	X		The study and evaluation was made with regard to the situation in the Netherlands.
25	McKinney et al. (1999) Modeling Water Resources Management at the Basin Level: Review and Future Directions. Technical Report	Water markets, water pricing, water charges, subsidies	a. Economics in water allocation: 1. valuation for agricultural uses: * Crop production functions with water * Optimization of water use - mathematical programming models 2. valuation of non-agricultural demand of water: * market based valuation tecniques * Economic value of hydropower generation * Nonmarket techniques 3. Benefit functions for water in a river basin context b. Integrated Hydrologic-Economic models: compartment (modular) and holistic approach. c. GIS-based decission support system	Water resources management modeling at the subsystem and river-basin levels. At the subsystem level, the tools of reservoir operation, groundwater management, conjunctive surface water and groundwater management as well as irrigation and drainage management are reviewed in the context of integrated water quantity and quality management. A river basin system is made up of water source components, in-stream and off-stream demand components, and intermediate (treatment and recycling) components.	X	X	X					

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
26	Neverre et al. (2010) Incentive tariffication: Which impact on water demand, budgetary balance and equity?	Domestic water tariffs (price level and tariff structure)	Qualitative narrative, simulation - economic model to forecast demand	Water demand (domestic behaviour)/environmental efficiency, revenue of water managers / cost recovery, surplus of consumers / equity, cost-efficiency	X		X	X				
27	OECD (2003) The use of economic instruments for pollution control and natural resource management in EECCA	Water effluent charges, charges on fertilizers, user charges for water supply and wastewater, water abstraction fees, fees for non-consumptive use of water	Qualitative narrative	Revenue impact, environmental effectiveness, economic efficiency, administration and compliance costs, wider economic effects (including income distribution, employment, etc.), impact on innovation, "soft effects" (e.g. changes in attitudes and awareness)	X	X	X	X	X	X		No in depth analysis for all elements. Focus on revenue generation.
28	PRI Project (2005) Economic Instruments for Water Demand Management in an Integrated Water Resources Management Framework	Pricing, taxes, water markets	Qualitative narrative (ex-ante)	Cost-effectiveness, efficient water use, legal framework, transaction costs		X		X	X	X		

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
29	Ribaudo et al. (1999) Economics of Water Quality Protection From Nonpoint Sources: Theory and Practice	Economic incentives for water quality protection from nonpoint sources	Qualitative evaluation matrix developed by the authors (judgements: poor, medium, high) (ex-ante)	Type of incentive provided by the instrument (performance-based or design-based), complexity, information requirements of a resource management agency in designing the instrument and of producers in using the instrument to evaluate their decisions, flexibility of the instrument to changing economic and environmental conditions, potential administration and enforcement costs	X	X		X	X	X	X	Comparison of economic instruments with other types of instruments
30	Sawyer et al. (2005) Analysis of Economic Instruments for Water Conservation	Economic instruments targeting water conservation	(Literature review) Ex-ante: qualitative screen through an informal "brain-storming" process that requires water managers to use a consistent set of outcome criteria to assess strengths and weakness of the instrument	Ex-post: Rationale for the selection of the economic instrument, distribution of related responsibilities, effectiveness of the instrument in stimulating sustainable water use and conservation and in what conditions, transferability of the instrument from a major water use to another. Ex-ante: Conservation effectiveness, economic efficiency, innovation, distributional impact, administrative feasibility, political feasibility, complementarity.	X		X	X	X	X		
31	Sjöberg (2005) Taxation of pesticides and fertilizers	Taxes on pesticides and fertilizers	Comparison of policies and consumption of the goods before and after tax changes (counterfactual approach)	Efficiency (indicators e.g. changes in pesticide sales, consumption of (nitrogenous and phosphate) fertilizers)				X				

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
32	Speck et al. (2006) The Use of Economic Instruments in Nordic and Baltic Environmental Policy 2001-2005	Tax on tap water, tax on wastewater, water abstraction taxes, water pollution taxes. (also: EPIs linked to energy and air emission, waste, agriculture and transport)	(Literature review)	Environmental effectiveness, economic effectiveness, distributional implications, competition and competitiveness (legal rules with relevance for application of market-based instruments)	X		X	X				
33	Swedish Environmental Protection Agency (2009) Proposal for a Permit Fee System for Nitrogen and Phosphorus	Permit fee system for nitrogen and phosphorus (ex-ante)	Qualitative narrative, small scale case studies, model of pollution discharges, qualitative comparison of present-day system and proposed system regarding transaction costs (counterfactual approach)	Cost-effectiveness, transaction costs, environmental outcomes, uncertainty, distributional consequences, dynamic efficiency, significance of the geographical scale of the instrument	X	X	X	X			X	
34	van Heerden et al. (2008) Integrated general equilibrium modelling of the impacts of water market instruments on the South African economy	Water taxation in forestry and agriculture (irrigated field crops)	Computable General Equilibrium Model	Target variables: total water demand, change in real GDP, change in real consumption by the poorest household group	X		X	X				
35	Ward & Pulido-Velázquez (2008) Efficiency, equity, and sustainability in a holistic water quantity — quality optimization model in the Rio Grande basin	Water pricing in urban drinking water sector	Holistic hydro-economic model	Hydrologic and economic impacts of alternative water pricing programs; quantity-quality relationships; economic efficiency; spatial and temporal scale integration; institutions	X		X	X	X			

			Global approach OR		Which criteria are assessed?							
No.	Name of the study	Type of EPI assessed	Tool(s) used	Criteria / Indicators assessed	2.1 - Environmental outcomes	2.2 - Transaction costs	2.3 - Distributional effects	2.4 - Economic outcomes	2.5 - Institutional background	2.6 - Policy implementability	2.7 - Uncertainty	Comments
36	Weber (2001) Markets for Water Rights under Environmental Constraints	Markets for water (abstraction and pollution) rights	Modelling of the optimal allocation of surface water and pollution rights along a river with water quality constraints	Cumulative effects of water rights; efficiency of markets; costs on third parties				X				
37	Zheng & Zhang (2006) Chinese Practices of Ecological Compensation and Payments for Ecological and Environmental Services and its Policies in River Basins	Ecological Compensation and Payments for Ecological and Environmental Services: state payment based on large project; local government payment; voluntary transaction mode (market-oriented compensation); water right trade; water charges (payment between water power company and water user)	Survey among habitants to determine who should pay and their willingness to pay	Feasibility (ability to pay of farmers and households based on income)	X				X			
38	Zinnes et al. (1999) Enforcement, economic instruments and water pollution abatement investment in Romania	Prices for raw water abstraction, tariffs for discharges into water bodies; fines; "privatization"	Development of a simple theoretical model of enterprise compliance. Econometric appliance of the model at the level of the enterprise and the river basin	Analysing the roles of enforcement and economic instruments in stimulating environmental investment in the presence of privatization.		X			X			The model of enterprise compliance is applied in the context of non-payment of environmental goods and services and an endogenous level of enforcement on the part of the water authority.
					27	12	14	28	16	13	7	

PART III – EPI-WATER Toolbox database

The xls version of toolbox database is available at the following link:
http://www.feem-project.net/epiwater/docs/ epi-water_D2-2_annex2_toolbox-database.xlsx

EPI - Water Project - Task 2.9 toolbox

The Toolbox aims at matching the most suitable instrument available to assess chosen criteria from the basic structure of the Assessment Framework which includes:

1. Institutional set-up;
2. Environmental criteria;
3. Economic assessment criteria;
4. Transaction costs;
5. Distributional effects;
6. Uncertainty;
7. Policy implementability; and
8. The toolbox also integrated the Environmental-Economic Accounts as part of its bundle of assessment tool options

The tools available are described and classified by assessment criteria in the different tabs.

For each criterion, a list of relevant chronological questions was defined (subcriteria) in the presentation of task. Their evaluation requires specific tools from analytic narratives to hydro-economic models. These tools are described in the toolbox focusing on their purpose, requirements, strengths and weaknesses. The toolbox also reference approaches or methods which could be useful for the assessment and make the link between the tools and the criteria.

"Assessment criterion"	
Subcriteria	Specify the subcriteria considered
Approach(es)	Indicate the name of general approach or set of methods the tool is part of. For instance, partial equilibrium approaches (approach) use amongst others positive mathematical programming (tool)
Description	Describe the approach
Name of the tool	Indicate the name of the tool
Type of tool	Experimental methods, Survey methods, Field study / social anthropology methods, Modelling, Interpretative, Critical, Participatory, Evaluative
Description and purpose	Objective of the tool
Principal steps required to implement the tool	Work flow through which the tool is being applied.
Indicators	Describe indicators and indicate if indicator is Direct or Proxy
Strengths	List strengths
Weaknesses	List weaknesses
Type of EPIs which can be assessed with the tool	All types, Water tariffs, Taxes & charges, Subsidies, Tradable permits, Compensation mechanisms, Voluntary agreements & PES, Insurance, finance and full cost recovery mechanism
References, handbooks and articles	Give references of guidelines documents or relevant papers
Comments	Including for example indications about experiences of project partners with this tool

Institutional set-up (task 2.5)

Subcriteria	**Institutions or institutional changes**	
Approach	Analytic narratives	Historic narratives
Description	An analytic narrative is a social science research method seeking to combine historical narratives with the rigor of rational choice theory, particularly through the use of game theory.	Assess the determinants of institutional changes
Name of the tool	Analytical narrative	Historic narrative
Type of tool	Modelling / Interpretative	Expert judgement / Interpretative
Description and purpose	successfully identify the causal factors that explain a particular historical phenomenon	same as analytic without the need to quantify contributions or exact relations. Allows, e.g., endogenous influences to evolve without need to determine which factor is independent or dependent
Principal steps required to implement the tool	First, extracting from the narratives the key actors, their goals, and their preferences and the effective rules that influence actors' behaviours. Second, it means elaborating the strategic interactions that produce an equilibrium that constrains some actions and facilitates others [Levy M., unpublished]	Same as analytic, with additional influences "beyond the model" (good news/bad news)
Indicators (Indicate if indicator is Direct or Proxy)	difficult to specify for institutions. Better to use this task as a means of organizing outcomes in 2.1-2.4 and explaining the success/failure of implementation (2.6	
Strengths	Combine historical and comparative research with rational choice models	historical narratives have first been implemented and have produced appealing results for the understanding of long-run socio-economic development
Weaknesses	Complexity due to model building	too nebulous for analytic point of view
Type of EPIs which can be assessed with the tool	All types	
References, handbooks and articles	Arias, L. M. (2009). Analytic narratives (not published) - http://econ.ucsd.edu/~luarias/pdfs/entryIPSA.pdf Bates, Robert H., Avner Greif, Margaret Levi, Jean-Laurent Rosenthal and Barry R. Weingast (1998). Analytic Narratives. Princeton University Press. Levy M. Modelling Complex Historical Processes with Analytic Narratives (not published)	Combarnous F. and Rougier E. (2010). Institutions, Socio-Economic Models and Development: An Overview of the Literature and a Methodology. Paper presented at Ifo / CESifo & OECD Conference on Regulation on "Political Economy, Measurement and Effects on Performance", 29 - 30 January 2010, Munich
Comments		

Institutional set-up (task 2.5) - Continued

Subcriteria	**Institutions or institutional changes**	
Approach	Institutional levels (Williamson (2000))	Analytical Decomposition of Institutions combined with cross-case study survey
Description	4 levels: L1: "Embeddedness: informal institutions, customs, traditions, norms, religion" L2: "Institutional environment: formal rules of the game – esp. property (polity, judiciary, bureaucracy)" L3: "Governance: play of the game – esp. contract (aligning governance structures with transactions)" L4: "Resource allocation and employment (prices and quantities; incentive alignment)"	Institutions are decomposed into broad components, i.e., law, policy, and administration and each of these institutional components is again decomposed to identify some of its major institutional aspects. A cross-case study survey of water sector experts having different disciplinary background and professional orientation from different case studies with diverse water problems, socio-economic settings, historical traditions, and political arrangements.
Name of the tool	Institutional stratification	
Type of tool	Interpretative	
Description and purpose	Identify institutions from deepest to most shallow (in terms of duration/durability), to assess exogenous constraints on EPIs from deeper institutions and endogenous impacts that EPIs will have on shallower institutions	
Principal steps required to implement the tool	describe ex-EPI influences on specification, implementation and operation. Separate into L1-L4 to *attempt* to rank order relative influences.	The methodology involves two interrelated steps. First, a set of variables is identified to capture various analytical components and aspects of both water institution and water sector performance. Second, given the identified set of institutional and performance variables, various layers of institutional inter-linkages and institution-performance linkages are translated in the form of functional models which can be empirically estimated within a regression framework.
Indicators (Indicate if indicator is Direct or Proxy)	difficult to specify for institutions. Better to use this task as a means of organizing outcomes in 2.1-2.4 and explaining the success/failure of implementation (2.6	(1) Legal treatment of water and related resources, (2) Format of water rights, (3) Provisions for conflict resolution, (4) Provisions for accountability, (5) Scope for private sector participation, (6) Centralization tendency, and (7) Degree of legal integration within water law
Strengths	Useful structure for understanding exogenous constraints (L1) vs. forces that are "in play" (malleable)	
Weaknesses	line between exogenous and endogenous institutions hard to draw; they are co-evolving	
Type of EPIs which can be assessed with the tool	All types	All types
References, handbooks and articles	Williamson, Oliver E. (2000). The New Institutional Economics: Taking Stock, Looking Ahead. Journal of Economic Literature, 38(3): 595–613.	Saleth and Dinar (2004). The Institutional Economics of Water: A Cross-Country Analysis of Institutions and Performance. Washington DC: The World Bank.
Comments		

Environmental criteria (task 2.1)

