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Economic approaches in water management

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Summary

As part of the Strategic Knowledge Exchange between EU and China in the EU-China River Basin Management Programme this report describes the use of economic and financial tools and mechanisms in water management.

Key recommendations are:

- An increased use of economic assessment tools can improve the decisions to be taken, since they provide a more complete picture of the existing and projected situation and possible consequences of action:
    - For this to happen, the specific economic assessment tools that are “fit-for-purpose” have to be selected, based on existence of information, the level of analysis etc., both for strategic/policy decisions and at the project level
    - A clear impact assessment framework for decisions at the strategic level is advisable, creating clarity of the consequences of action (as compared to non-action), since it would cover all relevant impact aspects (environmental, economic social) in a transparent manner. The EU impact assessment guidance is a useful tool for an integrated approach to strategic policy development
    - A precondition for impact assessments are clear projections of future demand based on the current situation, but also on different scenarios for the future, linked to different decisions taken at the strategic level.
- Agricultural water pricing is a key element of demand management, thus it needs to be considered thoroughly. A clear understanding of the financing, but also incentive function of the current water pricing regime is a starting point, related to this, the price elasticities of water demand in agriculture need to be understood at the appropriate level (e.g. regional level):
    - A clear pre-condition of water pricing is metering (even through proxies), since it is necessary to move from charging for water based on irrigation area to actual consumption (volumetric pricing) on order to set incentives for water saving
    - Water pricing cannot be the only measure related to water demand management in the agricultural sectors, but needs to be an integrated part of an overall water demand management strategic approach

- Considering the key importance of water pricing in agriculture, the social and economic effects of pricing need to be analysed/considered in great detail

- The concept of a financing strategy, which is about balancing the demand for and availability of finance, is a useful tool and can be suggested as an element of strategic planning. For example if more projects are initiated than can be financed, the result could be unfinished infrastructure projects.

- Public subsidies from central, regional or local government are likely to continue to be an important element of infrastructure financing, in particular for water resource infrastructure. If the subsidies are linked to requirements for impact assessment and cost- benefit analyses, it might be possible to increase the benefit of the subsidies

- User charges and user fees could become an important source of financing. In particular for water supply and sanitation infrastructure are user charges as financing mechanism relevant. Affordability and other social issues need to be considered.

• Economics as cross-cutting theme links to the three water securities analyses by the Strategic Knowledge Exchange project and thereby links to the implementation of the No.1 Document. The use of economic assessments would be important for all three water securities in order to assess alternative strategic options. For water resource security, demand management is crucial and the use of water pricing should be considered as one of the elements of water demand management to achieve water security

• A good example of the use of economic assessment methods is given with the proposed Cost Benefit Approach to flood risk assessment (RBMP Technical Report T-072 Flood Risk Economic Assessment).

1 Introduction

This report is prepared as part of the Strategic Knowledge Exchange (SKE) on water securities between EU and China in the EU-China River Basin Management Programme (RBMP). It describes the role of economic and financial tools and mechanisms in water resource management.

The report covers the following issues:

1 Economic assessment tools
Building on the experience from EU and implementation of the EU Water Framework Directive (WFD, see EC 2000b) the report provides examples of how economic appraisal tools such as cost-benefit analysis, cost-effectiveness analysis and multi-criteria analysis can support the implementation of No.1 Document priorities. Also economic valuation methods are presented.

2 Water pricing
Building on the experience from EU Member States and the WFD the report presents how the pricing of water can be used as demand management tool and for supporting the financing of new infrastructure. The report focuses on water pricing in agriculture. It describes the EU experience and highlights issues in determining appropriate tariffs and prices for irrigation.

3 Water infrastructure financing
The report provides examples of financing models used in EU covering irrigation, water supply and sanitation and flood protection. The report presents the financing strategy concept as a way to balance the targeted service level with the available financial resources. It outlines how a financing strategy for the irrigation sector could be done.

Based on the above, possible elements of the way ahead are sketched, referring to possible future work. This covers: 1) Strategy development and supporting technical analysis, 2) Strategic analysis and decision-making in support of improving the regulatory regimes in the context of implementing the No.1 Document, and 3) Scientific research work to advance the use of economic approaches to water management.

The economic elements are cross-cutting in relation to the three security strategy papers and links to them as follows:

- **Water resource supply security**
  Economic appraisal or assessment tools could be important in selecting the best solutions for balancing the supply and demand. Economic appraisals should build on water demand projections

to establish the right baseline. Then options for mitigating the gap between supply and demand should be assessed. Here, water pricing plays an important role as demand management instrument. Finally, a financing strategy where a realistic financing structure is identified for the implementation of the selected option would be crucial for achieving effective implementation.

- **Water ecology security**
  Pricing of pollution discharge could be an instrument to directly reduce pollution, but it could also provide part of the financing of the necessary infrastructure. A financing strategy identifying and assessing alternative financing structures would be crucial for achieving effective implementation of the ecological security.

- **Flood risk security**
- Flood security involves measures that are implemented by public authorities, measures that urban drainage companies could implement as well as actions by the households and companies exposed to flood risks. A strategic economic assessment would be a very useful tool for selecting the right mix of measures. A good example of the use of economic assessment methods is given with the proposed Cost Benefit Approach to flood risk assessment (RBMP Technical Report T-072 Flood Risk Economic Assessment).

2 Economic assessment tools

This chapter firstly clarifies the methods of cost-benefit analysis (CBA), cost effectiveness analysis (CEA) and multi-criteria analysis (MCA) of relevance for assessing options for water management, mainly at the strategic level. It provides information on the complexity of the different methods as well on which methods are to be applied under which circumstances. Based on the requirements of the WFD and the first implementation cycle of river basin management plan in the EU, some conclusions on supporting the implementation of No.1 Document priorities are given, linked to the current situation in China.

2.1 Existing assessment tools and their potential use

Economic assessment tools include CEA, CBA and MCA as well as valuation approaches such as Contingent Valuation or Stated Preference methods. Increasingly the ecosystem services approach is being included into economic assessments. This section is based on Interwies et al. (2005b).

2.1.1 Cost-effectiveness analysis (CEA)

Cost-effectiveness analysis assesses the least cost option of a programme or project, i.e. that with the lowest net present value. A prerequisite of this approach is that the benefits of meeting the goal are greater than the costs (Johannesson, 1995).

Cost-effectiveness analysis is done, if an estimation of the benefits of alternative options is not feasible, too complex or too time consuming. Instead of attempting to identify and value the benefits, the most cost-effective means of achieving a desired objective is identified. It is not the benefits of an option that are decisive but the costs. The aim is to find the solution with the minimum costs. A drawback is that if benefits are not assessed, it is difficult or impossible to assess the willingness of actors to pay for an option that could be a better solution for the environment or the people (Interwies et al., 2005b).

The cost-effectiveness analysis is usually highly site-specific. CEAs are performed when the objectives of the public policy have been identified and the only remaining question is to find the least-cost option to achieve these objectives. In a CEA, the cost-effectiveness of a policy option is calculated by dividing the annualised costs of the option by physical benefit measures, such as animal or plant species recovered, tons of pollutant emissions reduced, kilometres of river length restored, etc. Different options are then compared and prioritised based on their cost-effectiveness-ratio (Aulong, 2009; Interwies et al., 2005b)

The main steps of a CEA are presented below:

1 Identify the objective(s) – economic, environmental, social
2 Determine the extent to which the objective(s) is (are) met
3 Identify sources of pressures and impacts now and in the future over the appropriate time horizon
4 Identify measures to bridge the gap between the reference (current/baseline) situation and target situation
5 Assess the effectiveness of these measures in reaching the objective(s)
6 Assess the costs of these measures
7 Rank measures in terms of increasing unit costs
8 Assess the least cost option to reach the objective(s).

For more details on the different steps of a CEA, please see Interwies et al., 2005b.

2.1.2 Cost-benefit analysis (CBA)

Cost-benefit analysis aims at evaluating the economic efficiency of alternative options. "Economic" is different to "financial", since if considers socio-economic and environmental effects at the macro-level and not only the financial effects. The benefits of an option are compared with the associated costs also considering opportunity costs; the basis for this comparison are usually monetary units. The benefits and costs of each option are determined relative to the baseline scenario, or in other words the situation of no-action. The net benefit of each option results from the difference between the costs and benefits, also called net present value (NPV). An option is economically feasible, only if the NPV that it generates is positive (Pearce et al., 2006).

Cost-benefit analysis is a systematic approach to evaluate alternative management and policy options. All positive and negative effects of alternative options should be assessed. For this comparison, all socio-economic and environmental benefits and costs should be translated into monetary terms, including where possible, non-marketed social, environmental and other impacts. For many goods and services provided by water resources, there is no market in which they are traded, and therefore no market price is available to reflect their economic value. There are, however, several economic valuation methods, which allow setting a value on non-marketed goods and services. The economic valuation of water [use] compares the willingness to pay and opportunity costs of the goods and services supplied by water resources and the water environment. This means that a wider range of goods and services explicitly can be included in the CBA process (Brouwer, 2005).

Cost-benefit analysis as a decision-support tool is mainly carried out by economists as well as policy- and decision-makers. They have to make sure that the information basis of a cost-benefit analysis is appropriate and that the results are valid and reliable.

In general, the following steps are part of a Cost-Benefit Analysis (Interwies et al., 2005b):

1 Set the objective of the policy measure
2 Set the baseline (what would happen if no action is taken / business-as-usual)
3 Define the alternative options to achieve the objective
4 Identify and measure the investment costs of each option compared with the baseline option (in monetary units)

5 Identify and quantify the positive welfare effects of each alternative option compared with the baseline option
6 Value the positive welfare effects in monetary terms, using market prices or economic valuation methods for non-priced effects
7 Compare costs and benefits over time (using an appropriate discount rate)
8 Perform sensitivity analysis
9 Present conclusions and recommendations.

2.1.3 Multi-Criteria Analysis

Multi-criteria analysis is used for identification of best compromise solutions, for the ranking of potential solutions, for identification of available solutions to be followed by a more detailed analysis or for sorting the options that are feasible from those that are unrealistic (Interwies et al., 2005b; Herath, 2006). MCA helps to structure, analyse and clarify situations that are rather complex and with limited availability / access to facts that would be required for a CBA (DCLG, 2009; Munda, 2004; Banville, 1998; Hajkowicz, 2008; Belton, 2001).

A Multi-Criteria Analysis is an approach that helps to structure the preferences of alternative policy measures, in case the policy measure pursues several objectives, which often is the case in water management. It is suitable for situations in which a single-criterion approach is insufficient. Especially water management often has to face various environmental and social impacts, which are difficult to monetise. By integrating participatory approaches MCA facilitates the assessment of these inputs in a more appropriate way than classical monetary approaches could do (Gampera, 2007).

Some costs and benefits, however, can be valued in monetary terms even if an overall monetized approach is not possible, either by direct observation of prices or indirectly by using generally accepted techniques. In that case these data should be used within any wider MCA. Applications of MCA often involve combinations of some criteria, which are valued in monetary terms, and others for which monetary valuations do not exist (Interwies et al., 2005b; DCLG, 2009).

MCA is based on the assessment of groups and individuals that are involved in decision making by establishing objectives and criteria by which their relative importance is weighted. The concept incorporates the subjectivity of the people / experts involved. Nevertheless ‘hard’ data such as market prices are included in order to support such judgement.

The application of Decision Support Systems (DSS) can significantly facilitate an MCA by guiding the process for data collection and analysis. At the same time, using a DSS does not reduce the efforts that need to be put into information collection for an MCA, it merely gives a clearer structure to the process. As an example, the MULINO decision support system (mDSS) developed by G. Cojocaru, J.; Mysiak, C., Giupponi, and P. Rosato in the context of a European research project is a good reference described in more detail in the paper ‘Towards the development of a decision support system for water resource management’ (Mysiak et al. 2005). Further details on the tool can be found at the website http://www.netsymod.eu/mdss/.

Steps in a multi-criteria analysis (DCLG, 2009; Gampera,, 2007)

1 Definition of the decision situation: Identification of the MCA objectives; clarification of roles and competences of decision makers and other involved stakeholders
2 Identification of management options
3 Identification of criteria that reflect the benefits (and impacts)
4 Description and scoring of the criteria
5 'Weighting': assigning weights for each of the criteria to reflect their relative importance for the decision
6 Calculation of the overall value of the options through a combination of the weights and scores
7 Analysis of the results
8 Sensitivity analysis of the results to changes in scores or weights.

2.1.4 Which assessment method to use?

A universally valid statement, which method would be the best for an economic analysis in natural resource management (e. g. for water management) does not exist. The choice depends very much on the context and the data availability of the specific management situation.

A simplified, general overview of the criteria that could lead decision makers to prefer one method to the other and how the different assessment methods are related to each other is presented in Figure 1, based on the assumption that only one assessment method is applied. However, the three presented methods CEA, CBA and MCA have many elements in common and it can be useful in a specific case to combine distinctive elements of one method with the other. Figure 2 gives a schematic overview of how the different assessment methods can be usefully combined.

The figures show that the choice of method for making valid economic assessments very much depends on the availability of data and hard facts. If the situation is clear-cut and there are few trade-offs between different benefits to be expected and the costs of options are easy to identify, then a Cost Effective Analysis is the way to go. If the situation is more complex, but the availability of economic data for both costs and benefits are available, then the Cost Benefit Analysis provides for the most comprehensive analysis at least from the economic point of view. If however both situations apply with particular disagreements on viable option or significant trade-offs between existing options and insufficient data for monetising costs and benefits, then Multi-Criteria Analysis appears to be the best choice.

In any case policy processes can always be conditioned by heavy value judgements, while at the same time social actors rarely attribute the same importance or weight to the issues and problems under consideration. The management of a policy process involves many layers and kinds of decisions, and requires the construction of a dialogue process among many stakeholders, individual and collective, formal and informal, local and not.