Subcriteria	**Behavioural changes (to link drivers with water services use in the economy)**		
Approach	Partial Equilibrium Approaches		
Description	Partial equilibrium models (PEMs) provide the basic analytical tools to understand water services use decisions as determined by their driving factors such as income, prices, subsidies, technology, etc. These models focus in the analysis of water decisions at the level of individual agents (such as households, manufacturing firms and farmers) in order to understand how these agents would (and actually) react to changes in the market and the policy environ. On this basis, PEMs allow to assess direct intended and actual effects of EPIs (in terms of changes in the quantity and quality of water demanded and used) as well as providing basic information on the direct economic effect on water users (through the effects of EPIs on individuals' income, profits, crop decisions, etc.) These models may provide the basic information about the surplus that may be derived through reallocating water, as well as information on the maximum willingness to pay for having access to more water (demand) and the minimum required compensation to voluntarily accept the transfer of prevailing water use rights (supply). PEMs also provide basic information for the design of water-related EPIs through, for example, showing how farmers do not simply act as profit-maximizing agents and on how taking other decision attributes, such as risk aversion and avoidance of management complexities into account, provides a better explanation of decisions.		
Name of the tool	Water demand functions / Water demand econometric models	Multi-criteria Decision Methods (MCDM)	Positive Mathematical Programming (PMP)
Type of tool	Statistical and econometric model	Simulation model	Econometric and simulation model
Description and purpose	Demand analysis intends to explain observed water use individual decisions as a dependent variable of different driving factors such (as water prices, subsidies) including the characteristics of economic agents (income, age, education, family size, appliances, etc.) and other institutional and environmental drivers. Demand models provide information over the relative importance of the different factors explaining individual water decisions.	Multi-criteria decision methods (MCDM) are alternatives to understand farmers decisions by using information at a local scale (such as water endowments, land vocation, agronomic practices, subsidies, prices and production costs). MCDMs assume that farmers' preferences can be represented by an aggregation of different criteria, such as maximization of expected profits, risk avoidance and selection of alternative management options. These applied models try to provide a clearer intuition of the logic behind farmers' decisions by using standard economic analysis and by implementing a multi-attribute utility function.	PMP is an alternative to econometrically obtained demand functions and MCDMs when information at a local scale is not available or limited. Instead of using observed production and costs functions, PMP deduce the cost function from observed crop decisions (by using the information provided by the dual variables of the calibration constraints).
Principal steps required to implement the tool	* Collection of data on the dependent variable (use of a particular water service) and its determining factors (water prices, income, family size, ...). * Estimation of the demand function through the use of statistical and econometric procedures. * Hypothesis testing and simulation of expected water demand variations in response to changes in water policy and on the socio-economic environment. Validation of analytical results with observed responses.	* Identification of the decision problem (crop patterns, choice of irrigation techniques, water demand and supply for voluntary trade, etc.). * Definition of relevant attributes with the potential to explain observed decisions. * Identification and operational definition of the relevant criteria or attributes to be considered by individuals when making the decision (expected profit, avoided risk, etc.). * Data collection on observed behaviour, technical constraints and individuals endowments. * Model formulation and calibration to observed decisions.	* Identification of the decision problem. * Collection of the information available on the observed decision. * Mathematical formulation of the decision model. * Estimation on the implicit cost function (by using the shadows prices of the observed solution). * Calibration of the extended decision model (by using observed data and the implicit cost function to exactly reproduce the observed decision)

		* Identification of baseline and analysis of water used decisions based upon simulated results obtained from the empirical model. * Definition of the counterfactual policy scenario. * Simulation of expected changes in individuals' decisions. * Validation.	. * Identification of baseline and counterfactual scenarios. * Simulation of expected changes in individuals' decisions. * Validation.
Indicators	Water demand (quantity, quality per firm, farm or household per year). Price, income and other elasticities of water demand.	Water use (per farm , crop, …). Water productivity (yield or Euros per cubic meter). Profit, risk aversion coefficients. Elasticity of water demand.	The same than for MCDMs
Strengths	* Provide quantitative results on the potential effect of an EPI on water use at the level of individual agents (farms, households and firms). * Allows the analyst to control and distinguish the effect attributable to any individual factor included in the demand function (separating, for example, the effects of price changes, income variations, etc.). This allows controlling different effects that are relevant when assessing policy driven water demand changes. * Estimated results are in general easy to validate with observed outcomes.	* The same strenghts of water demand functions. * The method is more suitable to analyze crop decisions at a farm or agricultural area level. * Allows understanding of water use decisions based on factors other than expected profit maximization. These factors include avoidance of risk (e.g. of droughts and labour shortages in peak seasons) and of management complexities. * Provided the basic information is available, MCDMs are easy to calibrate and adapt to local characteristics. * Allows the identification of many different factors with the ability to explain water use decisions (including prices, costs, subsidies, technical, policy or agronomic constraints, factor endowments, irrigation technology, etc.).	* Require much less observed data than MCDMs. * The same as MCDMs.
Weaknesses	* Require detailed information at a very low scale (microdata), which may not be easily available (due, for example, to confidentiality concerns). * Econometric difficulties to determine the best fit demand function due to, amongst other problems, colinearity of different potential water demand driving factors (such as income, education, family size, etc.). * Demand functions are expensive to estimate and difficult to transfer. * When demand functions are obtained with a limited number of dependent variables the results are not robust (due to missing variables).	* MCDMs require detailed information (on revenues, yields, production cost and technologies) at a low scale (plots, farms or irrigation districts). * Most models use implausible assumptions (such as linear preferences and constant coefficients technologies), which limits the validity of the simulated results. * Only MCDM based on preference revelation methods provide a clear explanation of the driving factor behind farmers decisions on water use. * Most of the MCDM do not provide information on how robust are calibrated and simulated results.	* PMP models use a "black box" cost function making the interpretation of driving factors behind water use decisions impossible. * The analyst using PMP is forced to use *ad hoc* arguments to explain the empirical results. * PMP methods do not provide information about estimation errors making uncertainty analysis unfeasible.
Type of EPIs which can be assessed with the tool	For example, EPIs targeting water demand and adaptation strategies to climate change in power stations (Koch and Vögele, 2009) or	Any EPI affecting farmers decisions on crop selection, choice of techniques, water and fertilizer and	The same as for MCDMs.

	estimations of residential water demand (Schleich and Hillernbrand, 2009).	other chemical substance use, etc.	
References, handbooks and articles	Schleich and Hillernbrand, 2009; Koch and Vögele, 2009	Rehman and Romero, 1993; Sumpsi et al., 1996; Bazzani, 2005; Bazzani et al., 2005; Feás and Rosato, 2006; Gutierrez and Gomez (2010; 2011)	Paris and Howitt, 1998; Howitt, 1995; Heckelei and Britz, 2005; Henry de Frahan et al., 2007;
Comments			

Environmental criteria (task 2.1) - Continued

Subcriteria	**Behavioural changes (to link drivers with water services use in the economy)**	
Approach	Extended and General Equilibrium Approaches	
Description	Compared to Partial Equilibrium Approaches, Extended and General Equilibrium approaches stretch out the analysis of drivers and economic decisions beyond the level of individual economic agents. Rather than analysing decisions at a farm level , for example, these approaches look for explanations at the level of the agricultural sector, the region, or even the entire economy. To perform this task, extended approaches require an understanding of dynamics and, particularly, of the interactions between different markets (such as labour and agricultural markets at the national and the international levels). Models in this category can be classified according to the variety and detail of the market interactions considered. They cover from Input-Output models at local and regional levels to general equilibrium models at a national scale. The main advantage of extended approaches is their potential to inform about market effects (showing the interactions between the different sectors of the economy), labour and employment effects and income effects. Consequently, extended models set the basis for the analysis of the effects of water policy instruments on macroeconomic variables such as employment, regional competitiveness, GDP structure, and income distribution.	
Name of the tool	Input/output Analysis	Computable General Equilibrium Models (CGEM)
Type of tool	Social accounting and simulation model	Social accounting, simulation and econometric model
Description and purpose	Input-Output methods are comprehensive accounting systems based on national and regional accounts. They are informative on the connections between the economic activities producing final goods and services and their derived demand of raw and intermediate goods through the local economy and the external market . Water satellite accounts and other relevant information can be integrated with IO tables. IO models have the potential to inform about the induced direct and indirect effects of water policy on employment, economic activity, inter-regional trade, income, gross value added (either by companies or workers) and on water use and water productivity through the Hypothetical Extraction Method (HEM).	CGEM are comprehensive modelling and accounting systems designed to inform about the functioning of the whole economy (through the interaction between the different activities and markets of final and intermediate goods), the market equilibrium at an overall scale (and the connections between production, income and expenditure) and the integration in the world economy (through labour, trade and capital mobility). CGE models build upon general equilibrium theory that combines behavioural assumptions on rational economic agents with the analysis of equilibrium conditions. They provide counterfactual *ex ante* comparisons, assessing the outcomes with a reform in place with what would have happened had it not been undertaken. Apart from providing information AGEM are performed to evaluate how the economy adapts to different shocks (including those driven by changes in water policy).
Principal steps required to implement the tool	* Data Collection: I/O Matrix (that better fits the study area). * Adaptation of the I/O Matrix to the study area (sometimes it is possible to adapt I/O tables produced for a region - usually a country or a state - to the spatial units that are relevant for water policy (river basins, irrigation districts, etc.). * Extension of the original I/O Table to take into account water related services for the production of goods and services (e.g. by collating water satellite accounts into the I/O Matrix or by detailing water consumption and pollution loads for any relevant economic activity). * Implementation of the I/O methodology to obtain the Leontief inverse matrix, which is the core of the whole set of methodologies derived from IO. * Identification and assessment of counterfactual policy scenarios (through the impact over income, production by industry, inter-regional trade and gross added value).	* Building the information base (consisting in the same information required for I/O analysis converted into a Social Account Matrix, SAM). * Development of the mathematical specification of the general equilibrium model with some deterministic parameters (econometrically obtained). * Calibration of the mathematical model (to obtain the value of the free parameters allowing the general model to reproduce the data in the SAM). * Implementation of the model to obtain empirical results for counterfactual scenarios (including the baseline and the water policy alternatives). * Validation of model results.
Indicators	Water productivity (I/O coefficients).	The same as in I/O and variations of prices income and water use (per economic activity and region).

	Employment, income and production multipliers. Indirect and induced effects over employment, income and production.	
Strengths	* Is a relatively transparent method to measure some effects of water policy that are complex to define and assess (such as those over regional competitiveness, sectoral employment and income. * Ability to inform over all the indirect effects that are not considered in partial equilibrium analysis. * Results are relatively easy to communicate to stakeholders.	* The same strengths of IO (except for communication easiness). * In addition AGEMs have the potential to inform about all the potential interactions in the economy (among sectors, regions and in the short and the long term), and over the indirect effects of water policy.
Weaknesses	* National accounts and I/O account systems need to be complemented with non-market variables such as the environmental or social ones (which is partially covered by the use of satellite accounts). * Water use and productivity calculations, as well as it happens with any other social or environmental variable not included in conventional accounting, require data coming from satellite accounts. These data are not always available, and when available it can lack quality, be old or be referred to different years than IO tables. * IO is mainly a static analysis tool, valid for forecasting given the original economic structure remains. Dynamic assessments are possible if enough large data series are available.	* CGE approaches model economy-wide effects, but fail to capture the more detailed hydrological and biogeochemical processes involved. * Hence, the trade-off is that interest in the economy-wide impacts of water policy is at expense of the hydrological detail. * Calibrated CGE models and not based on empirical evidence. * These models can allow comparison between two steady-state equilibriums (e.g. before and after a policy shock) but not on short-term effects or on transitional effects and dynamics.
Type of EPIs which can be assessed with the tool	Wahetever EPI intended to promote a technical change (such as the promotion of most efficient technologies) or a reduction in the use of inputs (water, fertilizers, energy, etc.) or changes in prices and costs.	Water-related EPIs with the potential to affect many activities in the economy. They include water markets (with significant potential to affect water endowments all over and the different economic uses), water prices (if significant to induce changes in individual behaviour leading to significant changes in water use, technical changes), etc.
References, handbooks and articles	Rasmussen, P. N., 1956; Chenery, H. and Watanabe, T., 1958; Hirschman, A. O., 1958; Strassert, G., 1968; Cella, G., 1984; Duarte, R., Sánchez Chóliz, J. y Bielsa, J., 2002.	Robinson and Goldman, 1991; Tirado et al., 2006; Palatnik and Roson, 2009; Calzadilla et al., 2010 ;
Comments		