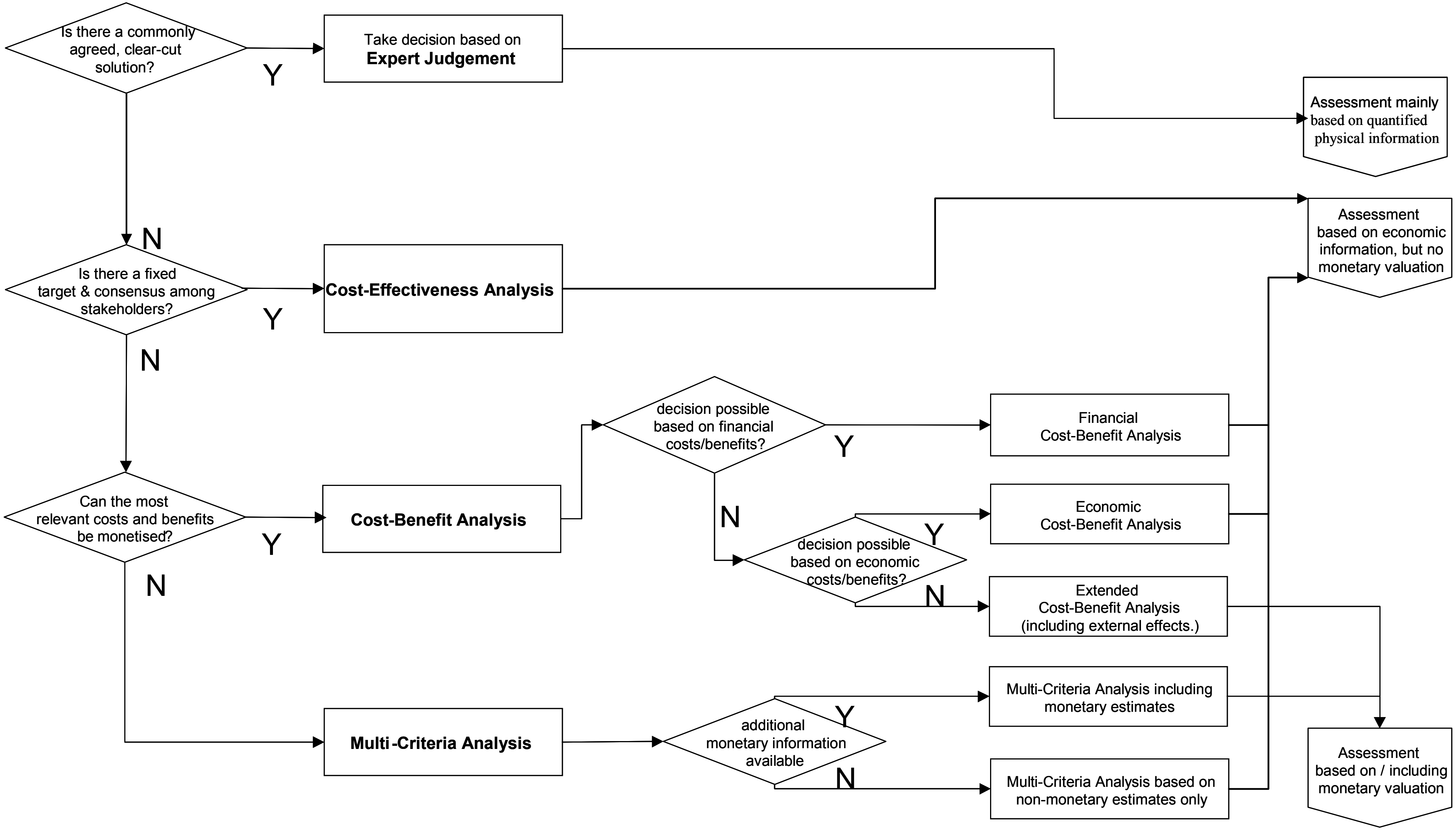


Figure 1 Decision flowchart for the choice of an economic assessment method (Note that monetary valuation is understood as a valuation of non-monetary values) (Adapted from Interwies et al., 2005)

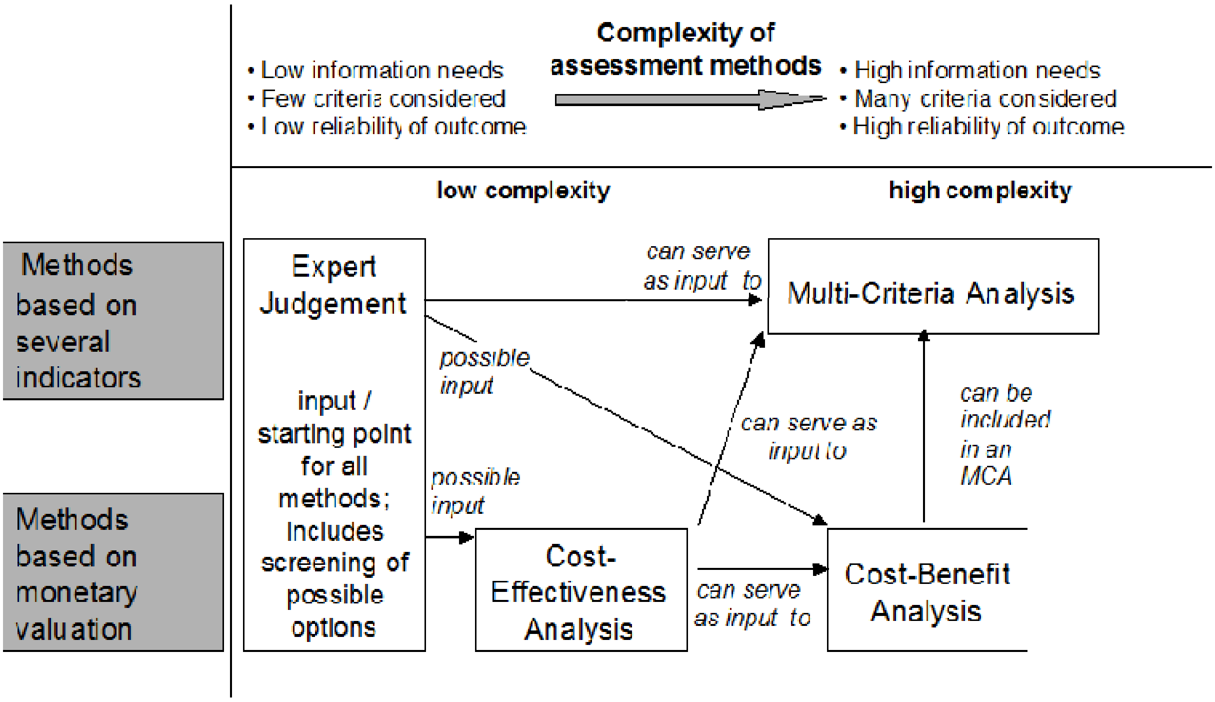


Figure 2 Order and possible combinations of different economic assessment methods (Adapted from: Interwies et al., 2005)

2.1.5 The role of economic valuation methods

While the cost side of economic considerations is more straight-forward to estimate, a lot of difficulties exist for the benefits side. Therefore, many international organisations have worked on the economic valuation of benefits, often linked to the concept of ecosystem services. Among the most important in the context of integrated water management are without doubt IUCN, WWF, the Ramsar Secretariat and the UN agencies. While each organisation has put a special focus on its work, all of them rely more or less on similar basic concepts/tools, for instance the ones used by the Millennium Ecosystem Assessment on the global scale.

The Millennium Ecosystem Assessment framework for the assessment of ecosystems is still is in process of development (MEA, 2003). This chapter gives an overview on the state-of-the-art of valuation methods of benefits based on the ecosystem service approach as a follow-up of the Millennium Ecosystem Assessment.

IUCN

IUCN has issued a tool book (Emerton, 2004; Bos, 2004) that aims at streamlining economic valuation into the cycle of water resource management. Their concept is based on the idea of the total economic value that includes the direct values, indirect values, option values and existence values. An important part of the book is the section that is dedicated to the embedding of the valuation into decision making and to the translation of values into management decisions.

WWF

The WWF co-operates with all major international organisations in the field of environmental economics. They have published a book reviewing the economic values of the world's wetlands (Schuyt et al., 2004), in which they analyse the functions and values provided by wetlands on the global scale and add a overview on the current status of global wetland conservation with special regard to the requirements of the Ramsar Convention.

Ramsar Convention Secretariat
Already in 1996 the "Conference of the Contracting" (COP) of the Ramsar Convention included the concept of economic valuation into their Strategic Action Plan. To support this, the 1997 book "Economic valuation of wetlands: A guide for policy makers and planners" was published by the Ramsar Secretariat (Barbier et al., 1997). Since then scientific developments have made fast advances, so a new guidance was published in 2006 in cooperation with the Secretariat of the Convention on Biological Diversity (De Groot et al., 2006). The guidance focuses on the application of economic valuation for wetlands establishing a strong link to the objectives of the Ramsar Convention. This book provides for many tools and techniques on wetlands conservation management.

UN Agencies
Rather than publishing guidance books, the UN agencies UNEP and UNDP in cooperation with the World Bank support the International Waters IW:LEARN Learning Exchange and Resource Network financed by the Global Environment Facility's (GEF). This Network aims to strengthen International Waters Management by facilitating structured learning and information sharing among stakeholders.

2.1.6 Different valuation methods

There is a vast range of methods that can be used for the valuation of ecosystem services (Figure 3). Here the following methodologies are briefly described:

- Market price
- Production function
- Hedonic pricing
- Travel cost method
- Contingent valuation
- Choice experiment
- Replacement Costs

Market price method
The market price method is applicable to direct use values. The value is an estimate from the price in commercial markets. Constraints in this method belong to market imperfections (subsidies, lack of transparency) and policy, which may distort the market (Emerton et al., 2004; Schuyt, 2004).

Effect on production method
The effect on production method is applicable for specific ecosystem goods and services (e.g. water, soils, micro-climate etc.). It estimates the economic values for ecosystem products or services that contribute to the production of commercially marketed goods. The methodology is straightforward and data requirements are limited, but the method only works for some goods or services. Data on change in service and the consequent impact on production are often lacking (Emerton et al., 2004; De Groot et al., 2006).

Revealed Preference Approaches			**Cost-based Approaches**	**Stated Preference Approaches**
Market Prices	Production Function Approaches	Surrogate Market Approaches		
Market Prices	Effect on Production	Market Prices	Replacement Costs	Contingent Valuation
		Hedonic Pricing	Mitigative or Avertive Expenditures	Choice Experiments
			Damage Cost Avoided	
			Travel Cost	

Figure 3 Categories of commonly-used ecosystem valuation methods (Adapted from Emerton, 2004)

Hedonic pricing method

The hedonic pricing method covers some aspects of indirect use, future use and non-use values. This method is used when ecosystem values influence the price of marketed goods. Clean air, large surfaces of water or aesthetic views will increase the price of houses or land.

This method only captures people's willingness to pay for perceived benefits. If people are not aware of the link between the environment attribute and the benefits to themselves, the value will not be reflected in the price. This method is very data intensive and very sensitive to specification. (Pagiola et. al., 2004; EFTEC, 2006)

Damage cost avoided, replacement cost or mitigative or avertive expenditures method

It is applicable to indirect use values (e.g. coastal protection, erosion and pollution control, water retention etc.). The value can be estimated by calculating the costs that would occur for building necessary infrastructures to replace the service (e.g. treatment plants) or by calculating the estimated damage of a hazardous event (storm) (Tallis, 2009).

A main constraint of this method is the assumption that the cost of avoided damage or substitutes match the original benefit. But many external circumstances may change the value of the original expected benefit and the method may therefore lead to under- or over-estimates. Because of its tendency to over- or under-estimate the actual value, the method should be used with extreme caution.

Travel cost method

The travel cost method is applicable to recreation and tourism. The value is estimated from the amount of money that people spend for visiting the area. This method only gives an estimate. Over-estimates are easily made as the site may not be the only reason for travelling to that area, thus it is hard to use when trips are to multiple destinations. (Emerton et al., 2004; Springate-Baginski et al., 2009)

Contingent valuation method

The contingent valuation method is applicable to Tourism and Non-Use values. This method asks people directly how much they would be willing to pay for specific environmental services. It is often the only way to estimate the non-use values. It is also referred to as a “stated preference method”. There are various sources of possible bias in the interview techniques. There is also controversy over whether people would actually pay the amounts stated in the interviews. It is the most controversial of the non-market valuation methods, but is one of the few ways to assign monetary values to non-use values of ecosystems that do not involve market purchases (De Groot et al., 2006; Emerton et al., 2004; Smith, 1996).

Choice experiment method

The choice experiment method is applicable for all ecosystem goods and services. It estimates values based on asking people to make tradeoffs among sets of ecosystem or environmental services. It does not directly ask for willingness to pay as this is inferred from tradeoffs that include cost attribute. This is a very good method to help decision makers to rank policy options (De Groot et al., 2006; Emerton et al., 2004; Smith, 1996).

2.1.7 The boundaries of economic valuation

The value of goods is always bound to certain rules and games set by the state and the society, such as property rules and property rights, environmental policies and legal framework, uncertainties (environmental, political, social, economic), standards for environmental regulations, environmental policy in international co-operative agreements. This chapter gives a short overview of the main difficulties related to the economic valuation of benefits, thus it sets the boundaries that one has to bear in mind when conducting a valuation exercise and using it for supporting policy decisions:

- Today in the most world’s economies, economic interaction is market driven. Thus price regulation and the designation of the value of goods and services follow the rules of markets. Nevertheless many public goods and services are lacking markets (e.g. absence of “markets” for species conservation or for most of the regulating and supporting services of ecosystems). Furthermore, there is potential for market-based instruments to produce results that are socially unacceptable (Sukhdev, 2008).

- Policy failures arise due to incentives that encourage harmful action. Tax incentives and subsidies can lead to the market working for the destruction of natural capital, even where natural assets offer a sustainable flow of services to the economy and to society. Environmentally harmful subsidies discriminate against sound environmental practices while encouraging other, less desirable activities. Policy failures also arise when the system of incentives fails to reward those who work to improve the environment, or fails to penalise those who damage it. Many agricultural practices can support high-value biodiversity (Tallis, 2009; Sukhdev, 2008), but they are rarely put in use.

- One important issue in economic valuation is the significant knowledge gap on the carrying capacity of ecosystems. The most extreme case is that it is almost unknown when the point of ecosystem collapse will be reached. The Stern Review (Stern, 2007) has formulated this incidence as follows: how to assess a roll of the dice, when one of the outcomes is the end of civilization as we know it? As a result we always need to bear in mind that an excessive use of an ecosystem could result in its extinction even if a margin of its area is put under conservation.

- Regarding social issues the quantification of economic values can hide substantial injustice. Even if the economic valuation has resulted in great values for one ecosystem service it could be that this would have severe consequences for parts of the population, that lack a strong economic lobby or for future generations. Also ethical issues need to be reflected in economic valuations. Societies may give preference to choices that do not represent a manifested specific economic value, only because it touches specific ethical values (Emerton, 2004).

- The cost of biodiversity loss is not possible to fully assess. One important reason is that we do not fully know when and which species will disappear next and the value these species really represent to our own or future generations (MEA, 2003).

- Also the complexity of ecosystems poses significant difficulties for any assessment. The benefits of ecosystems greatly vary from year to year or season to season due to the natural non-linearity variability and cumulative effects of the services provided. Timelines can help to provide for more or less reliable averages over the years or decades (Carpentera, 2009).

- Practical difficulties while doing an benefits assessment / ecosystem valuation may arise with 1) marginality (it is important to know what is the value of lost ecosystem services as, for example, parts of the stock of tropical forests in certain locations are degraded or destroyed), 2) double counting (many ecosystem services are not complementary, the provision of one may be precluded by others (for example, using a wetland for recreation or for effluent treatment), 3) typological issues (it is important to differentiate between valuations of the in situ ecosystem stock and estimates of the value of the flow of goods and services from a given stock, 4) spatial and temporal data transfer, and 5) distribution of benefits and costs etc.

The concept of economic valuation should incorporate the above mentioned issues, since it has been elaborated explicitly because conservative valuation techniques have not reflected uncertainty margins and non-use values. Since these aspects, however, still are very difficult to assess, the outcome of a valuation should always be examined in the regard that still a lot of these aspects are not reflected in the achieved total economic value of a valuation exercise (De Groot et al., 2006).

2.2 EU experience

This chapter presents some relevant experiences in Europe regarding the use of economic assessment tools. First, the specific requirements and current implementation on the context of the WFD are provided. In addition, more generally and beyond the WFD, for supporting decisions on the strategic/policy level, economic assessment tools are being increasingly used. An example of this is is the impact assessment guidelines of the European Commission, which currently are applied in the EU Water Blueprint preparation.

2.2.1 Brief introduction to EU-WFD requirements

Economics play a big role in the overall implementation of the WFD and especially for the development of the river basin management plans. The main points of the implementation cycle of the WFD for which economic assessment provide necessary information are:

- estimating the **cost-effectiveness of measures and sets of measures** at different scales in order to reach the WFD objectives (Art. 11)
- assessing the **proportionality/disproportionality of costs** associated with proposed measures in order to justify potential exemptions from the WFD-WFD environmental objective of good surface water status by 2015 (Art.4) which can be sought on different grounds. For each of these exemptions, a number of "derogation tests" have to be applied as input into decision making.
- the requirements regarding assessing and improving the **cost recovery level of water services** based on Article 9 of the WFD will be presented in Chapter 3 of this report.

Further information on the understanding of these economic WFD-elements has been provided by a number of documents produced in the context of the Common Implementation Strategy, e.g. the WATer ECOnomics-document 2004 (see http://circa.europa.eu/Public/irc/env/wfd/library) as well as different information sheets covering specific topics (on cost-effectiveness analysis, environmental and resource costs etc.) and the guidance on the use of exemptions (CIS, 2009).

While WFD Art. 11 clearly demands the use of CEA, Art. 4 does not specify which economic assessment tool to use. In order to clarify this, the CIS-guidance document on the issue (CIS, 2009) indicates that a CBA might be used in case of the disproportionate cost analysis is undertaken. At the same time, it is mentioned that a proportionate selection of the different analyses (cost-benefit analysis, benefits assessment, assessment of the consequences of non-action, distribution of costs, social and sectoral impacts, affordability, cost-effectiveness etc.) is useful to inform decision making.

More specifically, and in order to fulfil the requirement of “long-term forecasts of water demand” (WFD-Annex III), the WATECO-group at the European level developed the so-called baseline scenario (BLS)-approach (CIS 2003). It is the assessment of forecasts in key economic drivers likely to influence pressures and thus water status. In the BLS, trends in water demand need to be evaluated. The focus is on changes in general socio-economic variables (e.g. population growth), in economic growth of main sectors as well as changes in the implementation of planned investments linked to existing regulation. The baseline scenario approach is described in detail as well as practical examples of its application given in CIS (2003), Annex 3, pp. 140-160.

For more information on the issue of demand forecasts, please see RBMP Technical Report 076 Water Resource Security.

2.2.2 Experiences with implementing the WFD so far (1st river basin management planning cycle)

Overall, the first cycle of river basin management planning under the WFD showed an increase in the use of economic assessment tools, but with potential for being used more widely. It is clear that the economic aspects of the WFD pose significant challenges for water administrations at different institutional levels. This concerns both the content/economic assessment side, but also the policy side, since in most countries, the integration of economic considerations has not been systematic when taking water management decisions.

Overall, the CBA seems to be the main tool used at the strategic level, since it supports assessing different management options/levels of ambition and their feasibility (See box below).

Example of the Netherlands approach of using CBA at the strategic level for WFD-implementation

This example is from van de Veeren (2012), unpublished manuscript.

Starting 2005, several cost benefit analyses have been performed for the EU WFD in the Netherlands at the strategic level. These analyses had in common that they were meant to support the decision making process by informing policy makers and making the trade-offs as transparent as possible. The analyses also anticipate questions from Dutch Parliament. Nevertheless, each time the analyses were slightly different, depending on the situation and (political) questions to be answered. Even though the results are hardly comparable for a number of reasons, they show that economic analyses have played a role in the decision making process by making implicitly (latent) available knowledge more explicit, leaving the more transparency and traceability of the relevant tradeoffs. This offered the opportunity for an iterative dialogue with Dutch Parliament, which contributed to a decision making process that at the end resulted in a socially accepted programme of measures that is economically sound and transparent.

Summing up, most of the results of the cost-benefit analyses do not come as a surprise for most Dutch water professionals. For example, the cost-effectiveness of ecological measures compared to emission reduction measures is a typical result of Dutch water policies over the past decades.

Because, ever since the Pollution of Surface Water Act came into force (1970) many efforts have already been put into the reduction of emissions of various substances. However, not until the Forth Report on Water Management, the focus shifted more towards ecology. This increased with the WFD. The most important issues hampering ecological functioning (and the achievement of WFD objectives) are the present hydro-morphological situation (e.g. concrete instead of natural riverbanks, straightened canals instead of meandering rivers) and nutrient concentrations. Therefore, it makes sense that Dutch river basin management plans primarily focus on these issues.

2.2.3 The impact assessment guidelines of the European Commission – the EU Water Blueprint example

The EU Impact Assessment (IA) Guidelines (European Commission 2009) describe a process that prepares evidence for political decision-makers on the advantages and disadvantages of possible policy options by assessing their potential impacts. They describe a set of logical steps to be followed when EU officials prepare policy proposals, although it is not prescribed for which policy initiatives such assessments should be performed - this is decided each year by the Secretariat General/Impact Assessment Board and the departments concerned. In general, IAs are necessary for the most important EU initiatives and those which will have the most far-reaching impacts. Thus, the IA is an extensive analysis, requiring time (>12 months) and resources. It should be noted furthermore that the IA supports and does not replace decision-making – the adoption of a policy proposal is always a political decision.

The IA Step 8 consists of an analysis the impacts of the policy at hand on the economic, social and environmental "sectors". More specifically, after clarifying which impacts can be expected (Step 8.1), and identifying the most significant ones (Step 8.2), it is proposed to undertake further in-depth analyses to produce a quantitative/monetary estimate of expected benefits and costs. This can take a number of forms:

- In-depth analysis of expected impacts over time which typically requires a case study/scenario approach.
- Quantitative estimation of impacts: the impacts are estimated using quantitative techniques, varying from simple extrapolation – based for instance on previously derived coefficients (e.g. units of CO_2 per unit of industrial activity) – through statistical inference on the basis of similar impacts and occurrences elsewhere (e.g. impact assessment work in Member States and other countries) to full-fledged quantitative modelling (Annexes 9 and 11 provide guidance on quantitative analyses; it is proposed, for example, to apply a 4% discount rate).

Of importance in this context is that the guidelines do not prescribe which form of economic analysis has to be used. The guidelines require, however, to explain why quantification or monetization is not feasible (if this is the case).

Step 9 of the guidelines then details how to present the results of the analyses of impacts, i. e. how to best compare the expected costs and benefits. For this, the guidelines propose to use either:

- a full cost-benefit analysis (CBA) in cases where the most significant part of both costs and benefits can be quantified and monetized
- a partial CBA if only a part of the costs and benefits can be quantified and monetized - a qualitative aspect will then be included
- a cost-effectiveness analysis (CEA), if benefits cannot be quantified, and when different options will be compared, or
- a multi-criteria analysis (MCA), in cases where there is a need to present impacts that are a mixture of qualitative, quantitative and monetary data, and where there are varying degrees of certainty.

Thus, the EU IA Guidelines underline the importance of including economic assessment tools in estimating the possible impacts of policies in an integrative way, and present different options of doing so (CBA, CEA, MCA). The guidelines additionally make clear, however, that it is recommendable to choose the economic assessment tool according to the specific situation, dependent mostly on the topic and data availability.

Presently, the EU Commission´s "Blueprint to Safeguard Europe´s Waters", a synthesis document of policy recommendations for the future of EU-water policy (building on four ongoing assessments of EU policies and actions, and the Member States´ implementation of these), will be subject to a thorough IA in order to understand the potential environmental and socio-economic impacts of the proposed policies. Unfortunately, the results are not available yet, but expected within 2012.

2.3 Chinese context

Regarding the use of demand forecasts, according to Technical Outline for the National Comprehensive Plan on Water Resources (2002), the basic requirements for water demand forecasting are:

1 The water demand forecasting and water uses of relevant parts are categorized into three parts: domestic, production and ecological environment, and statistics shall be made for two categories respectively: urban and rural.

2 It is required to carry out additional investigations in accordance with new evidence ("new references") and classify statistics in accordance with references (the classification references are called "previous references") determined in the investigation and assessment on development and utilization of water resources for economic and social development purposes and water use indexes in 2000. Different regions shall select representative cities (towns), large irrigation areas, enterprises (or sectors), major rivers and areas to carry out investigations in accordance with local conditions to analyze and determine present water use data under "new references", such as water use structure and quotas, and to calculate statistical data under "new references" of 2000 (those in 2008 were adopted actually).

3 It is required to submit two sets of water demand forecasts corresponding to the water saving 1) Basic Plan and 2) Water Saving Enhancement Plan. The Basic Plan refers to a water demand plan determined on the basis of the present water saving level and corresponding water saving measures (business as usual), while the Water Saving Enhancement Plan is a water demand plan with the further improved water saving level under conditions of further increase of water saving investments and strengthening of demand management. The water demand forecast results in the Water Saving Enhancement Plan shall coordinate with the recommended plan in Water Saving part.

4 The outcomes of water demand forecasts shall be determined on principles of "multiple methods, comprehensive analysis and reasonable determination". The basic method is quota forecasting, and it is also necessary to recheck with other methods, such as tendency method, mechanism method, per capita water use method and elasticity coefficient method, and propose the water demand forecasting results through comprehensive analyses.

5 It is required that statistics about economic and social development indexes and water demand forecasting results of water uses shall be taken in accordance with "calculation divisions" for urban and rural categories

6 Due to significance of cities, it is required that all provinces shall make statistics separately for cities, forecast water demand of "urban areas" and that forecasting results shall coordinate with those in the "calculation division" for urban and rural areas.

2.4 Linking the use of economic assessment tools used in the EU to the implementation of the No.1 Document

Based on the above and considering how the use of economic assessment tools can support the implementation of No.1 Document based on the three “water securities”, the following can be noted:

- In EU an increasing use of economic assessment tools is obvious
- Economic assessment tools have a role to play at the project level, but also at the strategic level, as the example from the Netherlands shows.
- A clear impact assessment framework for decisions at the strategic level is advisable, creating clarity of the consequences of action (as compared to non-action) since it would cover all impact aspects (environmental, economic social) in a transparent manner
- Impact assessment of strategies/policies are useful and should include economic assessments. At the European level, such impact assessments are required, thus the current “Blueprint to Safeguard Europe’s Waters”-process is using the relevant guidelines to assess different options (results unpublished so far, to be expected later in 2012)
- The precondition for a systematic, useful application of integrated assessment and the use of economic assessment tools are clear projections of the future. (Socio-)economic changes can strongly influence the demand side projections. A good, systematic and transparent approach for assessment of key future developments of the “business-as-usual” is needed, as well as the alternative developments
- An increased use of economic assessment tools can improve the decisions to be taken, since they provide a more complete picture of the existing and projected situation and possible consequences of action
- For this to happen, the specific economic assessment tools that are “fit-for-purpose” have to be selected, based on existence of information, proportionality of the level of analysis etc., both for strategic/policy decisions and at the project level
- A precondition for impact assessments are clear projections of future demand, both based on the current situation but also on different scenarios for the future, linked to different decisions taken at the strategic level. This can take place by development of water demand functions at the appropriate level (both regarding scale – national, provincial, local) – but also sectoral – agriculture, urban industrial)
- A good example of the use of economic assessment methods is given with the proposed Cost Benefit Approach to flood risk assessment (RBMP Technical Report T-072 Flood Risk Economic Assessment).
- As also said above, please see the RBMP Technical Report 076 Water Resource Security on the necessity and content of future demand projections.

3 Water pricing

This chapter firstly provides an overview of the theoretical background to the issue of water pricing. Due to the big importance of the agricultural water demand both in Europe and in China, the focus is put on agricultural water pricing. Based on the requirements of the WFD and the first implementation cycle of river basin management planning some conclusions are given on supporting the implementation of No.1 Document priorities, linked to the current situation in China.

3.1 Background to the issue of water pricing in agriculture

The three underlying concepts regarding water pricing are (Interwies et al 2006, Bogaert et al 2012):

- The **polluter-pays-principle** establishes how payments should be allocated among water users, i.e. it looks at the adequacy of contributions from the different water uses towards the total cost based on their role in causing these costs
- **Incentive pricing** deals with the way water users pay for their use and whether the right price signals are transmitted, i.e. it addresses the question how water is being paid for and how the water price affects the behaviour of water users
- **Cost recovery** establishes the overall amount that users are charged for water services. The principle, however, cover not only the financial costs for the provision of a water service, but it also extends to the costs of associated negative environmental effects (environmental costs) as well as forgone opportunities of alternative water uses (opportunity or resource costs).

This chapter focusses on water pricing as demand management tool (thus, not getting into the issue of pollution and pollution fees), while pricing as financing instrument will be discussed in next section of water infrastructure financing. It is largely based on recent study for the European Commission by Bogaert et al. (2012).

3.1.1 Water allocation and water allocation mechanisms

“Water allocation” generally refers to a set of possible mechanisms to distribute water resources/water rights among a number of possible users. Such a process of water allocation sets out how, by whom, and on what basis decisions are made over who will be entitled to abstract water (FAO 2003; FAO 2004), or “whereby an available water resource is distributed to legitimate claimants and the resulting water rights are granted, transferred, reviewed, and adapted. Hence, water allocation processes generate a series of water rights governing the use of water...” (WWF 2007).