Environmental criteria (task 2.1) - Continued

Subcriteria	**Land-use Models (to link water uses to pressures on water bodies)**	
Approach		
Description	Land use models in their different versions are performed to inform how the use of water services in the economy (provision for the different uses and disposal of point and diffuse effluents) and the different land uses (urban and rural, drain and rain fed agriculture, infrastructures, etc.) are connected with different pressures over the water bodies (abstraction, infiltration, etc.) and affect the functioning and the structure of the concerned water providing ecosystems through the different processes of erosion, infiltration, soil transformations, pollution transport and transformation, etc.). The relationship between pressures over water bodies and water ecosystems and the quantity and quality of water services produced by the economy is informative about the efficiency with which water services are produced as well as the environmental impact of the different economic activities.	
Name of the tool	Agronomic Models	Rainfall-Runoff Models
Type of tool	Physical modelling	Hydrological modelling
Description and purpose	Agronomic simulation models are designed to describe and analyze the crop growth interaction with the climate, soil and agricultural practices (including irrigation). The primary purpose of these models is to analyse the effects and the pressures derived from the different technologies and agronomic practices used for the production of biomass (for food, fodder, bio-energy, reclamation, etc.). Hence, agronomic models combine biology, chemistry, ecology, earth science and genetics, and are also intended to analyse the environmental impact of agriculture.	Rainfall-runoff models are hydrological models describing the relations between precipitation and water flows. They provide the basic information required to assess the availability of water resources (surface and groundwater, flowing and stored in dams and aquifers), water demands across the space (such as the evapotranspiration deficit to be covered by the irrigation system) and the effects of land occupation and water infrastructures on the amount, quality and distribution of water resources all over the place. With additional geographical data these models can provide flood modelling, erosion modelling and aquifer recharge values through infiltration.
Principal steps required to implement the tool	* Data collection: meteorological data (rainfall, temperature, radiation), genetic data (plants and characteristics: roots, stem/trunk, branches, canopy) , soil data (welting point, soil moisture capacity, pedological discontinuity, permeability), management data (pesticides, nutrients, land use, mulch, irrigation techniques, slope). Irrigation and land use are both dependent on other physical models, which in turn depend on farmer behaviour. Pesticides and nutrients, if considered, conform the first step of a diffuse pollution model. * Data processing and model implementation using one of the models available (STICS, FAO crop-water model, EPIC, EPICPHAS, others) * Assessment of farmers' decisions (from behavioural models) to obtain the inputs required by the agronomic models' (profit, risk, productivity-hours of work). * Validation of the results.	* Data collection. Formulation of the hydrological model (a system of differential equations governed by the runoff or discharge equation). * Determination of the total hydrograph. *Determination of the unit hydrograph can be calculated. *Use of the rainfall and runoff data record to determine baseline and other scenarios. * Simulation and validation.
Indicators	Crop distribution (suface), crop yields (kg/H),	The same as in agronomic and economic models with

	water use (m3/H), pollution loads (gr/m3), etc.	detail and precision that depends on the particular characteristics of the model.
Strengths	* Accuracy of results when properly calibrated and implemented. * A wide range of models available depending on the species, regions and changes to be assessed. * Availability of alternatives (parameterized software) when data are not easily available.	* Precise and detailed results when properly callibrated and implemented. * A wide array of options in terms of software and tested empirical applications.
Weaknesses	* Require large amounts of difficult to collect and low scale data. * Integrating behavioural and physical models require considering complex interactions that are not always presented in a transparent way.	* Runoff historical data tend to be biased and inaccurate, especially when major changes are being implemented in the basin.
Type of EPIs which can be assessed with the tool	Every EPI affecting agricultural management and/or production, provided that a land-use model and behavioural model are available.	Any EPI with the potential to change the effective use of water services in the economy in a significant way.
References, handbooks and articles	Williams et al., 1984, 1989; INRA, 2002; Cabelguenne et al., 1990; Allen, R., Pereira, L. S., Raes, D. and Smith, M., 2006	USACE. 1994; NRCS, 2004; Dalen et al., 2008;
Comments		

Environmental criteria (task 2.1) - Continued

Subcriteria	**Land-use Models (to link water uses to pressures on water bodies)**	
Approach		
Description	Land use models in their different versions are performed to inform how the use of water services in the economy (provision for the different uses and disposal of point and diffuse effluents) and the different land uses (urban and rural, drain and rain fed agriculture, infrastructures, etc.) are connected with different pressures over the water bodies (abstraction, infiltration, etc.) and affect the functioning and the structure of the concerned water providing ecosystems through the different processes of erosion, infiltration, soil transformations, pollution transport and transformation, etc.). The relationship between pressures over water bodies and water ecosystems and the quantity and quality of water services produced by the economy is informative about the efficiency with which water services are produced as well as the environmental impact of the different economic activities.	
Name of the tool	Agent-based modelling (ABM) / multi-agent system / multi-agent simulation	Water diffuse pollution models
Type of tool	Computational modelling	Physical-chemical modelling
Description and purpose	MAS are computational models composed of autonomous entities or agents which have only limited knowledge and information processing capacities. In MAS, agents interact and exchange information in a decentralised and somewhat 'social' manner instead. These models simulate the interactions of autonomous agents (both individual or collective entities), with a view to assessing their effects on the system as a whole. ABM are therefore an attempt to re-create and predict the appearance of complex phenomena, on the basis of the idea that simple behavioural rules generate complex behaviour.	Diffuse (or non-point) pollution models are physical models that analyse polluting substances that cannot be easily traced back to a single or definite source. Since diffuse water pollution is mainly related to the way we use and manage land and soil, these models integrate variables linked both to those practices and also to the effects on water bodies. Although these pollutants have originated from a point source, the long-range transport ability and multiple sources of the pollutant make it a nonpoint source of pollution. Diffuse pollution models rely mainly on runoff-infiltration models (pollutants movement) and agronomic models (pollutants leaching). Extended models can be considered in the category of Hydro economic models. They link physical diffuse pollution models with agricultural practices (the main source of this kind of pollution). Some agronomic models (EPIC, EPICPHAS) already include a module for nutrient and pesticide leaching calculation that can be complemented with runoff-infiltration models.
Principal steps required to implement the tool	* Integration of the economic sub-model and the hydrological sub-model into the same spatial framework. * Identification of the relevant feedback effects (between the economy and the hydrology) for analyzing the use of water resources. * Design of scenarios, model simulation and validation.	* Many diffuse pollution models are a module of an existing agronomic model, and they operate simultaneously to obtain pollutants leaching. * Runoff-base flow-infiltration models predict pollutants movement and discharge into stream flow. * The decay process of diffuse pollutants is described in decay models.
Indicators	Combine indicators from economic, agronomic and other models depending on the characteristics of any particular model.	Depends on the particular model considered.
Strengths	* Ability to inform about social and political dimensions (as it can capture interactions and relationships between agents and institutions). * It provides insights into the diffusion of innovations and water resource use. * Ability to assess the plausibility of the behaviour of	* Capability to Integrate the bio-physical processes and the economic behavioural models into a comprehensive framework. * Combine the advantages of agro-hydro-economic models and pollution decay models.

Toolbox Database

	agents, the ways in which the agents interact and the consequences of that behaviour and interaction. * When data is not an issue these models allow for the accounting for scaling issues (and for how global change phenomena might result from the cumulative effect of numerous activities at regional and local scales).	
Weaknesses	* Problems to generalize results and interpretations of actual behavior based on limited information over some individual decisions. * Low robustness of the results and wide uncertainties (common to social models).	* Mostly based on 'representative' farms without capturing the variability among real-world farms. * Models usually concentrate on a single ecological effect of measures or are based on cost estimates of the sectors directly involved in the pollutant-reduction programme (i.e., co-benefits, trade-offs, and external costs are not examined) . * Models do not incorporate uncertainties in estimates.
Type of EPIs which can be assessed with the tool	Any EPI with the potential to change the effective use of water services in the economy in a significant way.	Every EPI affecting agricultural management and/or production, provided that a rainfall-runoff model and behavioural model are available.
References, handbooks and articles	Berger, 2001; Pahl-Wostl, 2002; Ekasingh and Letcher, 2005	Haygarth and Jarvis, 1999; Heathwaite et al., 2003; Collins and Anthony, 2008;
Comments		

Environmental criteria (task 2.1) - Continued

Subcriteria	**Hydrology and Environmental Impact Assessment (from environmental pressures to the ecological status of water bodies)**	
Approach		
Description	Hydrological models and impact assessment methods are means to understand how the different pressures derived from the production of water services result in changes of the status of water bodies both directly (as a result of water depletion, impoundment, effluent discharges, etc.) and indirectly through the interconnections between different water bodies including water circulation and the processes of transport, diffusion and transformation of pollution loads in the water environment.	
Name of the tool	Hydrological models	Water Impact Assessment
Type of tool	Hydrological modelling	EIA modelling
Description and purpose	As any other models, hydrologic models present a simplified conceptual representation of the hydrological cycle. Hydrological models can be based on data and use mathematical and statistical concepts to link a certain input to the model output, treating these relationships as stochastic processes. Transfer functions, neural networks, etc. are commonly used for these models. Besides these stochastic models, there are also process-based hydrological models, which represent surface runoff (which can derive into floods), subsurface runoff, groundwater flows, evapotranspiration, and channel flow, in a much more complicated (and deterministic) fashion.	Assessment of potential positive or negative effects (on water ecosystems) linked to the implementation of an EPI or a combination of them. It consists of identifying, predicting, and evaluating biophysical impacts (and other relevant effects), as well as mitigation strategies.
Principal steps required to implement the tool	(Most of this hydrological models are parameterised in available software, such as HEC-HMS) * Definition of the purpose of the model application. * A conceptual model should be established based on the purpose of the problem a the available data. * Selection of a suitable computer software. A code from existing modelling systems is often selected but in case of no existing code, a code development has to take place. * Model construction: designing the model with regards to the spatial and temporal discretisation, setting boundary and initial conditions and making a preliminary selection of parameter values from the field data. * Definition of performance criteria (due consideration to: accuracy definition and realistic threshold of accuracy determined by field situation and available data). * Model calibration: adjustment of parameter values of a specific model to reproduce the observed response of the catchment within the range of accuracy specified in the performance criteria. * Model validation: conduction of tests which document that the given site-specific model is capable of making sufficiently accurate predictions. * Model simulation (for prediction purposes): it is advisable to carry out a predictive sensitivity analysis to	

	test the effects of these uncertainties on the predicted results.	
Indicators	Water available (per water body per unit of time). Variations in available resources (and its distribution within the river basin). Water distribution (through the space and through time. River regimes (per different times of the year). Recharge rates (for aquifers). Floods and droughts probabilities (according to historical data).	Physic-chemical indicators measuring the status of water bodies.
Strengths		
Weaknesses	* Model forecasting capability constrained by the availability and quality of the required data. Data required is large. * CN and P0 values required are site-specific and not always available, which generates bias. * While runoff values can be obtained following an homogeneous formulae, sub-surface and infiltration values require further developments of the model, which vary according to the region considered.	
Type of EPIs which can be assessed with the tool	Every EPI implying a land-use change.	
References, handbooks and articles	USACE, 1994; USACE, 2000; Xu and Singh, 2004; McColl and Aggett, 2007; Saghafian et al., 2007; Ward and Pulido-Vazquez, 2008; Yusoff, 2011; Hoque, 2011;	
Comments		

Environmental criteria (task 2.1) - Continued

Subcriteria	Integrated Models and Water Decision-Support Systems (DSS)	
Approach		
Description	This category includes different approaches integrating the assessment of water services, pressures and impacts in a single and comprehensive model.	
Name of the tool	Modular approaches to hydro-economic modelling	Holistic hydro-economic models
Type of tool	Hydro-economic modelling	Hydro-economic modelling
Description and purpose	Modular approaches to hydro-economic models are simulation models in which the integration of economic and hydrologic variables is performed in a two-stage process, without the need to introduce the strong and simplistic assumptions required by holistic hydro-economic models. They provide a minimum understanding of the hydrology in the river basin and can be used to assess how a water policy in general and EPIs in particular would affect water pressures (abstractions and returns; pollution loads and natural assimilation capacities) not only on site but in the river basin as a whole. (In the modular approach a connection is built between the hydrological and the economic model, and output data from one module usually provide the necessary input for the other. The modules operate independently of each other and system equations are solved in an exogenous way; input variables from one model into the other are exogenous).	Integrated or holistic approaches are based upon the idea that an optimum can be reached both in hydrological and economic terms and, also, from an operational viewpoint, that this optimization can be performed by introducing some fixed parameters (shadow prices, elasticities of demand, etc., provided by optimization algorithms) or, at best, a demand function. Both modular and holistic models can actually be used to optimize or simulate. Holistic approaches, when used as optimization procedures, are aimed at obtaining the best decisions. Simulation models are rather more suited to support a decision process (DSS).
Principal steps required to implement the tool	* Identification of model components. * Choice of model formulation and design: - Simulation or optimization: both models answer different questioned, 'what if?' the first, and 'what is best the second?' can be used separately or together. - Representing time, deterministic (consider a single set of fixed boundary conditions and results) or stochastic (consider the probabilistic nature of model inputs and parameters). - Sub model integration: holistic or modular. - Modelling scales. - Environment and social goals: how to represent 'ecological' flows, either with economic valuation or treat environment requirements as low-flow constrains. Social criteria are also incorporated by specifying appropriate constraints and/or low discount rates in the objective function. * Software implementation. * Study design and results.	
Indicators	The same of economic and hydrological models and tools with a variable detail and robustness depending on any particular model.	The same of economic and hydrological models and tools with a variable detail and robustness depending on any particular model.
Strengths	* Easier to develop, calibrate and solve than detailed	* In the holistic approach there is one single unit with

	although less ambitious models. * The advantages of modularity include increased probability of convergence on an optimal solution, the ability to go into more detail in each sub-field, and the ability to be independently updated and developed.	both the hydrologic and economic component tightly interwoven in a consistent endogenous model.
Weaknesses	* Under the modular approach, a loose connection exists between the different hydrologic and economic components. * The various sub-models can be very complex and the main problem is to find the right transformation of data and information between sub-models. * Common limitations to integrated hydro-economic modelling (for modular and holistic approaches): - Hydrological models are often based on simulation techniques, whereas economic models usually use optimization techniques. - Water bodies, watersheds and basins usually are the geographical unit in hydrological models, while economic models often refer to administrative boundaries of a region (county, province, state) or a country as a whole. - Time scales in hydrological models often refer to days, months or seasons (summer and winter), while in economic models the time scales (intervals and horizon) are usually longer than that (years).	* Components tend to be presented in a too simplistic way (there is a trade off between the gains from having a comprehensive model and the losses due to oversimplification). * Difficulties to find software and solver algorithms able to represent both the simplified hydrological and economic components of the model in a meaningful way. * Based on representative farms, firms and households.
Type of EPIs which can be assessed with the tool		Water pricing (but the effects of water pricing on the general price level in the economy, and corresponding adjustments in inter-sectoral supply and demand, fall outside the scope of the analysis).
References, handbooks and articles	Burt, 1964; Bear and Levin, 1970; Young and Bredehoeft, 1972; Gisser and Mercado (1972; 1973); Noel and Howitt, 1982; Vaux and Howitt, 1984; Booker and Young, 1994; Draper et al., 2003	Braat and Lierop, 1987; Díaz and Brown, 1997; McKinney et al., 1999; Cai et al., 2003; Fisher et al., 2005; Pulido-Velázquez et al., 2006; Brouwer et al., 2007;
Comments		