Water allocation mechanisms become necessary in cases where the water demand exceeds the (sustainably available) water supply, or when other circumstances necessitate a planned approach to water use, for example in irrigation schemes with temporary varying water supply. The different mechanisms work on different scales, with different actors involved, and naturally affect user groups differently. Therefore, since circumstances vary widely between countries, regions and locally, the appropriate allocation mechanism varies from area to area, and must respect local conditions. There are a number of key systems of water allocation, though it has to be stated that there is no generally accepted classification of water allocation mechanisms in the literature (see for example World Bank 1997; FAO 2004; WWF 2007).

Each allocation system sets a stronger focus on either the equity or the efficiency aspects of water allocation where:

- Equity refers to the “spreading of income across sectors and societal groups”, e. g. the equal distribution of benefits derived from water use across the various economic and societal sectors (World Bank, 1997)
- Efficiency means an “allocation to where the highest economic gain results from one more unit of water”, e. g. the distribution of water follows purely economics as the decisive (World Bank, 1997).

These principles can be regarded as the two extreme positions wherein each water allocation scheme can be located. In practice, most allocation systems try to strike a balance between those two principles (FAO 2004).

The main water allocation mechanisms are:

- Public allocation
- Traditional or customary user-based allocation
- Water markets
- Water Banks

Public allocation

In the case of public allocation, the right to abstract or use water is issued by an administrative or bureaucratic authority, for varying durations (renewable on a yearly basis or with regard to an economic development plan, or – rarely - permanently) (WWF 2007). Rights may be distributed on the one hand according to a planning process (sometimes called “implicit allocation”; Asian Development Bank 2008) that reflects societal economic or social goals (food production, industrial growth, environmental protection etc.) and may also include various forms of public consultation. On the other hand, water rights may be given by issuing licenses or permits (“explicit allocation”; Asian Development Bank 2008), in accordance to targets set by the public authority. The explicit allocation is generally considered to be more reliable with regard to water use rights and investment security and may eventually be the basis for a water trading system. Generally, public allocation processes are the most widespread form of formal allocation mechanisms (World Bank 1997; FAO 2004; WWF 2007).

Traditional or customary user-based allocation

A range of allocation approaches exist that are based on traditional, non-state law or custom. The number of different systems is far too great to describe in detail, but farmer-managed irrigation systems serve as a good example. Generally, in user-based allocation systems water allocation can be based on various criteria, for example timed rotation, arable land area or flow shares, and also include inter-sectoral allocation issues through managing the shares available for irrigation, domestic or animal husbandry needs (World Bank 1997; WWF 2007).

Water markets

In some countries, water use rights are allocated – or reallocated – on the basis of trading rather than by authoritative decision. In a formal water market, each legitimate user is issued a number of tradable water use certificates or permits. Each user may decide whether to use his/her permits, sell them wholly or in part, or buy additional ones. Market forces then determine the price of one unit of water, theoretically ensuring economic efficiency.

Economically efficient allocation of water is desirable to the extent that it maximizes the welfare that society obtains from available water resources. Welfare in this context refers to the economic well-being of society and is determined by the aggregate well-being of its individual citizens. Economically efficient allocation maximizes the value of water across all sectors of the economy, and is achieved by allocating water to uses of high value to society and away from uses with low value (Rosegrant/Binswanger 1994; FAO 2004). Water markets may be designed to allow or restrict trade between certain sectors and/or areas (e.g. excluding industry from trading, or limiting inter-basin transactions), thus setting limits on the level of economic efficiency that can be achieved, or limiting economic efficiency gains to a specific sector.

Most of the intervention of public authorities is required beforehand to create the conditions necessary for the market to work, including:

- the initial definition and allocation as well as legal guarantee of tradable water rights
- the creation of institutional and legal frameworks for trade and enforcement
- the investments in basic infrastructure to allow and control water transfers (Kraemer/Interwies/Kampa 2002).

In addition to such regulated, official water markets, many informal water markets exist, where, for example, a seller offers water pumped from his own well to neighbouring water users. In an informal market environment, the mechanisms usually attributed to a formal water market do not work in the same way, as there generally is no competition or limited supply (FAO 2004; Asian Development Bank 2008).

Water banks

One challenge in designing water markets lies in the identification of ways to mitigate the potentially negative social impacts, while unlocking the considerable economic and environmental benefits (WWF 2007). Water Banks can be seen as a framework or design option for the trade of water use rights, with a focus on great amounts of water to be transferred or a special purpose.

A water bank is an organization that sets rules on prices and quantities regarding the trade of water use rights, and acts as a kind of intermediary between buyers and sellers, thus providing security and low transaction costs. A water bank may even buy an amount of water rights itself to ensure social and environmental minimum water availability. As in the case of regular water markets, water banks require clearly defined water use rights and a strong regulatory and enforcement framework (World Bank 1997).

3.1.2 Water tariffs and prices

A water tariff is basically a system in which a water (use) right is charged in monetary terms. ”The term water price is used...in its very general sense and defined as the marginal or overall monetary amount paid by users for all the water...they receive...”. (EC 2000a). Prices usually come either in the form of charges or taxes on water withdrawal or water abstraction, where a certain amount of money is charged for the direct abstraction of water from underground or surface water sources, or as a charge for water supply services covering extraction, treatment and distribution of water (Interwies et al. 2005a).

A water price is usually charged in form of:

- an abstraction tax/fee, payable to a public authority, that distributes property rights (Interwies et al. 2005a; OECD 2010)
- a water charge for the provision of water (abstraction, treatment, distribution) charged by the providing entity (public or private).

Varying from country to country, public revenues generated by abstraction taxes or water charges are often earmarked for explicit water management purposes. (EEA 2005; Interwies et al. 2005a)

The pricing of water can serve as a policy instrument to achieve the following policy objectives (EC 2000a; WWF 2007; Molle/Berkoff 2007):

- Cost Recovery: It may be a financial tool aiming to recover direct (water supply and infrastructure) and indirect (environmental, social and opportunity) costs
- Incentive Function: It may also aim to conserve water and promote a more sustainable use of the resource, address water scarcity problems and foster investments into alternative water saving technologies or less water demanding crops.

3.1.3 Water pricing: options in tariff design and price level

The design, structure and tariff are crucial success factors for water pricing to deliver the optimal level of cost recovery, and to ensure a sustainable use of water resources through incentives and investments in water saving technologies (OECD 2009).

The structure of the tariff is the most important element for the incentive function to work effectively.

In agriculture the following tariffs are most commonly used (Molle/Berkoff 2007):

- Uniform user charge: all users are charged the same amount, independent of the amount of water each user consumes.

- Area-based charge is mainly used in irrigation, where an irrigator is charged according to the area irrigated, the crop cultivated, or a combination of these two. Priorities in water supply or reduced charges may be justified by crop priorities (e.g. for food security).

- Volumetric charges are based on the actual consumption by volume. For a volumetric tariff to work properly, metering or a similar method of assessing water consumption is necessary.

- Volumetric block tariffs (differential pricing): volumetric charges may be fixed for different levels of consumption, instead of a flat rate per-unit:
  - Increasing block tariffs: the amount charged grows proportional to the amount of water used.
  - Decreasing block tariffs: the more water is consumed, the bigger the “discount”, often applied for productive uses in agriculture and industry.

- Mixed tariffs may combine an area- or crop-based flat-rate with a volumetric element.

- Quotas: a quota for using or abstracting water is administered, based on area or crop.
  - Quotas at fixed charges: users are charged according to the quota set and may not use more water than their quota allows
  - Quotas and marginal volumetric pricing: users may access more water than their quota allows but such additional use is charged at a proportionally higher rate.

- Seasonal varying tariff (either flat-rate, volumetric or quotas) which varies with changing water availability over the course of the year.

Tariffs combining fixed and variable elements are also referred to as “two-tiered” or “two-part” tariffs (ENTEC 2010).

Design Options: Setting the price right
In addition to the structure of the tariff, the price level is of crucial importance. In economic theory, demand for water would become excessive, if prices are set too low, and water from a costly source would not be used, if prices are set too high (World Bank 1997).

To set a price level that fulfils the cost recovery function, the financial cost of providing water has to be calculated, which is a difficult and debated task, especially regarding the inclusion or exclusion of historical investment costs and possible direct or indirect public subsidies.

For a price to reflect the “true value” of water, however, the matter gets even more complicated, as external costs would have to be included in the charges accordingly. Some European water agencies estimate the environmental or externality costs at 20-25% of the financial costs, but it is questionable if such an across-the-board approach can truly reflect locally or regionally varying factors influencing the cost of water supply (Berbel/Calatrava/Garrido 2007).

Furthermore, equity issues have to be considered in price setting. For example, in periods of water shortage or scarcity, lower income groups or economic sectors strongly dependant on water for production may be negatively affected, if prices increase.

Another challenge when considering an appropriate price level is the expected impact of the pricing scheme on water demand, i.e. the changes incurred in water use due to changing price levels (CIS 2003). This relationship is usually referred to as the "price elasticity of demand". So far, only a handful of large-scale studies have clearly demonstrated a link between agricultural water prices and a proportional reduction in water use (EEA 2009).

Generally, the price elasticity of demand is expected to be low. For example, higher prices have little effect on actual water use when 1) the price paid for water represents only a small percentage of a user´s production costs or income, or 2) the water user has no alternative or possibilities to reduce his/her water consumption (due to technical, social or economic constraints) (CIS 2003).

Setting an appropriate price level "high" enough to internalize the external costs, "fair" enough to not exclude user groups from water use, and "well-designed" enough to affect water consumption is, therefore, a highly complex task and can be considered to be more political than economic in nature (Interwies et al. 2005a).

3.1.4 Water pricing in agriculture: specific challenges

Cost recovery issues

Regarding the calculation of cost recovery rates, it should be distinguished between:

- general methodological issues of determining financial costs, and
- issues regarding the inclusion of external costs.

When calculating price levels to recover financial costs, the question arises wether recovery should be limited to recurrent costs (such as O&M) or if it encompasses some or all of the capital costs invested historically (Molle/Berkoff 2007). This is especially important in irrigation schemes, which usually require heavy – often public – investments (World Bank 1997).

Whether the "historical" investment costs should be included, to what extent and through which methodology is a hotly debated topic (ENTEC 2010). It is argued that the inclusion of full past financial costs of major infrastructural investments would be socially unacceptable, as an "extreme interpretation of...cost recovery would render many large schemes financially unsustainable".(Bosworth et al. 2002)

Instead, coverage of recurrent costs is often demanded, excluding the costs of past investments (Bosworth et al. 2002). Empirical evidence confirms that this is the case in most irrigation schemes, where pricing covers only O&M costs. (Molle/Berkoff 2007; OECD 2009) Including external costs into cost recovery rates is extraordinarily complex. Due to the magnitude of the effects agricultural production can have on the water environment, the full inclusion of external costs would increase the financial impacts on agriculture to a much higher degree than the sole inclusion of historical financial costs. Not including full external costs into water prices, however, generates a situation where agricultural water use is cross-subsidized by other sectors of society (e. g. the tax payer), because farmers do not pay the full price associated with their water use (Jordan 1999).

This fact, however, has to be seen in the context of the traditional role agriculture plays in societies. The extent to which irrigation is being and should be cross-subsidized by excluding historical (public) investment or external costs into financial cost recovery calculations is part of the political process of setting the “right” price level for water use.

Groundwater use and non-authorized water abstraction
In cases where irrigation water is extracted from groundwater sources, most or all capital is usually provided by the farmers themselves. This includes investing in pumps, in the maintenance and in electricity necessary to operate the equipment (OECD 2010). As private pumps and bore wells are much more difficult to control and monitor by public authorities than water distributed in irrigation schemes, most countries do not use tariff systems to control groundwater use, with some exceptions (Berbel/Calatrava/Garrido 2007; OECD 2009). Instead, other instruments are relied upon to control groundwater use, such as quotas, caps or zoning. This means that irrigation water pricing is nowadays primarily focuses on surface water and where infrastructures have been built to convey water from the source to the fields (OECD 2010).

Besides these general difficulties surrounding the pricing of groundwater use, a significant amount of groundwater abstraction takes place without being registered or monitored by any water authority (EEA 2009). Non-authorized water abstraction can be found in surface water extraction as well, although to a much lesser degree (Dworak et al. 2010b). When water is extracted in a non-authorized manner, high external costs may be generated either through overuse of the available resource (in case of groundwater aquifers) or through the effects such water use has on downstream users (in cases where surface water is abstracted from rivers or irrigation channels). Nevertheless, non-authorised water abstraction for agricultural purposes is commonplace in certain areas of Europe (Llamas/Garrido 2007; Schmidt et al. 2010).

As mentioned above, when resources are under-valued or not priced at all, they are treated as though they are abundant, which, in the case of groundwater, severely impacts groundwater resources and can rapidly lower groundwater tables and deplete aquifers (OECD 2010). Furthermore, non-authorized abstraction negatively affects the effectiveness of water pricing, as it allows water users to obtain water at lower economic costs than offered by the authorised supplier (Dworak et al. 2010b). To tackle the problem of non-authorised water abstraction, the challenge lies in establishing some form of extraction control, e.g. through abstraction fees (as is the case in France, Denmark, the Netherlands, England and Wales), and in setting the price to reflect the true scarcity value of the resource. Since evidence shows that increased groundwater charges alone do not necessarily lead to reduced abstraction, the establishment of efficient monitoring systems as a supporting measure is crucial. (OECD 2009)

Price elasticity of demand
There is a relation between price and demand following a demand curve (see diagram 3). The dimensionless slope of this demand curve is called the price elasticity of demand. It is defined as the percentage of increase in demand resulting from a percentage of increase in price. This elasticity is a negative number since demand is expected to decrease as price increases. However, the lower the price elasticity, the lesser the change in behaviour will result from a marginal price increase.

An important measure of whether or not pricing policies are likely to have an impact on agricultural water use is therefore this price elasticity of demand (OECD 2009). Although in general a price level that accounts for local environmental, economic and social conditions will provide incentives for a more sustainable use of agricultural water or for investments in water saving technologies, there are situations where a higher price for water may not lead to significant reductions in water use, e.g. where the price elasticity of demand is low. There are studies that suggest that the price inelasticity of demand diminishes upon reaching a certain threshold of water prices, dependent on factors such as water productivity, the price of water compared to other production inputs, alternative production strategies, etc. (Bosworth et al. 2002; Berbel/Calatrava/Garrido 2007). Moreover, depending on the framework for changing irrigation techniques (costs involved, subsidies on investments, generation of revenue by saving water etc.), demand responses to rising prices may take place in the long run instead of by short-term reactions (Bosworth et al. 2002).

Subsidies – "perverse incentives"

Even the best-designed pricing system will not prove to be efficient if a subsidy system is in place that promotes unsustainable water use in agriculture. Such "perverse incentives" can be created through subsidizing crops with high water demand in water-scarce areas, subsidies for electricity used for groundwater abstraction with no sustainable abstraction limits in place (or not enforced), etc.

Possible impacts of water pricing on the agricultural sector

Although the price elasticity in agriculture can be quite low, water pricing reflecting the true scarcity value of water can give incentives to reduce water consumption via a number of possible responses, including improved irrigation efficiency through water saving technologies, reduced irrigated land area, and modified agricultural practices such as cropping patterns and timing of irrigation, as demonstrated by several studies (Hernández/Llamas 2001; Rodríguez-Díaz 2004). Water pricing can also be an effective tool to control groundwater use, especially in cases where groundwater extraction can be measured and priced on a volumetric basis (Molle/Berkoff 2007).

Most analyses of the effect of increased water prices foresee that the agricultural sector would be severely affected economically, if the price levels should reflect the true cost of water, including historical capital costs as well as externality costs (Hellergers/Perry 2006). This is especially true for small-scale and family farms (Berbel/Calatrava/Garrido 2007). In existing pricing schemes, farmers often pay very low water prices in comparison with other economic sectors, namely domestic and industrial water supply (EEA 2009). This fact has again to be evaluated against the background of the role agriculture plays in societies and considering the different quality of water most farmers receive (OECD 2010).

Nevertheless, raising prices from low to higher levels will certainly affect agricultural income, as several studies predict. These studies indicate that price level increases between 0.03 € and 0.10 €/m³ - still mostly below full cost recovery rates - result in reductions in farm income ranging from 10% to 50% or increasing food prices (Berbel/Gómez-Limón 1999; Berbel/Calatrava/Garrido 2007). Of course, farmers have the possibility to adapt to higher prices, and the impacts of price increases will vary greatly according to possibilities to save water and change cropping patterns to higher value crops.

The impacts of changes in water pricing are furthermore dependent on the structure of the tariff system, as laid out above (Bosworth et al 2002; Molle/Berkoff 2007). Area-based charges represent a commonly used pricing structure in agriculture. As prices do not rise proportionally to the amount of water used, these tariffs are generally considered to be unsuitable for giving incentives and promoting a more sustainable use of water resources. On the other hand, area-based charges could serve as a starting point to calculate block tariffs and to reduce opposition from farmers (as a certain amount of water is still priced as before) and impacts (as the currently paid price is also not changed). To fulfil cost recovery and incentive functions, however, any area-based charge would need to increase in price or be combined with a decreasing quota to have any future effect on water consumption.

Well designed volumetric tariffs have the greatest potential to fulfil cost recovery and incentive functions, but also possibly have the greatest negative impacts on farm income or food prices. First of all, metering devices are necessary, which are complex to install and monitor. Second, a volumetric tariff reflecting the true value of water on a unit base would increase water prices for farmers without any possible resort to a relatively “cheap” basic tariff, as can be provided by other pricing structures. Therefore, in cases where water use is already highly efficient, rising water prices on a volumetric basis would have severe negative economic impacts.

The impacts of decreasing quotas or higher prices in systems using quotas and marginal volumetric prices can similarly be severe on agricultural water users, as in addition to a lower use rate the additional charge is increased as well. On the other hand, a quota system may have similar positive effects as increasing block tariffs. The latter can be used as a tool to secure basic water supply to poorer parts of a community or small-scale farms by charging a relatively low price (less than the full recovery costs) for low water consumption and a relatively high price (above full cost recovery) for amounts exceeding a specific threshold, which discourages extensive water usage. Decreasing block tariffs, on the other hand, represent an adverse incentive, as the price for a unit of water shrinks in relation to the amount used; such tariffs are applicable only in regions where water is abundant. Introducing seasonally varying tariffs could strongly affect availability of certain water-intensive crops in times of reduced water availability or affect the prices of those products accordingly.

It is a difficult task to predict the impacts that increasing water price levels may have on agricultural water use, farm income or food prices on a “cross-the-board”” scale. Instead, the impacts have to be assessed and analyzed on an case-by-case basis, taking into account local and regional circumstances regarding water use, water availability, farm sizes and crops grown, possible alternative crops and marketing channels, alternative technologies to save water or change irrigation techniques. In terms of fairness of water pricing schemes, the importance of water as a production factor and its varying importance in the cost structure of agricultural production, as well as the agricultural market situation and competitiveness of farmers have to be thoroughly considered. Water pricing regulatory mechanism that can possibly impact water users significantly. However, water is not a regular economic good. Since there are no substitutes or alternatives to water use, and since water is a necessary basis for many economic activities with large social importance, including agriculture, care must be taken in policy decisions that affect the costs of water use (Interwies et al. 2006).

3.2 EU experience

3.2.1 Brief introduction to EU-WFD requirements regarding water pricing

In a nutshell, the specific requirements of the WFD (Art. 9) are:

- to take account of the principle of recovery of the costs of water services, including environmental and resource costs and in accordance in particular with the polluter pays principle
- to ensure an adequate contribution of the different water uses, disaggregated into a least industry, households and agriculture, to the recovery of the costs of water services, also here taking account of the polluter-pays-principle
- to ensure that the water pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive.

Member States may in so doing have regard to the social, environmental and economic effects of the recovery as well as the geographic and climatic conditions of the region or regions affected.

3.2.2 Water pricing and European subsidies – the Common Agricultural Policy

In order to develop proper water pricing schemes along WFD provisions, there is a clear need to link the water pricing system to the current system of agricultural subsidies that affects the way in which farmers use water and how these subsidies relate to the incentives transmitted through the water pricing system (Bogaert 2012).

Under the two pillars of the Common Agricultural Policy farmers receive different payments or subsidies:

- Pillar 1: Direct payments
- Pillar 2: Rural development payments.

These payment may influence cost recovery and/or the incentive function of a water price. Payments issued through the EU Rural Development Fund, for example, allow member states to support new or modernize existing irrigation infrastructure. These payments can be used to decrease the period to recover costs potentially leading to lower water prices after a certain period or lower prices over the lifetime of the system.

The incentive function of water pricing schemes may be influenced by subsidizing specific production methods or crops which are more or less water intensive. These subsidies change the input/output cost ratio of a product, allowing a farmer to produce a certain type of crop even if a high water price would have stopped him/her. However, these direct payments under Pillar 1 have been reduced tremendously over the last years and only payments related to production of rice and tomatoes remain.

The current negotiations regarding the next phase of the CAP include discussions on how to better link the CAP-reform to the objectives of the WFD.

3.2.3 Experiences with implementing the WFD so far (1st river basin planning management cycle)

Overall, the results of the 1st River Basin Management Plans show that the issue of water pricing in general and the agricultural sector in particular remains a challenging issue. The following summary of the current situation is taken from a recent study for the European Commission by Bogaert et al. (2012).

The main incentive for a proper water price policy in Europe comes from the WFD and its implementation. However, the overview of water pricing policies in the EU showed that the implementation of Article 9 has had mixed results.

Generally, there appears to be a lack of incentive elements in the pricing of direct abstractions. Some Member States allow exemptions for agricultural water use or irrigation specifically, also in water stressed areas e.g. in Southern Europe. The level of the water price (excluding private on-farm costs) appears to be modest (well below 0.01 €/m³ in many cases), though some Member States have introduced higher tariffs, especially for specific water resources where availability is low. A limited number of implemented tariff systems include no incentives for water savings as quantities of water use have no relation with the amounts to be paid.

Overall, there is still an incomplete cost recovery in a significant share of EU Member States. The large investment in irrigation infrastructure (also modernisation) is often subsidised which comes down to insufficient capital cost-recovery. For at least 30% of the Member States, the O&M costs for the provision of water are only partly recovered.

Some Member States argue that a share of environmental and resource costs are recovered, e.g. Belgium, Denmark, France, Germany, Netherlands and UK. This partial internalisation of resource costs is generally realised through water abstraction fees; however these are generally low. It is of note that no clear evidence could be identified on the allocation of environmental and resource costs related to agriculture as a water user and associated cost recovery levels.

Generally there is a lack of methodologies how to fully address environmental and resource costs and how to equitably distribute this costs to different water-using sectors. Further work is needed in order to fulfil the requirements for full cost recovery under WFD. Some MS are in the process of improving the evaluation and internalisation of environmental and resource costs, e.g. Cyprus and Spain.

On the other hand, the polluter-pays-principle has been partially integrated into water policy through sewage taxes. However, diffuse pollution remains a problem and there are no easy solutions to deal with the associated costs. Finally, the case studies clearly indicate that water pricing is not incentivising sustainable water use. Rather, other factors play a role in reducing water use, for example drought conditions, water saving technologies but only to some extent, and awareness programmes. High prices, whether they come from the water price or electricity, do not necessary result in water savings but rather a shift in crop production to higher value crops or loss in profit. This is, however, highly dependent on the situation of the river basin.

Water Allocation and Pricing in Europe

An extensive (non-exhaustive) overview for all European Union Member States regarding their water allocation policies can be found in the Annex I of Bogaert et al. (2012). Annex II of that report provides an overview of the water pricing policies of all Member States (including information on: design of tariffs (for different kinds of water provided/for different sectors and for self-supply), the importance of self-supply (including information on irrigation infrastructure or collective facilities / services), cost recovery rates (financial costs + Environmental and Resource costs) as well as the current situation regarding metering.

3.2.4 Experience of water pricing for domestic water supply - Denmark as case example

The discussion on water pricing has focused on irrigation and agriculture. Within the water supply and sanitation sector, water pricing is much more widely used and there are many examples that illustrate the possible impacts. Here, the use of water pricing as demand management tool is illustrated by the development of the water tariff and the water demand for domestic water users in Denmark.

Figure 4 shows the development in the water tariff and the water demand for domestic water users in the period from 1993 to 2010. The demand has decreased by around 30%, while the water price has increased by a factor of 3, though in 2010 prices only by a factor of 1.8. While other factors play a role in this development, the price has been an important driver.

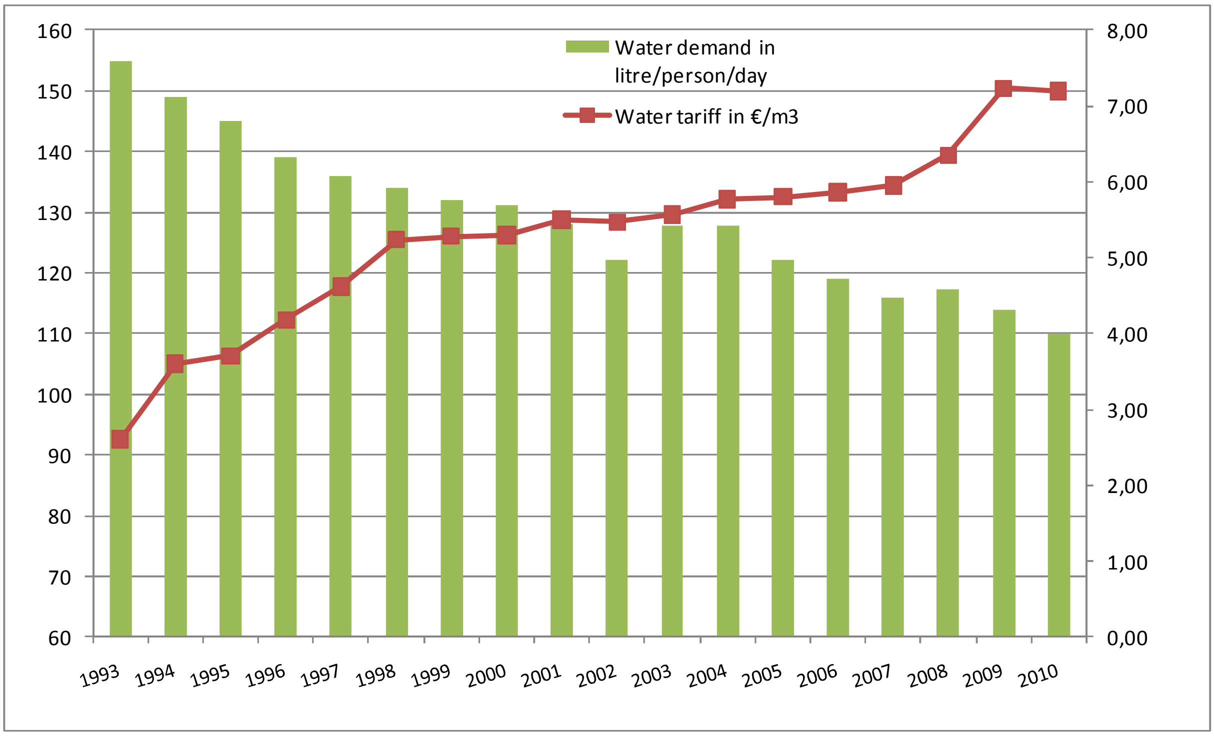


Figure 4 Development of domestic water tariff and domestic water use in Denmark (Source: Danva and own calculations)

It should be noted that not all households are metered individually. Many apartment blocks have only one main meter and distribute the costs based either on the size or the number of taps in each apartment. The increase in the water price has led the associations managing the apartment blocks to make their own local water saving campaigns to reduce the demand. Also public water saving campaigns have played a role in reducing the consumption.

This example illustrates the potential effects of water pricing for domestic water consumption. It can be noted that the water bill in the range of about 1%-2% of the households disposable income. It should also be noted that a large part of the increase in the water price is due to increase in the costs of wastewater treatment. During 1990-2000 the wastewater treatment plants were upgraded from primary and secondary treatment to include also nutrients removal. Today about two-thirds of the total water tariff is the contribution for wastewater treatment.

3.3 Chinese context

The current water pricing regime with a focus on agriculture, it is stipulated in the Water Law that it is necessary to pay a water fee to the water supplier in accordance with provisions to use water supplied from water supply works.

The water supply price shall be determined on the principles of cost compensation, reasonable income, high quality, favourable price and fair sharing. According to provisions in Management Measures for Water Supply Price of Water Conservancy Projects (Order 4 of National Development and Reform Commission and the Ministry of Water Resources) jointly issued by National Development and Reform Commission and the Ministry of Water Resources, the price of water supplied from water resources works shall consist of water supply production cost, expenses, profits and taxes. A two-part water pricing mode combining capacity and quantity pricing shall be implemented gradually for water supply from water resources works. The capacity pricing shall be calculated on the principles of compensation for direct wages, management expenses and 50% depreciation costs and maintenance expenses for water supply, and the quantity pricing is calculated on the principles of compensation for other costs beyond the capacity pricing, like water resources fees.