Environmental criteria (task 2.1) - Continued

Subcriteria		
Approach	Environmental benefits - cost based methods	
Description	The most basic information to estimate the value of water in productive uses, overall, stems from prices. However, not all observable prices can be seen as adequate measures of the value of water. This is explained not just because of the existence of income transfers through tax levying but also, more importantly, because of significant subsidies (often implied) Yet, water prices are far from representing the value of water. This conceptual problem is even more acute in situations where water is extremely scarce. The estimation of water productivity (monetary unit per cubic meter productively used) allows for the comparison of water uses, in order to shed some light on what uses tend to generate more welfare.	
Name of the tool	Water productivity methods	Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods
Type of tool	Indirect (based on observed behaviour and market prices) valuation method	Indirect valuation method
Description and purpose	The productivity method, also referred to as the net factor income or derived value method, is used to estimate the economic value of ecosystem goods or services that contribute to the production of commercially marketed goods. It is applied in cases where the products or services of an ecosystem are used, along with other inputs, to produce a marketed good.	The avoided damage cost, replacement cost, and substitute cost methods are related methods that estimate values of ecosystem service biophysical flows based on either the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services.
Principal steps required to implement the tool		
Indicators	Water productivity (yield, revenue or profits per cubic meter or per unit of pollution load). Variation in costs and benefits. Benefits and/or production foregone or obtained as a result of a policy change.	Dose-response coefficients. Foregone benefits. Avoided damage. Cost savings.
Strengths		
Weaknesses		
Type of EPIs which can be assessed with the tool		
References, handbooks and articles	Dinar, A. & Subramanian, A. 1997. Water pricing experiences: an international perspective. World Bank Technical Paper No. 386. Washington, DC, World Bank. Dixon, A. (1990) Valuation of protected areas in developing countries. In: J. Vincent, E.W. Crawford and J.P. Hoehn, Editors, Valuing Environmental Benefits in Developing Countries. Proceedings of a Seminar Series. February–May, 1990, Michigan Agricultural Experimental Station Special Report, Michigan State University, East Lansing.	Hanley, N., Wright, R.E., and Alvarez-Farizo, B. (2006) Estimating the economic value of improvements in river ecology using choice experiments: an application to the water framework directive. Journal of Environmental Management (78), 183–193 Mendelsohn, R., and Saher, G., 2011. The global impact of climate change on extreme events. Policy Research Working Paper 5566, World Bank, Washington DC.

	Dinar, A. & Subramanian, A. 1997. Water pricing experiences: an international perspective. World Bank Technical Paper No. 386. Washington, DC, World Bank. Dixon, A. (1990) Valuation of protected areas in developing countries. In: J. Vincent, E.W. Crawford and J.P. Hoehn, Editors, Valuing Environmental Benefits in Developing Countries. Proceedings of a Seminar Series. February–May, 1990, Michigan Agricultural Experimental Station Special Report, Michigan State University, East Lansing. Nauges, C., and Thomas,A. (2000). Privately Operated Water Utilities, Municipal Price Negotiation, and Estimation of Residential Water Demand: The Case of France, Land Economics, vol. 76(1), 68-85 OCDE 1987, 1999, 2003 Renzetti, Steven, 1992. "Evaluating the welfare effects of reforming municipal water prices," Journal of Environmental Economics and Management, Elsevier, vol. 22(2), pages 147-163 Resende M. Ramsey Pricing and Regulator's Social Welfare Weights: An Empirical Application. Review of Industrial Organization (1997) 12:413-416. Timmins,S.D (2002) Measuring the Dynamic Efficiency Costs of Regulators' Preferences: Municipal Water Utilities in the Arid West, Econometrica, vol. 70 (2), 603-629 Young, R. A. (2005) "Nonmarket Economic Valuation for Irrigation Water Policy Decisions: Some Methodological Issues,"Journal of Contemporary Water Research and Education: Vol. 131: Iss. 1, Article 4.	
Comments		

Toolbox Database

Environmental criteria (task 2.1) - Continued

Subcriteria	
Approach	Environmental benefits - Benefit transfer
Description	In order to avoid ad-hoc valuation studies, one may transfer values from the so-called study site (where economic valuation of environmental changes was carried out) to the "policy site" (where those values might be of use to inform decision-making processes). The process of transferring existing economic valuations of non-market environmental goods or impacts (benefit or damage) from one site to another through economic techniques is called the Benefit Transfer (BT) method. In essence, this involves using existing data to make predictions in a new policy subject in a cost-effective way. The transfer can be conducted between sites in the same country as well as between different countries, although the later rises among others, the issue of the monetary units.
Name of the tool	Benefit transfer
Type of tool	Value transfer
Description and purpose	Benefit transfer is the transfer of existing estimates of non-market values to a new study which is different form the study for which the values were originally estimated. What is to be transferred can be a scalar (a single value or a set of them) or rather the economic valuation function itself.
Principal steps required to implement the tool	A proper benefit transfer usually consists of three steps, following guidelines economists have developed to improve this practice: *Description of the policy site and the proposed policy action(s) that should specify the important biological and physical characteristics of the site (affected water body), and how humans are expected to use the site or have a connection to it in “non-use” ways. It should also identify the extent of the human population affected by the policy. * Selection of suitable existing studies to provide a basis for a benefit transfer. The degree to which all of these characteristics of existing studies are similar to those of the policy site determines what is called correspondence, which is central to determining the accuracy of a benefit transfer. * Estimation of the economic value of the relevant use or connection, and application to the policy site. An alternate (and preferred) approach is to use a benefit function. A benefit function relates an individual’s willingness-to-pay to a set of individual and site characteristics.
Indicators	Average and median willingness to pay or to accept.
Strengths	
Weaknesses	
Type of EPIs which can be assessed with the tool	
References, handbooks and articles	Bergland, O., K. Magnussen and S. Navrud (1995), Benefit Transfer: Testing for Accuracy and Reliability. Discussion Paper, #D-03/1995, Department of Economics and Social Sciences, Agricultural University of Norway. Eade, D.O.E. and Moran, D. (1996). Spatial economic valuation: Benefits transfer using Geographical Information Systems. Journal of Environmental Management 48:97–110. Kirchhoff, S., Colby, B., and LaFrance, J., 1997. “Evaluating the Performance of Benefit Transfer: An Empirical Inquiry”, Journal of Environmental Economics and Management, 33: 75-93. Loomis, J.B., 1992. “The evaluation of a more Rigorous Approach to Benefit Transfer: Benefit Function

	Transfer", Water Resources Research, 28 (3): 701-705; Brouwer, R., Akter, S., Brander, L. & Haque, E. (2009). Economic valuation of flood risk exposure and reduction in a severely flood prone developing country. *Environment and Development Economics, 14*(3), 397-417. Barton, D.N (2002), The Transferability of Benefit Transfer: contingent valuation of water quality improvements in Costa Rica", Ecological Economics (42: 147-164, 2002).
Comments	

Toolbox Database

Environmental criteria (task 2.1) - Continued

Subcriteria	**Economic values of environmental resources and services**	
Approach	Environmental benefits and costs - Stated preference methods	
Description	Stated preference methods are designed to eliciting economic values to enjoy an improvement in the provision of a water-related ecosystem good or service or rather to avoid an environmental damage. All these methods are based upon stated preferences, that is preferences that are directly expressed, via surveys, in answers to questions on the willingness to pay (WTP) for either of the above-mentioned environmental changes or rather the willingness to accept (WTA) a compensation for suffering the damage or for not enjoying an environmental benefit. In the context of non-market goods for which there is an implicit demand), there are several methods that work considering a hypothetical market. In the market, the stated preferences are collected, which allows for the estimation of the marginal WTP (or WTA) as an expression of how people value welfare changes linked to environmental changes. Two of the most relevant methods, in this respect, are the Contingent Valuation Method (CVM) and Choice Experiments (CE).	
Name of the tool	Contingent valuation method (CVM)	Choice experiments (CE)
Type of tool	Survey / Econometric modelling	Survey / Econometric modelling
Description and purpose	The Contingent Valuation Method is used in the context of natural resources management generally to derive values by directly asking respondents how much they are willing-to-pay (WTP) to obtain a benefit. In the questionnaire the demographic and socio-economic characteristics are surveyed together with some perceptions about the object of the analysis and the policy or institutional context. Respondents of the sample are offered payment vehicles to express their WTP. Data are then statistically analyzed (regression models, cluster analysis) to understand what the determinants that influence that WTP are.	Choice experiments (CE) are currently one of the most popular stated preference approaches to environmental evaluation, since they involve eliciting responses from individuals in a hypothetical market, rather than the study of actual behaviour. CVM and TCM can be said to be particular cases of CE. CE are based on the combination of two theories: random utility theory (RUT) and the characteristics theory of value. The result of this combination is the possibility to describe environmental goods in terms of their attributes, by applying probabilistic models to choices between different bundles of them Ideally, one of these attributes has to be price, such that the marginal utility estimates could be converted into willingness to pay (WTP) value for a change in the level of each attribute.
Principal steps required to implement the tool	* Definition of the valuation problem. * Construction of an hypothetical market: to construct and scenario which corresponds as closely as possible to a real world situation (reason for payment, bid vehicle, provisional rule). * Obtaining the data: select a population sample and design the interview. this include de definition of the valuation measure (WTP, WTA) and the possible bidding mechanisms ('bidding game' payment cards, open-ended questions, etc). * Estimating average WTP/WTA. * Estimating bid curves: the objective is to find a "best" fitting function for the material collected. * Aggregating data.	* Definition of attributes, attribute levels and customisation: conduct a series of focus group studies aimed at selecting the relevant attributes (number of attributes, attribute level and identification of interaction effects between them). * Experimental design: how to create the choice sets in an efficient way. It is developed in two steps: (i) obtaining the optimal combinations of attributes and attribute levels to be included in the experiment and (ii) combining those profiles into choice sets. * Experimental context and questionnaire development. * Choice of sample and sampling strategy: The choice of survey population obviously depends on the objective of the survey. Possible strategies include a simple random sample, a stratified random sample or a choice-based sample.
Indicators	WTP/WTA	WTP/WTA
Strengths	* CVM it is almost the only approach to estimate non-	* Unique approach (with CVM) to estimate non-market

	use values associated with environmental goods and services. * It offers a great deal of flexibility; in particular to the construction of a hypothetical market for a number of environmental goods and services at differing degrees of quality, irrespective of whether they have precedence. * It enables a great deal of information to be collated and analysed from the target population concerning their attitudes towards, use and experience of environmental goods and service in addition to eliciting WTP/WTA amounts and WTP functions concerning the determinants of WTP.	and non-use values. * Since choice experiments can incorporate more than two alternatives, they are more suited to this form of analysis. * Suited to measuring the marginal value of changes in the characteristics of environmental goods, which may be useful from a management of resources perspectives, rather than focusing on either the gain or loss of the good and more discrete changes in attributes. * Choice experiments may also avoid some of the response difficulties which are encountered in CVM studies.
Weaknesses	* Time and resource consuming. * Consumer sovereignty: to accept that the anyone is the best one to judge her own welfare. * The value that is given to a certain environmental good depends (+) on the income of the person.	* Time and resource consuming. * Disadvantages of choice modelling include the fact that more complex choice modelling designs may cause problems for respondents leading to an increased degree of random error in responses. * Contingent rating and paired comparisons will not yield values consistent with economic theory due to the absence of a status quo option for respondents.
Type of EPIs which can be assessed with the tool		
References, handbooks and articles	Schaafsma M., and Brouwer R. (2006). Overview of existing guidelines and manuals for the economic valuation of environmental costs and benefits. Amsterdam, IVM. For AquaMoneu Eu funded project Mitchell and Carson, 1989; Report of the NOAA Panel on Contingent Valuation January 11, 1993; Meyerhoff, J. and A. Dehnhardt (2007), The European Water Framework Directive and economic valuation of wetlands: the restoration of floodplains along the River Elbe, European Environment, 17(1), 18-36.	McFadden, 1974; Louviere J. (1988). Conjoint Analysis Modelling of Stated Preferences, Journal of Transport Economics and Policy, 10, 93–119.
Comments		