At present water supplied from water resources works is priced by type of use. The price of water supplied from water resources works is divided into the agricultural water price and the non-agricultural water price. The agricultural water refers to water directly supplied from water resources works for grain crops, cash crops and aquiculture, and the agricultural water price shall be calculated on the principles of compensation for water supply production costs and expenses, excluding profits and taxes. The non-agricultural water refers to water directly supplied from water resources works for industry, water plants, hydropower and other purposes, the price of which shall be determined on the basis of compensation for water supply production costs and expenses and taxes according to law, as well as profits withdrawn as per net assets of water supply at a rate of the long-term loan interest rate of domestic commercial banks plus 2%-3%.

The charge for irrigation water is generally paid in accordance with the irrigation area reported by farmers at the beginning of each year and the water rate per mu (1/15 ha) estimated on the basis of experience. In some cases the water charge is paid at the end of each year after using water, but in those cases it is often difficult to collect the charge. In some river basins, farmers must buy a water ticket for a specific quantity of irrigation water, such as Shiyang River Basin, Gansu Province.

The present situation of collection of the irrigation water fee in China is:

- the rate is below delivery costs
- collection is low
- some areas are exempt from

The agricultural irrigation water rate is far lower than the water costs. In 2005 the agricultural water charge is only 38% of the actual water supply cost. The average collection rate is only 50%-60%. In particular, the collection rate has declined dramatically following taxation reform in rural areas. Besides, the agricultural water charge is deducted or exempted by local governments in some economically developed regions. Wenling and Yongkang of Zhejiang Province, for instance, have stopped collecting the agricultural water charge since 2004 and all exempt agricultural water rates are paid by local government. Likewise, some locations in Guangdong Province, such as Dongguan and Foshan, have stopped collecting the agricultural water charge. Such practices have had a huge social influence, but making it more difficult for water administrations in other places to collect the irrigation charges.

3.4 Linking the use of water pricing to the implementation of the No.1 Document

Based on the above and considering how water pricing and especially agricultural water pricing can support the implementation of No.1 Document based on the three “water securities”, the following can be noted:

- Agricultural water pricing is a key element of demand management, thus it needs to be considered thoroughly; a clear understanding of the financing, but also incentive function of the current water pricing regime is a starting point; related to this, the price elasticities of water demand in agriculture need to be understood at the appropriate level (e.g. regional level)
- There are various ways how water pricing can be introduced or reinforced via tariff structures, etc., which have very different impacts on water savings, but also its economic and social effects
- Therefore, an impact assessment of various pricing options needs to be performed. New pricing scheme or higher price levels need to reflect local and regional circumstances regarding water use and water rights, water availability, farm sizes and crops, possible alternative crops and marketing channels, alternative technologies to save water or change irrigation techniques and existing subsidies (see also OECD 2010).
- The development of strategic options regarding water pricing has to consider not only the current situation regarding the structure of agriculture, e.g. current crop composition and farming systems, but also different underlying strategic options regarding, e.g. shifts to less water-intensive crops depending on regional water availability, added value of different crop types, subsistence/local consumption of agricultural products versus global market potential, etc.

- A clear pre-condition of water pricing is metering (even through proxies) since it is necessary to move from charging for water based on irrigated area to actual consumption (volumetric pricing) in order to set incentives for water saving

- Water pricing cannot be the only measure related to water demand management in the agricultural sectors, but needs to be an integrated part of a strategic water demand management approach

- Closely linked to the issue of water pricing are subsidies to the sector. Any changes in the water pricing regime needs to be accompanied by a parallel evolution of the conditions which are associated to agricultural subsidies. In this way, the social and economic affects can be "softened" in the short term, while the transition to lower water consumption ratios is supported through enabling investments in water-saving irrigation technologies and shifts of crop composition

- Considering the key importance of water pricing in agriculture, the social and economic effects of pricing need to be analysed/considered in great detail.

4 Water infrastructure financing

This section describes the overall principles of water infrastructure financing. Then it presents the EU and other international experience with financing in the water supply and sanitation sector, within irrigation and within flood protection. Finally, it presents briefly the Chinese situation and presents suggestions for issues around financing of the No.1 Document investment.

4.1 Introduction

It is important to consider the financing aspects of water infrastructure. Water infrastructure has in most cases characteristics that call for public involvement in financing and or regulation of services and pricing. Water infrastructure is a natural monopoly, meaning there is rarely competition, there are significant economies of scale and there are various externalities related to the construction and operation of water infrastructure.

Traditionally, this has meant significant public sector involvement. Economic theory does not have definitive solutions for how infrastructure for bulk water supply, irrigation and similar systems should be financed.

The financing structure should cover the whole lifecycle of the infrastructure: construction, operation and maintenance:

- Construction: Often water infrastructure is very capital demanding so the up-front investment costs are huge, but the lifetime of the infrastructure is also very long. It means that a very high proportion of the costs falls in the beginning, while benefits are spread over the long lifetime of the infrastructure.

- Operation: Water irrigation and transfer infrastructure might have low operational costs if it benefits from gravity flow but high costs if it requires pumping, while treatment of clean water or treatment of wastewater are more expensive to operate.

- Maintenance: Initially maintenance costs will be low but later they will start to increase and if neglected the infrastructure will start to deteriorate.

The financing comes from different sources (Figure 5). This overview is based on OECD (2010) and it shows that the basic financing is coming from the three Ts: tariffs, taxes and transfers, while repayable finance in the form of various loans can be used to bridge the financing gap between the costs and the revenues, especially in the construction phase.

The main financing sources are:

- Tariffs (water pricing)
- Taxes: Government subsidies (based on general tax revenue)
- Transfers (international assistance)
- Repayable finance:
  - Concessional loans
  - Market based finance
  - Commercial loans
  - Bonds (state or company bonds)
  - Equity (share holding or private capital)

Figure 5 illustrates the typical situation where the revenue income is not sufficient to cover for new investments. When there is a need to undertake investments either in new water infrastructure or in major rehabilitation of existing infrastructure it results in financing gap. This financing gap is then closed by applying various forms of repayable financing. Over time it is necessary to increase the revenue income and/or to reduce new investments in order to create a balance. Otherwise the debts will continue to increase.

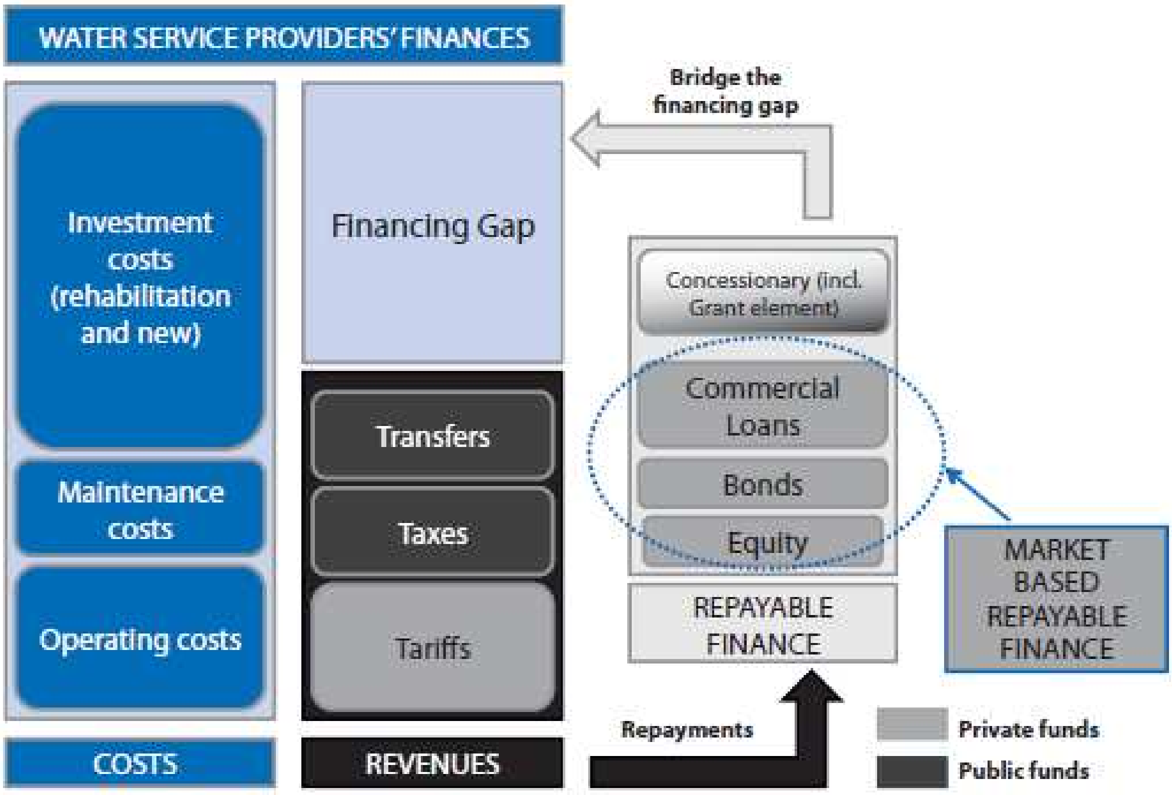


Figure 5 Overview of financing sources and bridging the financing gap. Source: OECD (2011)

The different financial sources can be characterised in the following way:

- User tariff/charges: This is in important source of finance. As described in the previous section on water pricing, the use of water tariff has multiple purposes. Providing finance is one of them, given an incentive to optimise the use of the water resource is another very important objective. The constraint of the use of user tariffs is affordability. While the user often might be able to cover the operating costs, the high up-front investment costs might be beyond what they can afford.

- Taxes: Taxes mean all type of government subsidies that are based on the general tax revenue. The economic arguments for why the public should subsidise water sector infrastructure include first of all the external effects that go beyond the benefit to the individual user. For water supply and sanitation services there is a public health aspect which could justify public subsidies. Similarly for irrigation services, here food security would be a reason for public subsidies. Public subsidies can take many forms depending on each country's institutional structure.

  The most important elements to consider include:
  - What should be the criteria and conditions for receiving public subsidies?
  - How to make sure that the users have incentives to maintain the infrastructure?

  The benefits of the investment can be increased by defining allocation criteria in a way the rewards for example water efficiency or polluting reduction. Having some form of user payments will generally increase the user's incentive to maintain the infrastructure. This can also be promoted by requiring that a part of the investment is financed through commercial loans. Commercial banks will be focused on monitoring the infrastructure company's performance as they want to make sure that the conditions on loan repayment and interest are fulfilled.

- Transfer: The third T in the OECD definition of financing sources refers to international transfers. In China's case this sources is of decreasing importance.

- Repayable finance: Repayable finance is a source that only bridges a possible financing gap. The finance should be paid back and in most cases there are interest payments to be covered as well. Both repayment and interest payment will ultimately have to come from three Ts

  - Concessional loans are often provided by international development banks such as the World Bank or the Asian Development Bank. They could also be provided by national institutions for example if a revolving fund is set up (see example below from Poland where the National Environment Fund provided concessional loans).

  - Market based repayable finance includes 1) commercial bank loans that typically are short to medium term finance with interest payments that depend on how risky the bank considers the loan to be, 2) bonds, which can be state, municipal or corporate bonds that also carry an interest payment that will depend on how the investors assess the risk associated with the bonds, and 3) equity which means that private investors bring in finance either as shares or as private funds. This type of finance does not have a specific payback period, but it carries and expectation of dividends or increased value of the shares and again the costs of this type of finance depends on the investors assessment of risks.

It is not possible to give a general recommendation on the best or optimal combination of financial sources for water infrastructure. The best combination of the financial sources depends in the institutional set-up and the specific type of water infrastructure.

From an economic perspective the key criteria for determining the financing structure are:

- Efficiency in allocation of resources
- Distribution of income that takes appropriate account of for example the social situation.

Preparing a financing strategy - as described later in this section - could be a tool to analyse the advantages and disadvantages of the different financing sources and to determine the best combination.

Here a number of general considerations are presented. They describe issues that the planning authority should consider when assessing how to finance water infrastructure. The main relevant types of finance are covered by:

- User charges
- Public subsidies
- Involvement of private financing and public-private partnership (PPP) arrangements

User charges should in most cases be the basis of the financing as it should provide financing for the operation and maintenance of the infrastructure. This is closely linked with issue of providing an appropriate incentive for efficient use of the water. This is partially the case for water supply and for irrigation. See the section on water pricing for more consideration on how to define and apply appropriate water tariffs.

If repayable financing is considered, then the owner or operator of the water infrastructure will have to be able to cover interests and repayment and this could be achieved, if user charges generate sufficient income to service the financial debts in addition to cover the operation and maintenance costs.

From the perspective of financing, the main constraint on setting user charges is affordability. It is therefore necessary to consider what is affordable for the users. This issue is linked to the discussion on the reasons for having public subsidies as an important financing source.

Public subsidies can be justified both on economic efficiency and income distribution reasons. Water supply and sanitation services are considered to be merit goods which have additional public health benefits above the each individual's benefit. Water infrastructure is also often natural monopolies due the economies of scale. Some types of water infrastructure, for example flood protection, are public goods.

All these factors lead to a need for public subsidies or for public regulation or water charges. From a distributional perspective, it can be relevant to subsidise poorer regions and low income groups - for example small scale farmers. The question is then how to design the public subsides to achieve the maximum benefits from the water infrastructure investments.

The key consideration is about assessing the incentives and includes:

- What are the incentives to design the infrastructure with appropriate capacity?
- What are the incentives to minimise the environmental impacts?
- What are the user's incentives to use water efficiently?
- What are the incentives to maintain the infrastructure?

These considerations are closely linked with the other two areas covered in this paper. The use of economic assessment tools - for example a Cost-benefit-Analysis as part of application for public subsidies is one tool that can help to make sure that appropriate issues are considered before construction is started. Water pricing would be an important element in providing incentives for the more efficient use and potentially for providing incentives to maintain the infrastructure. If private operators or private financing should be involved, the key issue is about risks and interest payment. Private financing including commercial loans will involve transaction cost and interest payments.

Private investors will want to investigate the level of risks and they will want to be compensated for these risks. In water infrastructure the risks mainly concerns whether there is sufficient revenues to cover the payment of interests and the payback of loans and bonds. In case of water supply systems, the risk is typically relatively low as water is basic good. The condition is that there are user charges and that they are sufficient to cover the operation, maintenance and costs of repayable financing.