Environmental criteria (task 2.1) - Continued

Subcriteria	**Economic values of environmental resources and services**	
Approach	Environmental benefits and costs - Revealed preference methods	
Description	Based upon the complementarity between some market goods and other non-market (environmental) goods, preferences (and therefore economic values) can be revealed through market behaviour. Since it is possible to discern the best possible option on the basis of consumer behaviour, revealed preference methods use an indirect way to access to preference ordering structures or individuals regarding their perception of environmental changes. As in stated-preference methods, the aim is to estimate the marginal WTP for an environmental benefit or to avoid an environmental cost, and consequently to estimate the demand for a number of water ecosystem services, to be able to assess social welfare changes resulting from the implementation of an EPI.	
Name of the tool	Travel cost method	Hedonic price method
Type of tool	Survey / Econometric modelling	Econometric modelling
Description and purpose	The Travel Cost Method (TCM) is used to estimate economic use values associated with ecosystems or sites that are used for recreation. The basic premise of the travel cost method is that the time and travel cost expenses in which people incur to visit a site represents, to some extent, the "price" of access to the site. Thus, individual willingness to pay to visit the site can be estimated on the basis of the number of trips interviewees make at different travel costs.	The hedonic pricing (HP) method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing or land prices that reflect the value of local environmental attributes. It is based upon the assumption that the hedonic price of a house or land property is a function of different vectors of variables, which include the variable which will be the subject of valuation. The derivative of the hedonic price on the variable to be valued is actually the marginal WTP for a change.
Principal steps required to implement the tool	* Define a set of zones surrounding the site. * Collect information on the number of visitors from each zone, and the number of visits made in the last year. * Calculate the visitation rates per 1000 population in each zone. * Calculate the average round-trip travel distance and travel time to the site for each zone. * Estimate, using regression analysis, the equation that relates visits per capita to travel costs and other important variables. From this, the researcher can estimate the demand function for the average visitor. * Construct the demand function for visits to the site, using the results of the regression analysis. * Estimate the total economic benefit of the site to visitors by calculating the consumer surplus.	* Collect data on residential property sales or land property trades in the region for a specific time period (usually one year). * Statistically estimate a function that relates property values to the property characteristics, including the distance to open space . Hedonic pricing employs multiple regression econometric techniques and requires two stages of analysis: * Estimation of the hedonic price function;- in this stage, variation in property prices is explained by regressing property price on explanatory variables relating to the attributes of properties. * Derivation of demand curves and underlying values - property prices are determined by the interaction of supply and demand in the property market, and hence do not reflect the excess of willingness to pay over price paid (it seeks to estimate the demand curve for the characteristic of interest so that full economic value may be inferred).
Indicators	WTP/WTA	WTP/WTA
Strengths	* It allows for the estimation of non-market benefits. * The method is based on actual behavior—what people actually do—rather than stated willingness to	* Uses readily available market data from actual behaviour and choices. * Firmly grounded in the principles of economic theory,

	pay—what people say they would do in a hypothetical situation. * Analysis of travel cost derived demand curves can also yield significant input to analysis of visitor rates and changes in these, which can aid the management of these sites.	relying on the derivation of demand curves and elasticity estimates.
Weaknesses	* Limited to recreational benefits. * Travel cost is unlikely to be a low cost approach to valuation of non-marketed services. * Practical applications of the approach, may be limited by data availability. * More methodological concerns may disadvantage the use of TCM results, particularly with regards to different estimates of consumer surplus that may arise as a result of adopting either the ITCM or ZTCM approach, as well as the treatment of substitute sites, the choice of appropriate functional form and the calculation of the value of time (all as discussed above). Finally, the TCM is not able to account for environmental goods (or bads) that are imperceptible to short-term visitors.	* Limits scope of the environmental benefits that can be measured. * Copious amounts of data and specialist econometric expertise. * Issues of identification and complementarity in the econometric implementation of the model.. * Not suited for application where environmental impacts are not perceived (or observed) in property purchasing decisions, or where environmental impacts are yet to occur,.
Type of EPIs which can be assessed with the tool		
References, handbooks and articles		
Comments		

Toolbox Database

Economic assessment criteria (task 2.4)

Subcriteria	**Economic efficiency principle - Net benefit maximization**	**Cost-effectiveness principle - Cost minimization on equal results**
Approach	**Overall aggregation: costs and benefits comparison**	**Partial information: cost minimization on equal results**
Description	The economic efficiency principle is based on the criterion of the net benefits maximization which consider the net present value (NPV) or the net benefit if considered in a static context. It is able to estimate costs and benefits and to evaluate if a project (measure or policy) provides a net social benefit.	The aim of this principle is to minimize the cost on equal conditions, such that between two actions that produce the same benefit, the action chosen will be that has a lower cost
Name of the tool	Cost-benefit analysis (CBA)	Cost effectiveness analysis (CEA)
Type of tool	Evaluative	Evaluative
Description and purpose	The CBA is an ex-ante evaluation method used to investigate if a project (policy or measure) respects the criterion of acceptance based on its profitability.	The CEA is an ex-ante method and it compares all the relative costs and outcomes (effects) of two or more actions or interventions.
Principal steps required to implement the tool	Several steps: 1. Definition of project objectives'/Identification of alternatives (including a baseline); 2. Identification of project's effects; 3. Monetary evaluation of project effects; 4. Comparison between costs and benefits; 5. Judgment on economic feasibility.	1. Identification of the measures/action that achieve to the same results. 2. Estimation of all costs 3. Comparison between the cost of several measures
Indicators (Indicate if indicator is Direct or Proxy)	Some indicators to use and to compare to have good information about the policy or project implementation: NPV – Net Present Value, IRR – Internal Rate of Return, B/C ratio – Benefit-Cost ratio. Indicator: net present value (NPV), IRR or B/C Proxy: Differences between marginal values of different uses; Differences of marginal net economic benefits of water across different uses Indicator: Total surplus	Two main indicators based on physical characteristics: 1) cost per each unit of result: ratio between costs and effects of action 2) result per each unit of cost: ratio between effects and cost of action. Other indicators proposed: NPC (net present cost) Proxy: Cost per each unit of good used or saved (levelized cost) Performance indicator Proxy: Water Productivity (WP); Irrigation water productivity; Evapotranspiration water productivity (ETWP)
Strengths	It is used in the context of public goods	Under the conditions of budget and time limitations, the CEA results more feasible than CBA and the two main indicators of the CEA are based on physical characteristics
Weaknesses	The use of the discount rate	The analysis does not consider the benefits
Type of EPIs which can be assessed	All	

with the tool		
References, handbooks and articles	INEA (2009). Aspetti economici per la valutazione dei progetti infrastrutturali in ambito irriguo. Hanley N. Spash C.L. (1993). Cost-Benefit Analysis and the Environment. Edward Elgar Publishing. UK Pearce D. W. (2006). Cost- Benefit Analysis and the Environment: Recent Developments . Oecd Publishing,, pp. 320	Net present cost: White S. e Howe C. (1998): Water efficiency and reuse: a least cost planning approach, Proceedings of the 6th NSW Recycled Water Seminar, Australian Water and Wastewater Association, Sydney, November. Fane S. e White S. (2003): Levelised cost, a general formula for calculations of unit cost in integrated resource planning. In: Efficient 2003: Efficient Use and Management of Water for Urban Supply Conference, April 2- 4, Tenerife, Australia Fane S., Robinson J. e White S. (2003): The use of levelised cost in comparing supply and demand side options, Water Supply Vol 3 No 3 pp 185–192 Water Productivity: Garcìa-Vila M., Lorite I.J., Soriano M.A., Fereres A. (2008). “Management trends and responses to water scarcity in an irrigation scheme of Southern Spain”, Agricultural Water Management, 95, 458–468 Irrigation Water Productivity: Malano H. e Burton M. (2001): Guidelines for benchmarking performance in the irrigation and drainage sector, IPTRID-FAO, Roma.
Comments	Some more information on the indicators NPV, IRR and B/C ratio is given in the WP2 framework document.	

Economic assessment criteria (task 2.4) - Continued

Subcriteria	**Distributional effects**	**Distributional effects**
Approach	**Partial information: measures for the income distribution under policy scenario and measures**	**Partial information: measure the costs and benefits of specific groups of stakeholders**
Description	The core content of the instrument concerns a measurement how much income is concentrated in few members of a population. In addition equity principle recall issues about: 1. allocating sufficient quantities to small farms for economic viability of irrigated agriculture, 2. intergenerational equity, 3. environmental justice, by which environmental insults are allocated fairly among society's major groups.	Estimates costs and benefits and evaluates if a project (measure or policy) provides a net benefit for a specifc individual or group.
Name of the tool	Income distribution (not really a tool)	Stakeholder-oriented Cost-benefit analysis (CBA)
Type of tool	Gini indicator	Evaluative
Description and purpose	This method allows the analysis of income distribution under several policy scenario such as pricing. The description is based on the computation of the Gini's indicator in an economic perspective.	The CBA is an ex-ante evaluation method used to investigate if a project (policy or measure) respects the criterion of acceptance based on its profitability.
Principal steps required to implement the tool	As an ex-ante analysis, the method consists in a simulation of income distribution As an ex-post analysis, the method consists in the computation of the Gini indicator and Lorenz diagram to understand the distribution after measure adoption	Several steps: 1. Definition of project objectives'/Identification of alternatives (including a baseline); 2. Identification of project's effects; 3. Monetary evaluation of project effects; 4. Comparison between costs and benefits; 5. Judgment on economic feasibility.
Indicators (Indicate if indicator is Direct or Proxy)	Indicator: Distribution effect Proxy: Gini's indicator, Lorenz curve and equivalent variation	Some indicators to use and to compare to have good information about the policy or project implementation: NPV – Net Present Value, IRR – Internal Rate of Return, B/C ratio – Benefit-Cost ratio. Indicator: net present value (NPV), IRR or B/C Proxy: Differences between marginal values of different uses; Differences of marginal net economic benefits of water across different uses Indicator: Total surplus
Strengths	Robust method in the evaluation of income distribution	It is used in the context of public good
Weaknesses		The use of the discount rate
Type of EPIs which can be	Comparison between several water price system taking in account the issue of the economic inequality	All

assessed with the tool		
References, handbooks and articles	Rawls C., Borisova T., Berg S., Burkhardt J. (2010). Incentives for resindetion water conservation: water price, revenue and consumer equity in Florida. Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Orlando, FL, February 6-9 Ruijn A. (2009) Welfare and Distribution Effects of Water Pricing Policies. Environmental Resource Economics 43:161–182 Ward F.A., Pulido-Velazquez M (2008). Efficiency, equity, and sustainability in a water quantity–quality optimization model in the Rio Grande basin. Ecological Economics, Vol. 66, Issue 1, 15 May 2008, pp 23-37	Rawls C., Borisova T., Berg S., Burkhardt J. (2010). Incentives for resindetion water conservation: water price, revenue and consumer equity in Florida. Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Orlando, FL, February 6-9, 2010 Ruijn A. (2009) Welfare and Distribution Effects of Water Pricing Policies. Environmental Resource Economics 43:161–182
Comments	This principle has been changed respect to the DoW. In this task an economic perspective is considered while in task 2.3 the equity in term of social is considered	

Economic assessment criteria (task 2.4) - Continued

Subcriteria	Cost recovery and revenue generation	Risk reduction / avoided damage
Approach	**Policy mechanism: cost recovery**	**Partial information: cost/changes in variability; value of uncertain events**
Description	Accounting for costs and revenues and their comparison	Risk reduction is associated with uncertain negative events. Risk is commonly defined in economic evaluation as the product of the damage brought by a negative uncertain event times the probability of its occurrence. Reduction of risk or avoided damages can be treated as an estimate of the benefits generated by a project or policy and can be associated with specific actions.
Name of the tool	Budgetary analysis and calculation of revenue/cost ratio	Early warning systems (EWS), cost/risk analysis
Type of tool	Evaluative	Evaluative
Description and purpose	Accounting for costs and revenues and their comparison	An example of application of this raiotnale is the Global Facility for Disaster Reduction and Recovery (GFDRR)/World Bank and the United Nations International Strategy for Disaster Reduction (UNISDR) have jointly commissioned an Assessment of the Economics of Disaster Risk Reduction (EDRR) to evaluate economic arguments related to disaster risk reduction through an analytical, conceptual and empirical examination of the themes identified in the Project Concept Note. Findings of the Assessment are intended to influence broader thinking related to disaster risk and disaster occurrence, awareness of the potential to reduce costs of disasters, and guidance on the implementation of disaster risk-reducing interventions (Subbiah et al. 2008). In the paper, one possible approach to this principle is base on the idea to adopt early warning systems (EWS) especially for flood damage reduction and the adoption of a EWS produces benefits in the reduction of damage or loss and these aspects are evaluated using the cost-benefit analysis.
Principal steps required to implement the tool		For a definition of the actual benefit due to EWS consider: the loss due to a disaster without early warning as A, and the decreased loss that may be incurred after appropriate measures following early warning as B. Then the potential reduction in damages due to early warning is A minus B. However, there may be a cost or investment required for providing the early warning services C. Therefore, the actual benefit due to early warning is A-B-C. The benefits due to adoption of the early warning may be estimated by summing the monetary benefits obtained: Direct tangible benefits in the form of damages avoided by households and various sectors due to appropriate response by utilizing the lead time provided by the early warning + Indirect tangible benefits such as avoidance of production losses, relief and rehabilitation costs, and

		costs involved in providing such services The cost of EWS is calculated under three broad components: 1. Scientific component costs: input costs for technical institutions required to generate forecast information 2. Institutional component costs: refers to costs of training and other capacity development required for institutions to be able to use forecast information, especially to facilitate its use at lower levels 3. Community component: refers to the input costs at community level to enable them to adopt forecast information and respond appropriately In the adoption of the EWS there are several constraints' levels: policy, political, technical institutions, community.
Indicators (Indicate if indicator is Direct or Proxy)	Ratio between costs and revenue	For maximization of benefit in the early warning system adoption: Indicator: Disaster effects Proxy: Loss and benefit (for every 1$ invested in EWS there is a return of 40.85$ in benefits - as an example).
Strengths	Simple and clear in the understanding	
Weaknesses	The costs definition depends on the context and several kinds have to be considered (such as financial, economic, social, environmental, opportunity, direct, indirect). In the WFD vision under the hypothesis of a more interest to the environment, the full cost components are about financial, resource and environmental. If the financial costs are easily calculated from classical economic accountancy, for the other two their identification and then the estiamntion process is not so simple. The introduction of these two components causes difficulties in the full cost estimations because the gap between the theoretical and operation definitions.	
Type of EPIs which can be assessed with the tool	All	
References, handbooks and articles	Danesi, L., Passarelli, M. and Peruzzi, P. (2007). Water services reform in Italy: its impacts on regulation, investment and affordability. Water Policy, 9 (1), 33-54. Carvalho, P., Simoes, P. and Marques, R.C. (2010). Affordability and accessibility in the water and wastewater services in Portugal. Engenharia Sanitatia e Ambiental, 15 (4), 325-336 Easter K. W., Liu Y. (2005). Cost Recovery and Water Pricing for Irrigation and Drainage Projects. Agriculture and Rural Development Discussion Paper 26. The International Bank for Reconstruction and Development - The World Bank Fankhauser, S. and Tepic, S. (2007). Can poor consumers pay for energy and water? An affordability analysis for transition countries. Energy Policy, 35 (2), 1038-1049	Subbiah, A.R. et al. (2008)

Comments		These principles are linked to Lower Middle Income Countries and in particular the risk disaster arises when hazard interact with vulnerability and resilience. Hazard is a natural event that causes (geophysical and hydro-meteorological events) loss of life, injury or other adverse impact; vulnerability refers to physical, social, economic, environmental and individual factors (poverty, disability, disease) that increase the likelihood of loss from hazard; resilience is the ability to resist , absorb, accommodate from the effects of a hazard.