For irrigation infrastructure it is not so easy to establish an institutional set-up that guarantees a stable income based on user tariffs. Low affordability of the farmers, fluctuations in their income resulting from extreme climate events or global market prices could mean that user charges do not provide a secure financing source. Hence, it will be more difficult to obtain repayable financing.

For flood protection infrastructure where the "users" typically are a very broad group it is difficult to establish an income stream to repay loans, bonds or other forms of repayable financing. Hence, public finance and subsidies are likely to continue to be the main financing source.

Involvement of private financing can be motivated by different issues and the involvement can take place in alternative ways. Figure 6 presents questions that are relevant in considering whether private involvement is an appropriate solution to an infrastructure performance issue. It gives examples of where Public-Private-Partnerships (PPP) could be relevant. It also indicates how the public sector alternatively can make changes that will improve the performance.

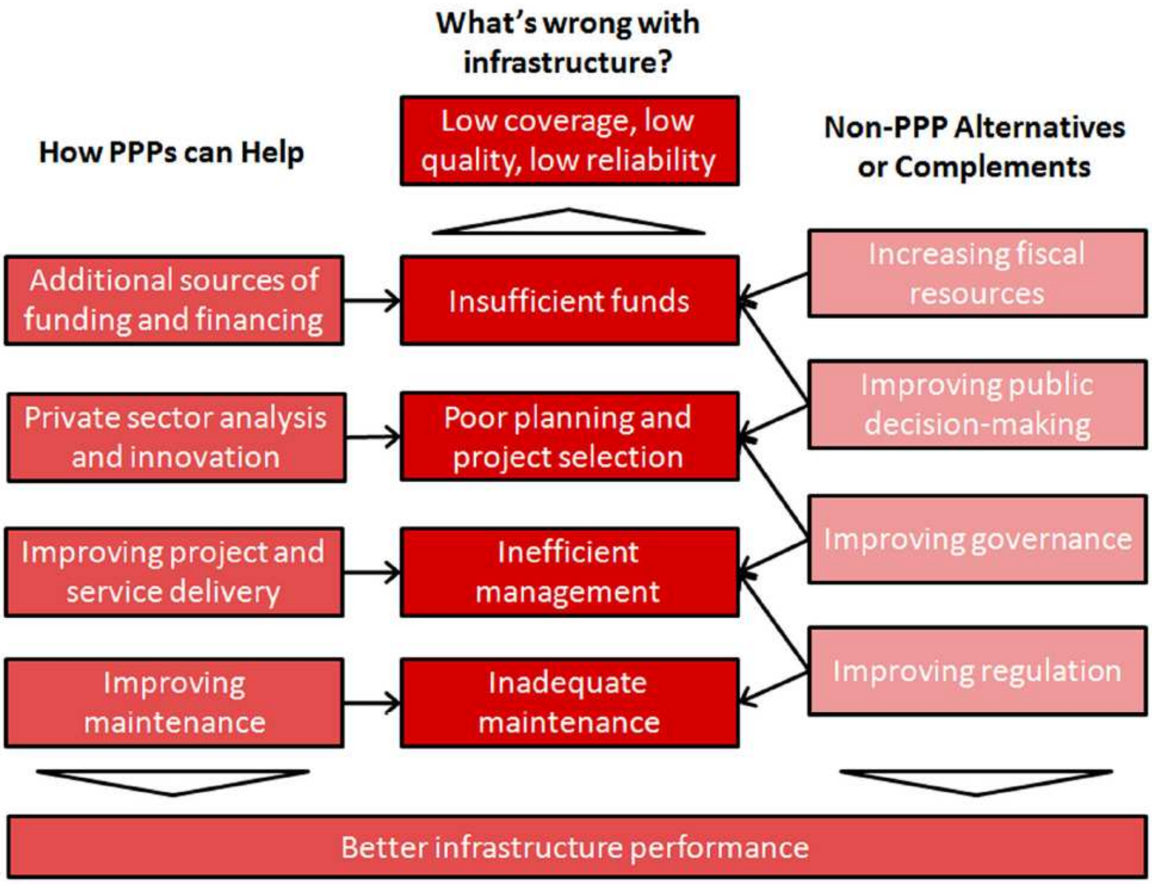


Figure 6 Overview of situations where public-private partnerships (PPP) can improve water infrastructure performance. Source: World Bank (2012)

Table 1 presents different forms of Public Private Partnerships and describes the key characteristics of each form. The main differences are ownerships and risks.

Service contracts are when a private operator is just responsible for daily operation of the infrastructure. They receive a fee to cover their costs and they do not collect user charges. Concession contracts are typically longer agreements where the operator also have responsibility for maintenance of the assets and therefore will have to investment in the infrastructure. Here they would in some cases also manage the collection of user charges. The third type of PPP is privatisation when the private entity also owns the assets.

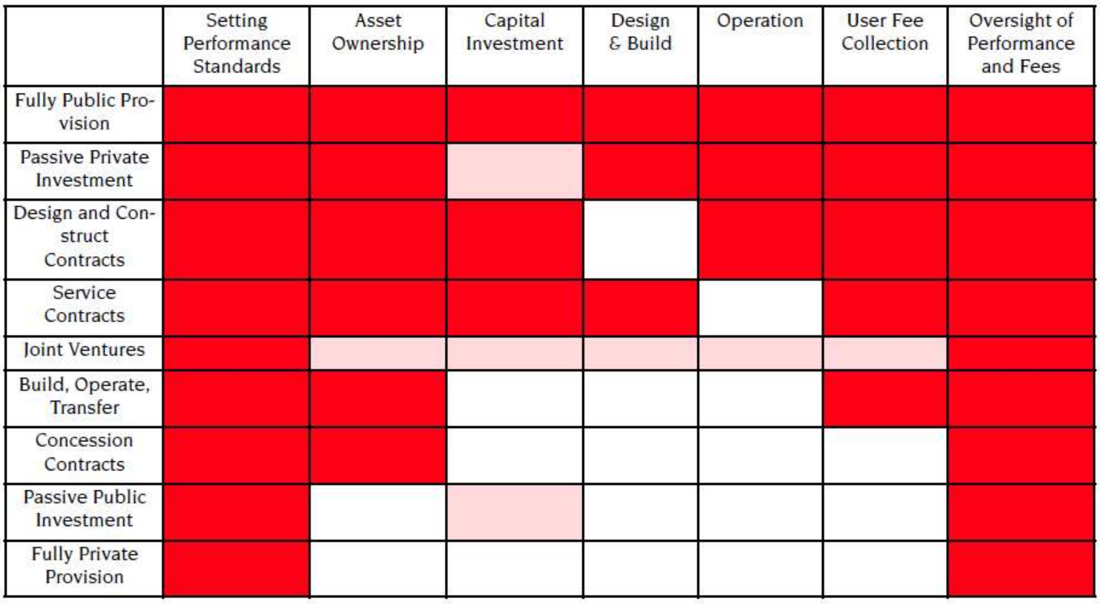
What is important to consider is that regulation needs to be in place for PPPs to be able to provide water infrastructure improvements. It is necessary that the asset value of the infrastructure is known before the PPP can be initiated and that the asset value of the infrastructure can be monitored on an ongoing basis. It will also be necessary to establish rules for how the user charges and tariffs are determined. The water infrastructure company will often be a "natural monopoly" and without regulation, economic theory predicts that such a monopoly will set user charges and tariffs that are too high.

Table 1 Forms of public-private partnerships (PPP) and their characteristics.

	Involvement of the private sector in traditionally procured projects	**PPP with increased risk transfer to the private sector**	**Full private, merchant based provision of services**
PPP modalities	• Service contracts • Operating and management contracts • Simple leasing	• Design, Build and Operate (DBO/BOT) • Design, Build, Operate and Finance (DBFO / DBFOT) • Concession contracts • Complex lease	• Privatisation • Divestiture of public assets • Design, Build, Own, Operate (DBOO)
Key characteristics	Service provision against a fee and often with remuneration linked to performance, no investments.	Private party designs, builds, and operates the assets with external, its own, or combination of external and its own funding. Operation is typically fee-based, however, in some cases, private operator might be allowed directly to define and charge service payments (tariffs) to customers.	Service provision on fully merchant basis and charging own defined market price for services to customers. In some cases (for example DBOO, or BOO) ability to set any service charge could be limited during predefined period
Payment Mechanism	Payment Mechanism is annual Fee payment by Public Authority covering cost of provided services. Fees are not linked to tariff to customers.	Payment Mechanism is, typically, an annual Fee payment by Public Authority covering O&M costs and provide reasonable profit margin. Fees are usually not linked to tariff to customers. However, in number of variations of this types of contracts (for example Concession type of contracts) PPP operator receives right to directly charge and collect tariff payment from customers.	Payment Mechanism is market based price of service.

The distribution of responsibilities is illustrated in Table 2. This table shows different forms of private sector involvement and it shows the various roles that exist regarding responsibility for managing and regulating the sector. If private finance is involved, it is necessary that the public authority appoints or sets up a “Regulator” that can define performance standards and monitor the performance.

Table 2 Forms of public-private partnerships and the division of responsibilities



Key: Dark Red: public responsibility - Light red: shared public/private responsibility - White:private responsibility

Source: Yale-UNDP Partnerships Program 1998

Source: OECD, (2000), Global Trends in Urban Water Supply and Waste Water Financing and Management: Changing Roles for the Public and Private Sector, Paris

4.2 EU and international experience

Financing of water infrastructure varies across EU countries as it does internationally. Traditionally, government subsidies have been an important form of financing in many countries.

The introduction of the WFD has increased the focus on user tariffs and cost-recovery. However, the WFD simply requires "adequate contributions" from users, so it does not prescribe a specific financing structure. Adequate contributions imply that some cost-recovery should be present meaning that 100% subsidy is not allowed. Furthermore, the requirement for user charges for "water services" and the discussion about the exact definition of water services is still ongoing. It includes water supply and wastewater collection and treatment. Irrigation is likely to be included as well but other types of water infrastructure might not be included.

The way that cost-recovery is calculated varies across Member States. Given that there are approximately 180 river basins in 27 individual countries, it is difficult to provide a simple overview.

Table 3 summarises our assessment of the overall situation in a simplified way. In the subsequent sections the financing of each type of water infrastructure is discussed in more detail.

Table 3 Financing of water infrastructure

Sector	**Typical level of investment**	**Source of finance**
Water supply and wastewater infrastructure	Medium high	User fees + EU subsidies + loans
Irrigation systems	Varies from low to high	Public subsidies + EU subsidies + user charges + user investment + loans
Flood defence systems	Medium to high	Public subsidies + EU subsidies + loans

4.2.1 Financing of water supply and wastewater infrastructure

This section describes the financing of water supply and wastewater infrastructure. The issue of financing is closely linked to the issue of institutional set-up and ownership.

Table 4 provides an indication of the distribution between public and private management in the water supply sector. It shows the percentage distribution by ownership type. The majority of companies in the EU are public though some Member States have private involvement as well.

Table 4 Management in the water supply sector in different countries by % of management types Source: Moreau-Le Golvan and Bréant (2006)

	Public	Public limited company	Delegated private	Direct private
US	86		14	
EU	48	15.5	20.5	16
Germany	55	30	15	
France	23	2	75	
UK	12			88
Netherlands	15	85		

Delegated private means primarily concession contracts, where operation and in some cases maintenance of the infrastructure is managed by a private company, while direct private means that also ownership infrastructure assets has been transferred to the private company.

This can further be elaborated based on the way management of the utilities are organised (Figure 7). The figure shows the situation in the EU countries regarding water supply (WS) and wastewater collection and treatment (WW).

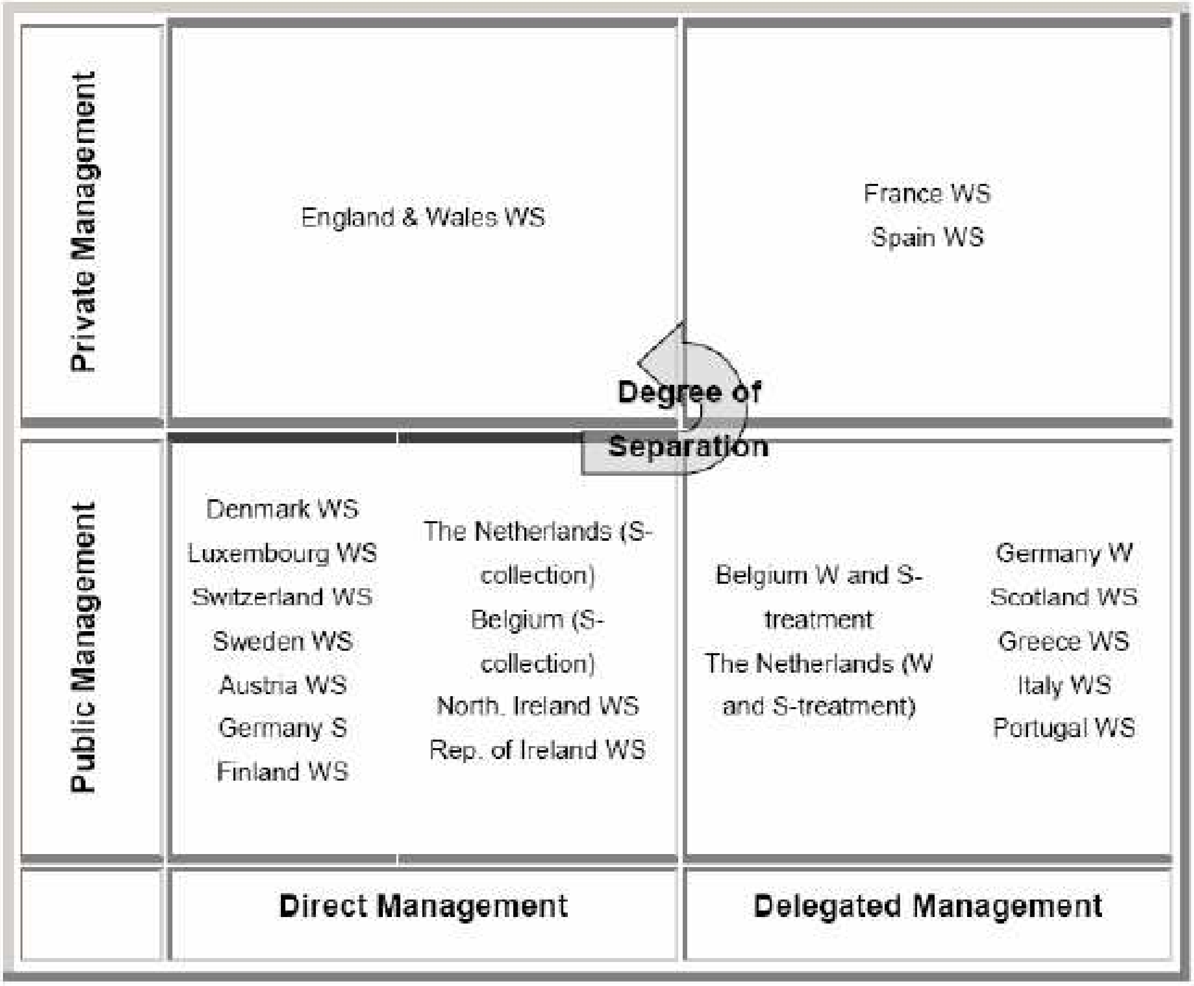


Figure 7 Ownership in the water supply sector in different countries (Source: Moreau-Le Golvan and Bréant (2006))

Based on Moreau-Le Golvan and Bréant (2006), the different types of management are:

- Direct public management where the ownership and operation is within the same public entity
- Delegated public management is where a public limited company is formed to operate the infrastructure on behalf of the responsible public authority
- Delegated private management is where a private operator on a lease or concession basis - typically long term - operates and maintains the water infrastructure
- Direct private management is where also ownership is transferred to a private company that owns and operates the infrastructure.