Economic assessment criteria (task 2.4) - Continued

Subcriteria	**Incentive compatibility**	**Promotion of innovation**
Approach	**Policy mechanism: optimal policy design**	**Partial information: econometric models or programming models**
Description	Relate with the ability of EPI to provide the "right" economic incentives to agents	Technological change is a relevant issue in changing the production function of water and hence affecting economic performance of water using sector.
Name of the tool	Principal-agent models	Dynamic programming models; panel based or time series econometric models; qualitative analysis
Type of tool	Normative	evaluative, interpretative
Description and purpose	Incentive compatibility criteria may relate with the ability of EPI to provide the "right" economic incentives to agents. This is partly detectable through policy design and economic expectations related to them, e.g. as it occurs for marginal pricing. Principal agent models, or, generally speaking, models under asymmetric information are a way of accounting for this issue in policy design.	Programming model allow simulation of technological change based on optimising behaviour and adoption mechanisms. They can well represent investment-type changes in technology. Econometric models can explain technological change and innovation based on actual behaviour.
Principal steps required to implement the tool	1. Identification of the policy problem; 2) modelling; 3) data feed; 4) optimisation	Programming models: mathematical structuring, calibration, simulation; Econometric: mathematical model, data collection, estimation, data analysis
Indicators (Indicate if indicator is Direct or Proxy)	Proxy: size of the volumetric component of pricing; degree of differentiation of contracts across differnet actors	Number of new technologies adopted in a given time frame; change in some parameter representing technology n(e.g. resource/product ratio)
Strengths	Incentive compatibility is a particularly relevant issue when water is not metered and straight mechanisms to guarantee incentives to optimal water use cannot be applied.	Address a major issue
Weaknesses	The main weakness is that most of these models use very simplified assumptions; hence the translation of modelling results into prescription is always difficult. In addition, as asymmetric information plays an important role here, lack of information is usually important.	It is always difficult to detect and explain/simulate changes that occur slowly ove time, and are often associated to long term vision and scenarios
Type of EPIs which can be assessed with the tool	proxies of volumetric pricing (e.g. area-based)	all, even not EPI
References, handbooks and articles	Briscoe, J., 1996. Water as an Economic good. The idea and what it means in practice. In: Proceedings of the World Congress of the International Commission on Irrigation and Drainage (ICID). ICID, Cairo, Egypt. Lund, J.R., Israel, M., (1995). Water transfers in water-resource systems. Journal of Water Resources Planning and Management – ASCE 121 (2), 193–204.	Krozer Y., Hophmayer-Tokich S., van Meerendonk H., Tijsma S., Vos E. (2010) Innovations in the water chain – experiences in The Netherlands, Journal of Cleaner Production 18, 439–446. Partzsch L. (2009) Smart regulation for water innovation – the case of decentralized rainwater technology, Journal of Cleaner Production 17 (2009) 985–991. Requate T. (2005) Dynamic incentives by

	Rogers, P., Silva, R.d., Bhatia, R., 2002. Water is an economic good. how to use prices to promote equity, efficiency, and sustainability. Water Policy (4), 1–17. Viaggi, D., Raggi, M., and Gomez y Paloma, S. (2010) An integer programming dynamic farm-household model to evaluate the impact of agricultural policy reforms on farm investment behaviour, European Journal of Operational Research 207, 1130–1139 Ward, F.A., Pulido-Velázquez, M., (2009). Incentive pricing and cost recovery at the basin scale. Journal of Environmental Management 90 (1), 293–313 OECD 2010	environmental policy instruments—a survey, Ecological Economics, Volume 54, Issues 2-3, 1 August 2005, Pages 175-195. Wolfe S. E. and Hendriks E. (2011) Building towards water efficiency: the influence of capacity and capability on innovation adoption in the Canadian home-building and resale industries, J Hous and the Built Environ 26:47–72.
Comments		

Transaction costs (task 2.2)

Subcriteria	private & public transaction costs	
Approach	Mapping all transaction costs following a chronology of when TCs occur	Systematic collection of TC information
Description		Systematic collection of TC information while the EPI is being debated, planned, and implemented.
Name of the tool	Flow chart	
Type of tool	Interpretative	
Description and purpose	The easiest way to assess EPI performance is to trace the steps necessary to implement and operate an EPI and compare those TCs to status quo TCs. Such a flow chart requires that researchers trace, understand and measure TCs within the current system, probably via a flow chart, and then compare these costs to reasonably accurate TCs within an EPI system.	
Principal steps required to implement the tool	Researchers trace, understand and measure TCs within the current system, probably via a flow chart, and then compare these costs to reasonably accurate TCs within an EPI system. As we have to do both ex-post and ex-ante assessment, it could be useful to use a flow chart through time following a chronology of when TCs occur and when they should be measured (at least accounted for). Note: Public transaction costs require documentation about personnel assigned to specific tasks, internal budget, etc., but these costs need to be "marginalized," i.e., what are the additional TCs from an EPI on a public institution that already has full time employees who may not be completely active?	(1) Ex ante measurement during the period when there is growing awareness of the need for policy action, (2) Data collection during the development stage when EPIs are proposed, debated, negotiated, lobbied for and against, defined and redefined, (3) Data collection during early implementation of an EPI, (4) Data collection and preliminary ex post estimates during full implementation, (5) Finalized ex post estimates after the EPI has been well-established
Indicators (Indicate if indicator is Direct or Proxy)	Institutions affect the costs of running the economic system (or transaction costs) and its performance. In order to assess transaction costs, Laurenceau, et al. (2009) suggest that the following aspects are worthwhile being investigated: - the number and roles of actors involved - the time spent (on selecting measures) - the existence of decision-support tools (i.e. models) - the methods and methodology used - the distinction made between basic and supplementary measures - administrative procedures required to carry out the selection of measures - the documents/guidance provided - coordination that was required - number of studies undertaken/outsourced	(1) Research and Information costs, (2) Enactment or litigation costs, (3) Design and implementation costs, (4) Support and administration costs, (5) Contracting costs, (6) Monitoring and detection costs, (7) Prosecution and enforcement costs

	- potential staff hired - number of meetings, discussions, negotiations Indicators that could be good proxies of TCs (e.g. labour time etc.) could be useful. The distinction between administrative costs and Tcs, or the distinction between private and public transaction costs can also be relevant.	
Strengths		Completeness of measurements
Weaknesses	Usually interviews are needed to detect TCs and this can be a practical limitation. In interviews TCs are difficult to explain; small compared to other costs, and mixed in with other costs	The transaction costs of systematically collecting information of transaction costs can be prohibitively expensive compared to the actual TC being measured
Type of EPIs which can be assessed with the tool		All types
References, handbooks and articles	McCann, L. and Easter, K.W. (2004). A Framework for Estimating the Transaction Costs of Alternative Mechanisms for Water Exchange and Allocation, Water Resources Research, 40(W09S09). McCann, L., Colby, B., Easter, K., Kasterine, A. and Kuperan, K. (2005). Transaction Cost Measurement for Evaluating Environmental Policies. Ecological Economics, 52(4), 527-542. Laurenceau, M., Destandau, F. and Rozan, A. (2009). A Transaction Cost Approach to Assess the Water Framework Directive Implementation. WIT Transactions on Ecology and the Environment, 125: 567-578.	McCann, L., Colby, B., Easter, K., Kasterine, A., Kuperan, K., 2005. Transaction cost measurement for evaluating environmental policies. Ecol. Econ. 52, 527–542.
Comments		

Transaction costs (task 2.2) - Continued

Subcriteria	private transaction costs	public transaction costs
Approach	Survey	Government expenditure reports
Description		
Name of the tool		
Type of tool		
Description and purpose	Directly survey water users who had been involved in a water transaction due to an EPI's implementation to determine their transaction costs. Mexico who had recently been involved in a water transaction to determine their transaction costs.	
Principal steps required to implement the tool		
Indicators (Indicate if indicator is Direct or Proxy)	contract costs, compliance costs,	Most types of transaction costs both ex ante and ex post (during the whole life cycle of an EPI): (1) Legislative costs, (2) Information costs, (3) Search costs, (4) Set-up costs, (5) Operational costs, (6) Negotiation costs, (7) Monitoring and enforcement costs, (8) compliance costs,
Strengths	(1) Use of statistical analysis of survey data provides acceptable accuracy of results extrapolation. (2) Can obtain information on the full range of relevant costs and on implicit as well as explicit costs.	Data comes from actual expenditures
Weaknesses	(1) In cases where transaction costs are expected to exceed net benefits a transaction would not have been observed, so their recorded measurement have potentially underestimated transaction costs. (2) Surveys are time consuming and thus costly.	(1) incomplete coverage of costs desired by researchers, (2) data poorly organized for research purposes in that it may be difficult to separate out costs for different EPIs or to clearly separate transaction costs from abatement or transfer costs, (3) the need for cooperative agency contacts willing to pull together information, (4) the potential for confidentiality issues
Type of EPIs which can be assessed with the tool	All types	All types
References, handbooks and articles	Brown, F. L., C. DuMars, M. Minnis, S. A. Smasal, D. Kennedy, and J. A. Urban (1992), Transfers of water use in New Mexicom, Rep. 267, N. M. Water Resour. Res. Inst., Las Cruces. 2) Hearne, R. R., and K. W. Easter (1995), Water allocation and water markets: An analysis of gains-from-trade in Chile, Tech. Pap. 315, World Bank, Washington, D. C. Kuperan, K., N. M. R. Abdullah, R. S. Pomeroy, E. L. Genio, and A. M. Salamanca (1998), Measuring	Falconer, K., and M. Whitby (1999), The hidden costs of countryside stewardship policies: Investigating policy administration and transaction costs in eight European Member States, paper presented at Agricultural Economics Society Conference, Belfast, Northern Ireland, 26– 29 March. Falconer, K., P. Dupraz, and M. Whitby (2001), An investigation of policy administrative costs using panel data for the English environmentally sensitive areas, J. Agric. Econ., 52(1), 883–903. 3)

	transaction costs of fisheries co management, paper presented at the 7th Common Property Conference, Int. Assoc. for the Study of Common Property, Vancouver, B. C., Canada, 10– 14 June.	McCann, L., and K.W. Easter (2000), Estimates of public sector transaction costs in NRCS programs, J. Agric. Appl. Econ., 32(3), 555– 563.
Comments	One needs to distinguish between transaction cost measurements conducted before or after the EPI implementation. If alternatives are being evaluated prior to making a decision, it is necessary to try to predict transaction costs, but this may require surveys, which may suffer from hypothetical bias. Ex post measurements are feasible only for the chosen alternative.	A problematic issue is implicit versus explicit costs. If the transactor pays a consultant or middleman to locate a willing buyer or seller, this is an explicit cost, but if they do this themselves, it is an implicit cost. In the public sector, reallocation of agency staff time is an implicit cost, while allocation of additional staff and monies is an explicit cost. Estimating the hours spent and then attaching an appropriate value to that time is a standard technique to deal with farm family labour, and a similar technique has been employed in estimating the implicit cost associated with agency staff time

Distributional effects (task 2.3)

Subcriteria	**Distributional Justice**
Approach	Assessment of distributional equity for Stiglitz wellbeing components
Description	Social equity describes the distribution of "goods" and "bads" across different groups in society. The ideal distribution would reduce unequal burdens of bads and maximise distributions of goods so that inequalities are reduced. Examining the distribution of impacts of EPI across impact groups (such as farmers, businesses and local communities) will identify which groups are better or worse off following the introduction of EPI. A more detailed assessment can be undertaken based on the initial identification of directional changes by considering each of the welfare criteria in turn. Surveys, focus groups, workshops and MCA may all be used to gain insight into stakeholder perspectives and power. These methods are well discussed in literature This may then be used to highlight social acceptability issues and to conclude on the equitability of the distribution of goods and bads in terms of wellbeing.
Name of the tool	Qualitative and quantitative matrix
Type of tool	Evaluative
Description and purpose	Developing a matrix based on the same methodology as Schiellerup and Chiavari (2009) allowing qualitative and qualitative measurement of changes of each and every indicator (see Stiglitz, 2009). Using Schiellerup and Chiavari's method, both types of data (qualitative and quantitative) can be considered together to provide an overall understanding of the change in wellbeing as a result of the introduction of the EPI. Comparing the results across the different impact groups will demonstrate the degree to which the distribution of "goods" and "bads" is equitable.
Principal steps required to implement the tool	First, for each aspect of welfare described in the typology, the base scenario will be determined by measuring the situation before the introduction of and EPI. This base scenario may then be used to assess the impact of the EPI by examining the changes in each of the welfare aspects from the base to the introduction of the EPI. In order to avoid a purely numerical assessment of the impact of an EPI, changes will be measured using the indicators outlined below. These changes will then be converted into a standardised form of report that will allow the different components of welfare to be considered comparably and also as a whole. This will be achieved by awarding a +, 0 or – to describe the direction of change as a result of an EPI. This methodology has been previously used by Schiellerup and Chiavari (2009) in a similar context. + represents a positive change from base scenario to implementation of EPI 0 represents no discernible change from base scenario to implementation of EPI - represents a negative change from base scenario to implementation of EPI
Indicators (Indicate if indicator is Direct or Proxy)	The Stiglitz Commission (2009) defined the independent components of 'well-being' '- **Material living standards**: Objective: Household income vs. costs incurred under of EPI. - **Health**: Objective: Cost for basic needs quantity of water and/or water treatment as a proportion of household income. Costs of sanitation as a proportion of household income. Water quantity restrictions imposed. Costs for additional water (above basic needs quantity) as a proportion of household income. Changes in water quality standards as a result of changes in water treatment processes. - **Education**: ? - **Personal activities**: Subjective: Assessments on changes in time budgets and allocation of time for water access and treatment. - **Employment**: Objective: Unemployment/Employment rates (Utility); Skill level of any lost or created employment (Rawls) - **Political voice/power**: Subjective: Qualitative measures- surveys to assess perspectives on any changes to political voice/power balance as a whole community (Utility) and as groups (Rawls) - **Social connections / relationships**: Subjective: Network analysis before and after Qualitative measures- surveys to assess perspectives on any changes and why any changes in social connections

	- **Environment**: Subjective: Surveys of opinions and perceptions on the local living environment and whether or not it supports well-being. - **Insecurity**: Subjective: Surveys to identify main areas of insecurity. Before and after surveys can identify any changes in these as a result of the introduction of the EPI
Relevance for analysing pre-conditions for the implementation of EPIs	All types
Strengths	
Weaknesses	
Type of EPIs which can be assessed with the tool	
References, handbooks and articles	Stiglitz Commission 2009; Schiellerup P, Chiavari J (2009) Climate change mitigation policies and social justice in Europe, King Baudouin Foundation, Brussels.
Comments	A list of questions to decide whether and how the EPI influenced the different welfare aspects is given in the WP2 framework document. It could be added in annex to the toolbox document.

Toolbox Database

Uncertainty (task 2.7)

Subcriteria	**Uncertainty**	
Approach	Expert judgment: focus group, expert meeting, etc.	Bounded uncertainty
Description	Qualitative statements are used to fill in the pedigree matrix. They can be obtained from various techniques such as focus group, expert meeting, phone interviews, etc.	A common method for denoting uncertainty is to use error bars or similar techniques designed to convey the degree of statistical uncertainty. While uncertainty can often be modelled statistically, a second form of uncertainty, bounded uncertainty, can also arise that has very different properties than statistical uncertainty.
Name of the tool	Pedigree analysis	
Type of tool	Expert judgement	
Description and purpose	The pedigree criteria is a set of variables named proxy (functional relationship between the outcomes and outputs), empirical basis, methodological rigor, and validation. The pedigree criteria are assessed through expert judgement, using qualitative statements. Aggregated scores are calculated for each data source or assumptions	
Principal steps required to implement the tool		
Indicators (Indicate if indicator is Direct or Proxy)		
Strengths		Visualization is a powerful way to facilitate data analysis
Weaknesses		Visualization systems may not explicitly convey the presence, nature, and degree of uncertainty to users Error bars should not be used for bounded uncertainty because they do not convey the correct properties
Type of EPIs which can be assessed with the tool	All Types	
References, handbooks and articles	Van der Sluijs, J. P., Craye, M., Funtowirz, S., Kloprogge, P., Ravetz, J. & Risbey, J. (2005) Combining quantitative and qualitative measures of uncertainty in model-based environmental assessment: the NUSAP system. Risk analysis 25(2).	Olston C., Mackinlay J.D. Visualizing Data with Bounded Uncertainty. unpublished
Comments		

Uncertainty (task 2.7) - Continued

Subcriteria	**Uncertainty**	
Approach	Probability distribution functions derived from observed frequencies - Fuzzy-set approach	Probability distribution functions derived from observed frequencies -Bayesian approach
Description	Rough and fuzzy sets are important techniques that can be used in various ways for modelling uncertainty in data and in spatial relationships between data entities Rough set theory, introduced by Pawlak is a technique for dealing with uncertainty and for identifying cause-effect relationships in databases as a form of database learning.	The Bayesian approach minimizes the importance of this distinction by introducing the notion of "subjective probability." According to this approach, when objective probabilities are not known, they can be replaced by subjective ones, so that problems of decision under uncertainty are reduced to problems of decision under risk.
Name of the tool		
Type of tool		
Description and purpose		
Principal steps required to implement the tool		
Indicators (Indicate if indicator is Direct or Proxy)		
Strengths	Relevant for spatial data (implementing fuzzy set theory as a way to model uncertainty in spatial databases has a long history)	
Weaknesses		
Type of EPIs which can be assessed with the tool		
References, handbooks and articles	Pawlak, Z. (1985) Rough sets and fuzzy sets, Fuzzy Sets and Systems vol 17, pp. 99–102	Gilboa I., Postlewaite A. W. and Schmeidler D. (2008). Probability and Uncertainty in Economic Modelling. Journal of Economic Perspectives, vol. 22 (3), pp. 173-188
Comments		

Policy implementability (task 2.6)

Subcriteria	Instrument implementation process (Policy maker objective function)	
Approach	Direct specification	Direct inference from policy/planning documents
Description	Ask the policy maker to directly write down the variables of the objective function and their respective weights	Look at the objectives of relevant policies and stated means to achieve them
Name of the tool		
Type of tool (or approach)	Survey methods / Expert judgement	Interpretative
Description and purpose		
Principal steps required to implement the tool		
Indicators (Indicate if indicator is Direct or Proxy)		
Strengths		
Weaknesses		This elicitation mechanism would not give us an overview of the interacting effects between differing objectives of public policy that are likely to determine the implementation of EPIs. This is an especially important consideration to take into account when economic instruments may achieve different policy targets beyond compliance with an environmental standard
Type of EPIs which can be assessed with the tool		
References, handbooks and articles		
Comments		

Policy implementability (task 2.6) - Continued

Subcriteria		
Approach	Revealed preference functions	Analysis of "policy styles"
Description	Perform interviews to those that directly take part in the deliberations during the policy making process in order to elicit their preferences for the construction of a mathematical form of their objective function.	Policy styles are the 'standard-operating-procedures' that nations have developed for making and implementing policies (Richardson, 1981: 22). According to Richardson's definition, national policy styles are: "...the interaction between (a) the government's approach to problem solving and (b) the relationship between government and other actors in the policy process"
Name of the tool		Classification
Type of tool (or approach)	Survey methods	
Description and purpose		Richardson makes a distinction between policy styles according to a consensual/imposing dimension and an active/reactive dimension, thus creating four categories of national policy styles
Principal steps required to implement the tool		
Indicators (Indicate if indicator is Direct or Proxy)		
Strengths	Analysis of simple questionnaires is a method that could be employed here to assign weights to the different variables.	National policy styles allow analysing economic policy instrument in regard to their context
Weaknesses	This would imply that we need to find out the relevant variables of the function beforehand. The EPI Water Policy Think Tank could be approached for this.	No sophisticated and broad classification
Type of EPIs which can be assessed with the tool		
References, handbooks and articles	Van Velthoven, Ben C J, (1990). The Applicability of the Traditional Theory of Economic Policy. Journal of Economic Surveys, Blackwell Publishing, vol. 4(1), pages 59-88.	Andersen M. S. (2001). Economic instruments and clean water: why institutions and policy design matter. OCDE, Paris Richardson J. ed. (1982). Policy Styles in Western Europe, London: Allen and Unwin.
Comments		

National Account

i) Economic assessment criteria, ii) Environmental outcomes and iii) Distributional effects

Approach	Environmental-Economic Accounting: SEEAW
Description	Environmental accounting is one of the key tools for assessing environmental issues and their relation to the economy, and was claimed to be the "best option" for integrating social and environmental considerations into EU decision making in the long term" at the "beyond GDP" conference (Brussels, 19 November 2007 - ENDS Europe DAILY 2432, 20/11/07 http://www.endseurope.com/14171?referrer=search). A key advantage of the accounting framework is that it offers a platform for better integrating heterogeneous information, qualifying it and, to some extent, paving the way for accurately quantified scenario analysis. The "System of Environmental-Economic Accounting for Water (SEEAW)" developed by the United Nations Statistics Division (UNSD) aims at standardizing concepts and methods in water accounting. It provides a conceptual framework for organizing economic and hydrological information permitting a consistent analysis of the contribution of water to the economy and the impact of the economy on water resources. It is linked to a full range of economic activities with a comprehensive classification of environmental resources and includes information about all critical environmental stocks and flows that may affect water resources and that may be affected by water policies.
Name of the tool	SEEAW
Type of tool	(National) Environmental-Economic Accounting / Accounting framework
Description and purpose	The SEEAW is a useful tool in support of IWRM by providing the information system to feed knowledge into the decision-making process assisting policy makers in taking informed decisions on (SEEAW, 2006): - Allocating water resources efficiently, as it presents the quantity of water used and who is using it, and provides information about the economic values added generated by different industries. It allows thus the derivation of water efficiency and productivity indicators, and helps water managers with developing policies for competing water uses. - Improving water efficiency: Water efficiency can be improved from the demand or the supply side. On the demand side, policy makers are faced with the decision of which economic instruments to put in place in order to influence the users' behaviour. On the supply side, they can encourage the efficiency of the water supply or irrigation systems as well as the reuse of water. SEEAW provides information on the fees paid for water supply and sewerage services, as well as payments for permits to access water resources, either for abstracting water or for using water resources as a sink. It also provides information on the quantity of water which is reused within the economy that is water that, after use, is supplied to another user for further use, thus offering policymakers a database that can be used to analyze the impact of the introduction of new regulations throughout the economy on water resources. - Understanding the impacts of water management on all user, and evaluating tradeoffs of different policy options on all users. - Getting the most value for money from investment in infrastructure. Investment in infrastructure needs to be based on the evaluation of long-term costs and benefits. Policy makers need to have information on the economic implications of infrastructure maintenance, water services and potential cost-recovery. The water accounts provide the information of current costs to maintain existing infrastructure, the service charges paid by the users, as well as the cost structure of the water supply and sewerage industries. Therefore they can be used in economic models to evaluate potential costs and benefits of putting in place new infrastructure. - Linking water availability and use. Improving efficiency in the use of water is particularly important in situations of water stress. For the management of water resources, it is important to link water use with water availability. The SEEAW provides information on the stocks of water resources as well as all changes in stocks due to natural causes (e.g. inflows, outflows, precipitation) and human activities (e.g. abstraction and returns). Further, water abstraction and returns are disaggregated by industry, thus facilitating its management. - Providing a standardized information system which harmonizes information from different sources and is used for the derivation of indicators. Information on water is often generated, collected, and analysed by different agencies. The individual datasets might be collected for different purposes, use different definitions and classifications and show overlaps in data collection. A SEEAW based water account allows for disparate information to be integrated

Principal steps required to implement the tool	Gathering of data and filling the following standard tables: a. Water asset accounts These accounts focus on the quantitative assessment of the stocks and the changes in stocks which occur during the accounting period and link information on the abstraction and discharge of water with information on the stocks of water resources in the environment. In particular, the attempt will be to represent: - Opening and closing stocks which are the stocks level at the beginning and end of the period of time - Increases in stocks which include those due to human activities (i.e. returns) and natural causes (e.g. inflows, precipitation) - Decreases in stocks which include those due to human activities (i.e. abstraction) and natural causes (e.g. evaporation/evapotranspiration, outflows etc.) - Additional information on the exchange/flow of water between water resources b. Water supply and use accounts The compilation of the water supply and use per source and sector can describe three types of flows (from the environment to the economy, within the economy, and from the economy to the environment) allowing for: - The assessment and monitoring of the pressure on water quantities exerted by the economy; - The identification of the economic agents responsible for abstraction and discharge of water into the environment; and - The evaluation of alternative options for reducing the pressure on water.
Indicators (Indicate if indicator is Direct or Proxy)	Various indicators can be created using the parameters reported in the standard SEEAW tables on physical supply and use and assets accounts: Indicators on Water Resource availability based on Precipitation, Evapotrasnpiration, External Inflow, Outflow, Returned water, Streamflow, Inflow/outflow to groundwater and reservoirs, soil water. Indicators on Dependency, as ratio of External/internal floes, returns/natural availability Indicators on Water Abstraction (per source and sector, and per distributor) Indicators on alternative water resources (Reused water, desalination) and dependency ratio Indicator on wastewater discharge Indicators on Water use for human activities (per economic sector) and returns per economic sector, thus illustrating pressure on water resources and opportunities to increase water efficiency (through management of return flows, reuse, and system losses) In combination with monetary information on value added, indicators of water use intensity and productivity can be calculated.
Strengths	- Water accounts provide the opportunity to show the supply and use of water in the economy, and the interaction of the economy with the environment - Water accounts describe the pressures exerted on the water system, not the state of the water system or the impact of drivers on this state. Based on time series analysis, one can get an idea about the impact of policy and management responses on these pressures though, but this kind of analysis usually requires also a more in-depth assessment of the various influencing factors that may have played a role in the observed trend. - Homogenised system, harmonised indicators allowing global assessments and comparison
Weaknesses	- The data needed for the standard and supplementary SEEAW tables are not only based on monitoring, but require hydrological modeling (e.g. flows between water resources). - It is not a straight forward task to fill the SEEAW standard tables, one needs to have expertise and good

	understanding of the data, thus not so easy to be filled e.g. by statistical services. - Based on time series analysis, one can get an idea about the impact of policy and management responses on these pressures though, but this kind of analysis usually requires also a more in-depth assessment of the various influencing factors that may have played a role in the observed trend. Consequently, two main questions arise: - Could, through time-series analysis, one get information on the cost-effectiveness of different EPIs once implemented by looking the changes in the water resources availability, abstraction and use on the SEEAW table? - Could, vice-versa, water accounts be used to help designing EPIs? Both questions are open and the answers are not straight forward, requiring further testing and investigation
Type of EPIs which can be assessed with the tool	Water related EPIs that affect different sectors (industry, household) and they have a potential impact either on oncreasing water availability/supply or reducing demand
References, handbooks and articles	Eurostat (2002c). Water Accounts — Results of pilot studies. Luxembourg: Office for Official Publications of the European Communities, 2002. ISBN 92-894-4526-2. French Institute for the Environment (2000). Environmental accounts in France. NAMEA pilot study for France Phase III – Extract on Wastewater accounts. Final Report to Eurostat Subvention 98/778/3040/B4/MM. Statistics Denmmark (2004). The Danish Environmental Accounts 2002. Statistics Denmark: Copenhagen. Statistics Sweden (2003). Water accounts 2000 with disaggregation to sea basins. Statistics Sweden: Stockholm. Rijkswaterstaat (2004). NAMWA: A new integrated river basin information system. Authors: Rob van der Veeren, Roy Brouwer, Sjoerd Schenau, Ronald van der Stegen, RIZA rapport 2004.032, ISBN 9036956900 United Nations Statistic Division-UNSD (2006). System of Environmental-Economic Accounting for Water Final Draft. User-Producer Conference: Water Accounting for Integrated Water Resource Management (Voorburg, 22-24 May 2006), organized by UNSD under the auspices of the UNCEEA.de Haan, 1997; van der Veeren et al., 2004; UNSTATS, 2007 Van der Veeren R., R. Brouwer, S. Schenau, R. van der Stegen (2004). NAMWA: A new integrated river basin information system. RIZA rapport 2004.032. ISBN 9036956900. Available on the internet at http://www.umweltbundesamt.at/fileadmin/site/umweltthemen/wasser/IWG_ENV/Papers/30A_4B_-_NAMWA_P.pdf Central Bureau of Statistics: Voorburg, Netherlands.
Comments	The possibilities of linking existing water information systems to the economic accounting system, previously investigated in The Netherlands, resulted in the creation of the National Accounting Matrix including Water Accounts (NAMWA), which is based on the system of integrated environmental and economic accounting (SEEA), and also of the SEEAW (SEEA for water).

Annex I: SEEAW Tables

A. WATER ASSET ACCOUNTS

Asset accounts

Physical units

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.1313 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Total
1. Opening Stocks							
Increases in stocks							
2. Returns							
3. Precipitation							
4. Inflows							
4.a. From upstream territories							
4.b. From other resources in the territory							
Decreases in stocks							
5. Abstraction							
6. Evaporation/Actual evapotranspiration							
7. Outflows							
7.a To downstream territories							
7.b To the sea							
7.c To other resources in the territory							
8. Other changes in volume							
9. Closing Stocks							

Note: Grey cells indicate non relevant or zero entries by definition.

Matrix of flows between water resources

Physical units

	EA.131 Surface water						
	EA.1311 Artificial Reservoirs	EA.1312 Lakes	EA.1313 Rivers	EA.1314 Snow, Ice and Glaciers	EA.132 Groundwater	EA.133 Soil water	Outflows to other resources in the territory
EA.1311 Artificial Reservoirs							
EA.1312 Lakes							
EA.1313 Rivers							
EA.1314 Snow, Ice and Glaciers							
EA.132 Groundwater							
EA.133 Soil water							
Inflows from other resources in the territory							

B. PHYSICAL WATER SUPPLY AND USE TABLES

Physical use table

Physical units

		Industries (by ISIC categories)							Households	Rest of the world	Total
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total			
From the environment	**1. Total abstraction** (=1.a+1.b=1.i+1.ii)										
	1.a. Abstraction for own use										
	1.b. Abstraction for distribution										
	1.i. From water resources:										
	1.i.1 Surface water										
	1.i.2 Groundwater										
	1.i.3 Soil water										
	1.ii. From other sources										
	1.ii.1 Collection of precipitation										
	1.ii.2 Abstraction from the sea										
Within the economy	**2. Use of water received from other economic units**										
3. Total use of water (=1 + 2)											

Physical supply table

Physical units

		Industries (by ISIC categories)							Households	Rest of the world	Total
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total			
Within the economy	**4. Supply of water to other economic units**										
	of which:										
	4.a. Reused water										
	4.b. Wastewater to sewerage										
To the environment	**5. Total returns** (=5.a+5.b)										
	5.a. To water resources										
	5.a.1. Surface water										
	5.a.2. Groundwater										
	5.a.3. Soil water										
	5.b. To other sources (e.g. sea water)										
6. Total supply of water (=4+5)											
7. Consumption (=3-6)											

Note: Grey cells indicate zero entries by definition.

Physical use table

Physical units

		Industries (by ISIC categories)							Households	Rest of the world	Total
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total			
From the environment	**1. Total abstraction** (=1.a+1.b=1.i+1.ii)										
	1.a. Abstraction for own use										
	Hydroelectric power generation										
	Irrigation water										
	Mine water										
	Urban runoff										
	Cooling water										
	Other										
	1.b. Abstraction for distribution										
	1.i. From water resources:										
	1.i.1 Surface water										
	1.i.2 Groundwater										
	1.i.3 Soil water										
	1.ii. From other sources										
	1.ii.1 Collection of precipitation										
	1.ii.2 Abstraction from the sea										
Within the economy	**2. Use of water received from other economic units**										
	of which:										
	2.a. *Reused water*										
3. Total use of water (=1 + 2)											

Physical supply table

Physical units

		Industries (by ISIC categories)							Households	Rest of the world	Total
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total			
Within the economy	**4. Supply of water to other economic units**										
	of which:										
	4.a. Reused water										
	4.b. Wastewater to sewerage										
	4.c. *Desalinated water*										
To the environment	**5. Total returns** (=5.a+5.b)										
	Hydroelectric power generation										
	Irrigation water										
	Mine water										
	Urban runoff										
	Cooling water										
	Losses in distribution because of leakages										
	Treated wastewater										
	Other										
	5.a. To water resources(=5.a.1+5.a.2+5.a.3)										
	5.a.1. Surface water										
	5.a.2. Groundwater										
	5.a.3. Soil water										
	5.b. To other sources (e.g. sea water)										
6. Total supply of water (=4+5)											
7. Consumption (=3-6)											
of which:											
7.a. Losses in distribution not because of leakages											

Note: Grey cells indicate zero entries by definition.

Matrix of flows of water within the economy

Physical units

User ⇨ / Supplier ⇩		Industries (by ISIC categories)							Households	Rest of the world	Supply of water to other economic units
		1-3	5-33, 41-43	35	36	37	38,39, 45-99	Total			
Industries (by ISIC categories)	1-3										
	5-33, 41-43										
	35										
	36										
	37										
	38,39, 45-99										
	Total										
Households											
Rest of the world											
Use of water received from other economic units											

C. HYBRID AND ECONOMIC ACCOUNTS FOR ACTIVITIES AND PRODUCTS RELATED TO WATER

Hybrid supply table

Physical and monetary units

	Output of industries (by ISIC categories)								Imports	Taxes less Subsidies on products	Trade and transport margins	Total supply at purchaser's price
	1-3	5-33, 41-43	35 Total	35 *of which:* Hydro	36	37	38,39, 45-99	Total output, at basic prices				
1. Total output and supply (Monetary units) *of which:*												
1.a Natural water (CPC 1800)												
1.b Sewerage services (CPC 941)												
2. Total supply of water (Physical units)												
2.a Supply of water to other economic units												
of which: 2.a.1- Wastewater to Sewerage												
2.b Total returns												
3. Total (gross) emissions (Physical units)												

Note: Grey cells indicate zero entries by definition.

Hybrid use table

Physical and monetary units

	Intermediate consumption of industries (by ISIC categories)								Actual final consumption					Capital formation	Exports	Total uses at purchaser's price
			35						Households			Government	Total			
	1-3	5-33, 41-43	Total	*of which:* Hydro	36	37	38,39, 45-99	Total industry	Final consumption expenditures	Social transfers in kind from Government and NPISHs	Total					
1. Total intermediate consumption and use (Monetary units) *of which:*																
1.a Natural water (CPC 1800)																
1.b Sewerage services (CPC 941)																
3. Total use of water (Physical units)																
3.a (U1) Total Abstraction																
of which: 3.a.1- Abstraction for own use																
3.b - Use of water received from other economic units																
1. Total intermediate consumption and use (Monetary units)																

Note: Grey cells indicate zero entries by definition.

Hybrid account for supply and use of water

Physical and monetary units

	Industries (by ISIC categories)								Rest of the world	Taxes less subsidies on products, trade and transport margins	Actual final consumption		Capital Formation	Total
	1-3	5-33, 41-43	35 Total	35 *of which:* Hydro	36	37	38,39, 45-99	Total industry			Households	Government		
1. Total output and supply (Monetary units)														
of which:														
1.a. Natural water (CPC 1800)														
1.b. Sewerage services (CPC 941)														
2. Total intermediate consumption and use (Monetary units)														
of which:														
2.a. Natural water (CPC 1800)														
2.b. Sewerage services (CPC 941)														
3. Total value added (gross) (= 1-2) (Monetary units)														
4. Gross fixed capital formation (Monetary units)														
of which:														
4.a. For water supply														
4.b. For water sanitation														
5. Closing Stocks of fixed assets for water supply (Monetary units)														
6. Closing Stocks of fixed assets for sanitation (Monetary units)														
7. Total use of water (Physical units)														
7.a. Total Abstraction														
of which: 7. a.1- Abstraction for own use														
7.b. Use of water received from other economic units														
8. Total supply of water (Physical units)														
8.a. Supply of water to other economic units														
of which: 8.a.1- Wastewater to Sewerage														
8.b. Total returns														
9. Total (gross) emissions (Physical units)														

Note: Grey cells indicate zero entries by definition.

Hybrid account for water supply and sewerage for own use

Physical and monetary units

		Industries (by ISIC categories)								Households	Total industry
		1-3	5-33, 41-43	35 Total	35 *of which:* Hydro	36	37	38,39, 45-99	Total		
Water supply for own use	**1. Costs of production** (=1.a+1.b) (Monetary units)										
	1. a. Total intermediate consumption										
	1.b. Total value added (gross)										
	1.b.1 Compensation of employees										
	1.b.2 Other taxes less subsidies on production										
	1.b.3 Consumption of fixed capital										
	2. Gross fixed capital formation (Monetary units)										
	3. Stocks of fixed assets (Monetary units)										
	4. Abstraction for own use (Physical units)										
Sewerage for own use	**1. Costs of production** (=1.a+1.b) (Monetary units)										
	1.a. Total intermediate consumption (Monetary units)										
	1.b. Total value added (gross)										
	1.b.1 Compensation of employees										
	1.b.2 Other taxes less subsidies on production										
	1.b.3 Consumption of fixed capital										
	2. Gross fixed capital formation (Monetary units)										
	3. Stocks of fixed assets (Monetary units)										
	4. Return of treated water (Physical units)										

Note: Grey cells indicate zero entries by definition.

Government accounts for water-related collective consumption services

Monetary units

	Government (ISIC 84) (by COFOG categories)			
	05.2 Wastewater management	05.3 (part) Soil and groundwater protection	05.6 Environmental protection n.e.c.	06.3 Water supply
1. Costs of production (=1.a+1.b)				
1. a. Total intermediate consumption				
1.b. Total value added (gross)				
1.b.1 Compensation of employees				
1.b.2 Consumption of fixed capital				

National expenditure accounts for wastewater management[15]

Monetary units

	USERS/BENEFICIARIES					
	Producers		Final consumers			
	Specialised producers (ISIC 37)	Other producers	Households	Government	Rest of the world	Total
1. Use of Wastewater services (CPC 941 and CPC 91123)						
1.a Final consumption						
1.b Intermediate consumption						
1.c Capital formation	nr	Na				Na
2. Gross Capital Formation						
3. Use of connected and adapted products						
4. Specific transfers						
5. Total domestic uses (=1.+2.+3.+4.)						
6. Financed by the rest of the world						
7. National expenditures (=5.-6.)						

Note: Grey cells indicate non relevant or zero entries by definition, nr not recorded to avoid double counting; Na not applicable in the case of wastewater management.

Financing accounts for wastewater management[15]

Monetary units

	USERS/BENEFICIARIES					
	Producers		Final Consumers			
FINANCING SECTORS:	Specialised producers (ISIC 37)	Other producers	Households	Government	Rest of the world	Total
1. General government						
2. NPISHs						
3. Corporations						
3.a Specialised producers						
3.b Other producers						
4. Households						
5. National expenditure						
6. Rest of the world						
7. Domestic uses						

Note: Grey cells indicate non relevant or zero entries by definition.

Economic accounts - supplementary information

	Industry (by ISIC categories)							
			35					
	1	2-33, 41-43	total	*of which:* hydro	36	37	38,39, 45-99	Total industry
Labour input								
Number of workers								
Total hours worked								

Economic accounts - supplementary information

	Industry (by ISIC categories)							
			35					
	1	2-33, 41-43	total	*of which:* hydro	36	37	38,39, 45-99	Total industry
Labour input								
Number of workers								
Total hours worked								

National expenditure accounts for the Protection and remediation of soil, groundwater and surface water

Monetary units

	USERS/BENEFICIARIES					
	Producers		Final consumers			
	Specialised producers (ISIC 37)	Other producers	Households	Government	Rest of the world	Total
1. Use of EP services						
1.a Final consumption						
1.b Intermediate consumption						
1.c Capital formation						
2. Gross Capital Formation (for EP activities)						
3. Use of connected and adapted products						
4. Specific transfers (implicit subsidies,)						
5. Total domestic uses (=1.+2.+3.+4)						
6. Financed by the rest of the world						
7. National expenditures (=5.-6.)						

Note: Grey cells indicate non relevant or zero entries by definition,

Financing accounts for the Protection and remediation of soil, groundwater and surface water

Monetary units

	USERS/BENEFICIARIES					
	Producers		Final Consumers			
FINANCING SECTORS:	Specialised producers (ISIC 37)	Other producers	Households	Government	Rest of the world	Total
1. General government						
2. NPISHs						
3. Corporations						
3.a Specialised producers						
3.b Other producers						
4. Households						
5. National expenditure						
6. Rest of the world						
7. Domestic uses						

Note: Grey cells indicate non relevant or zero entries by definition.