In the majority of the EU countries the water supply and wastewater companies are owned by the municipalities and in many cases is a department within the municipality. There is trend in direction of going from direct public management to delegated public management, which implies that water companies are reorganised into financially and administratively autonomous companies owned by the public.

There are a large number of water supplies in EU. Table 5 shows an estimate of the number by size of the supplies. There are no data regarding the very small supplies so this number is estimated as the residual. The very small supplies could be supplying just one house.

Table 5 Water supplies and population serviced by category of zones - EU27 (Source: COWI 2010)

Scale	**Supply (m^3/day)**	**Water supply zones (Number)**	**Population (million)**	**Population (%)**
Very small	< 10	Na	47	9%
Small	10-1000	88,000	65	13%
Large	> 1000	16,000	388	78%
Total		104,000	500	100%

In Denmark, the situation is similar to the EU average. The structure of the water supply sector is as illustrated in Table 6. The private water supplies are typically smaller rural supplies that are owned in a cooperative manner by the users. In the rural areas there is a historical tradition of self-organisation in co-operatives. The availability of good quality groundwater has made it possible for such co-operatives to develop the water supply systems in villages and small towns. Increasing demand from national and EU legislation combined with increasing pollution of the groundwater means that it is becoming more difficult for the small user-owned water supplies to comply with the requirement. Hence, there is trend of water supplies merging into larger units or being taken over by the large municipal water supplies.

Table 6 Number of water supplies in Denmark (Estimated based on published data from Danva and GEUS)

Ownership	**Water supplies (Number)**	**Water abstracted (million m^3 per year)**
Municipal	75	240
Private (owned by the users)	2,525	160
Private (owned by users supplying less than 10 households)	50,000	≈20
Total	52,600	≈420

Regarding the financing of water supplies and wastewater companies in the EU, the overall structure can be described as shown in Table 7. The operations of the companies are mainly financed through the user charges. Investment in new infrastructure or renovation/rehabilitation of the existing infrastructure is financed through a combination of sources.

Table 7 Financing of water supply and wastewater companies

	Public subsidies	**Loans**	**User tariffs charges**
Investments new infrastructure/ rehabilitation - public management	√	√	√
Investments new infrastructure/ rehabilitation - private management		√	√
Operation and maintenance - public and private management			√

The level of public subsidies varies across EU Member States. Public subsidies include both national and EU subsidies. The new Member States and the less wealthy Member States receive support from EU through what is called the Cohesion Fund, which provides grants to Member State infrastructure development according to each country's GDP. The rich countries receive little or no support while poorer countries may receive up to 80% of the investment costs as grants from the Cohesion Fund. Additional funding sources in EU include the European Investment Bank (EIB) and the European Bank for Reconstruction and development (EBRD). They provide concessional loans at "softer" conditions than commercial banks, for instance with longer payback time and/or lower interest rates. In the period from 2000 to 2006, the Cohesion Fund provided grants to water infrastructure projects in the order of 2.6 billion EUR per year, while the amount of loans from EIB was about 2 billion per year.

Some Member States have also set up a system of earmarked funds to support investment in water infrastructure. A case example is Poland.

The National Environment Fund in Poland

After the political changes in the beginning of the 1990s Poland introduced a National Environmental Fund. The purpose was to finance investments mainly in wastewater infrastructure. The income to the National Environmental Fund is based on pollution charges paid by wastewater dischargers (industry and municipal wastewater treatment plants) according the level of water pollution. That means that the revenue from the pollution chares were concentrated at one unit and it became sufficient to be provided as finance for water infrastructure investment. The National Environmental Fund gave both grants and concessional loans. The ratio between the two was gradually changed from grants to loans so the Fund could continue its operation. The illustration below shows how the financing in the water section in Poland changed over time.

The trends in the composition of financing shows:

- Fewer subsidies from the central government
- More subsidies from local budgets (municipalities) and from utilities (income from user tariffs)
- More repayable finance from commercial loans

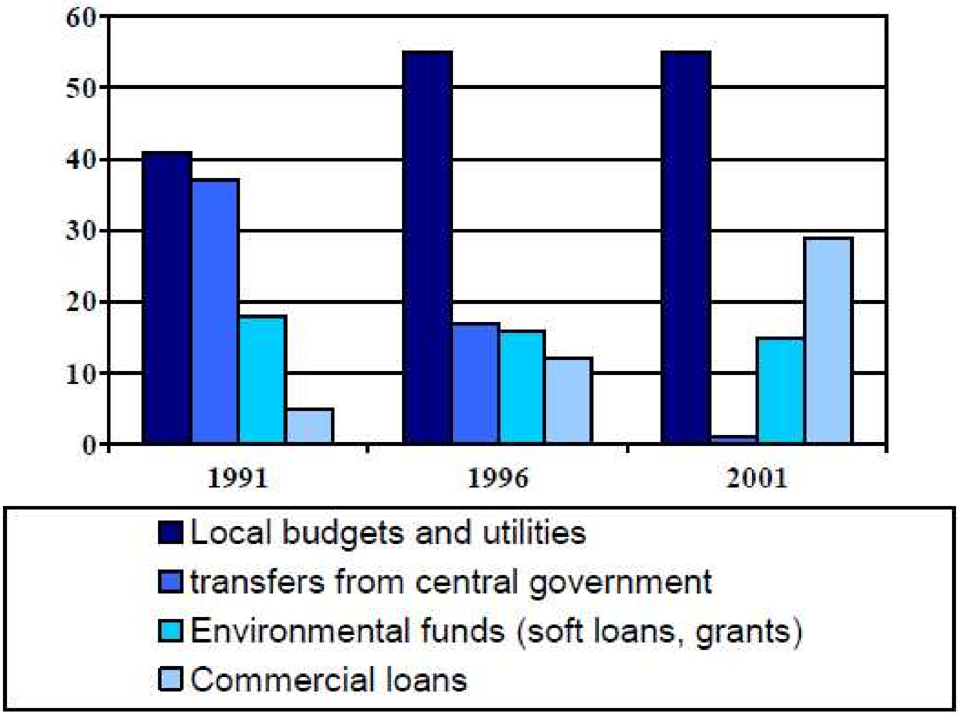


Figure 8 Financial sources for investment in the Water Section in Poland

4.2.2 Financing of irrigation systems

The water consumption for irrigation varies across EU and it is only in few countries that irrigation is an important element of the total water resource management.

One country with large irrigation infrastructure is Spain. As case on the financing of the irrigation system, the following example for Spain is presented.

The Spanish National Irrigation Plan – Horizon 2008

The Spanish irrigation plan was introduced in 2002 after more than seven years of studies, research and enquiries. The National Irrigation Plan - Horizon 2008 (in Spanish, Plan Nacional de Regadíos, PNR) was introduced as a response to the new challenges and society demands for the Spanish irrigation- based agriculture. This section builds on Barbero (2005).

The aims of the national irrigation plan were:

- Saving water and rationalizing water management in irrigation bodies
- Contributing to consolidate the national agro-food system under the framework of the CAP and the market evolution
- Improving social and economic status of farmers
- Contributing to the territorial balance, maintaining population in rural zones
- Controlling the inputs use, reducing diffuse pollution and water consumption

- Incorporating other environmental aspects into the management of irrigation bodies

The PNR implementation is based on principles of coordination and cooperation with the regional authorities (autonomous administrations) and the stakeholders, mainly those grouped into irrigating farmer's communities.

Actions included in the PNR are implemented through agreements between the State General Administration (SGA) and the autonomous governments and between the SGA and irrigating farmer's communities.

- Improvement and modernization of traditional irrigation bodies
- Infrastructures in irrigation bodies into execution, completing works in the big irrigation zones created during the 20th century
- New infrastructures for social purposes, implemented in irrigation zones of less than 2,000 ha, in order to maintain population in rural settlements
- New infrastructures in private irrigating farmers communities, implemented in irrigation zones of less than 2,000 ha to consolidate local agricultural production
- Supporting programme: includes monitoring and permanent assessment programmes, training, dissemination of modern technologies and complementary studies

Table 8 shows the diverse importance of the irrigation programmes in irrigated land and investment.

Table 8 Elements of the National Irrigation Plan

Programme	**Surface (hectares)**	**Investment (million €)**
Improvement and modernisation	1,135,000	3,060
Zones into execution	138,365	1,140
New infrastructure for social purposes	86,425	680
New infrastructure for Private IC	18,000	125
Support Programme	0	25
Total	**1,377,790**	**5,030**

Source: Barbero (2005).

The investment of each participant in the total amount is in Table 9.

Table 9 Financing of the National Irrigation Plan Investments

Source of financing	**Amount (Million €)**
Total investment	
Private investment	2,010
Public investment (MAPA)	1,430
Public investment (Autonomous Communities)	1,590
Total	**5,030**

Source: Barbero (2005).

The distribution of the financing is illustrated in Figure 9. It shows that 40% of the investment is coming from private sources, which are the farmers. The farmer contribution is provided by payment of 50% of their share up-front and the remaining 50% as loans with payback period of about 25 years.

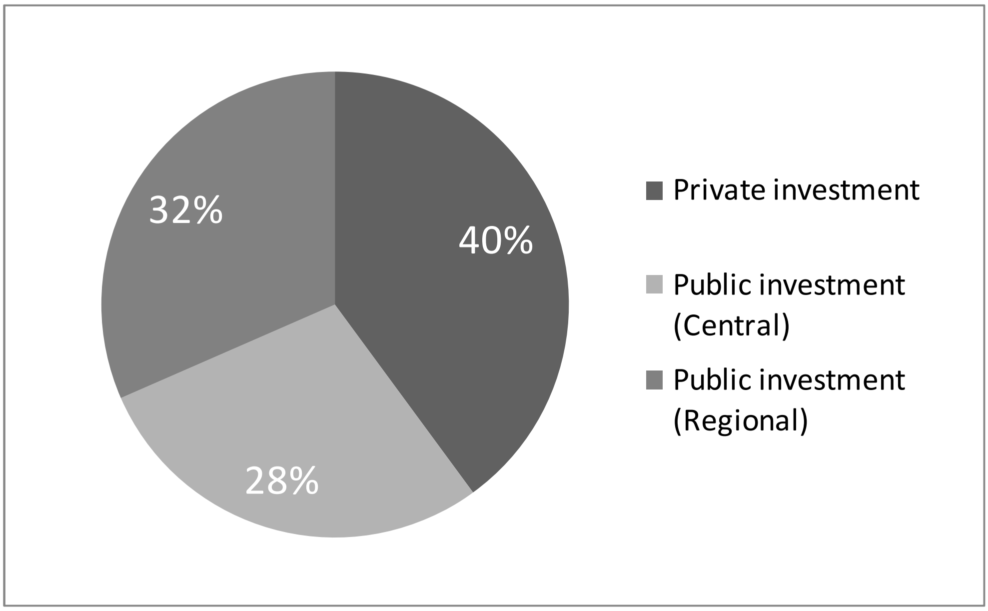


Figure 9 Financial sources for investment in the Spanish National Irrigation Plan

4.2.3 Financing of flood defence infrastructure

Flood protection or flood defence infrastructure is typically financed through public budgets. It is difficult to define the "users" and flood protection has the character of a public good. If the flood defence in towns and cities are related to the collection of storm water, it might be under the responsibility of wastewater companies. They could finance investments in for example additional storm water retention capacities through user charges or by loan financing. For flood defence related to modifications of rivers or coast lines, the available data suggests this type of flood defence infrastructure is finance through public subsidies.

4.2.4 Financing strategy concept

The Financing Strategy (FS) concept has been developed by COWI in cooperation with OEDC (OECD, 2001) and it would be relevant as a strategic planning tool.

The financing strategy concept is basically very simple: There needs to be a balance between the supply of finance and the demand for finance for a given service area for example water resource management infrastructure or water supply and wastewater infrastructure.

A financing strategy is strategic planning tool that helps to make decision about the level of ambition for water sector performance whether it is water resources, irrigation, water supply or wastewater.

An environmental financing strategy is a methodological framework for medium to long-term strategic balancing of the service targets in infrastructure sectors and the future available financing for the same sectors. It has been developed to cover particularly sectors that require investment in heavy public infrastructure such as water infrastructure.

Sector policies and programmes are typically based on a thorough analysis of the problems and the regulatory framework within which the programming takes place. They also identify overall priorities and long-term general objectives. In addition, sector policies and programmes often include a list of short-term emergency measures that are then proposed for immediate inclusion in the public budgets.

However, while many sector programmes provide a clear analysis of existing problems and also often well-thought-through objectives, the task of translating these objectives into time-bound and ranked targets has proven to be more difficult. Cost-benefit analysis has very rarely been done to prioritise the targets. Furthermore, specific policy actions with costing and assigned responsibilities could be lacking. Finally, analysing and documenting how the expenditure can be financed and how targets and related financing should be phased over time have also rarely been done. As a result, many sector programmes have been good strategy and policy statements, but not well suited to guide the implementation of a (public) investment programme.

The financing strategy concept has been designed to address some of the above mentioned shortcomings. The Financing Strategy is particularly intended to bring together target setting and financing of related investments. As described in more detail in the following sections, the financing strategy is prepared by analysing the expenditure needs related to the environmental objectives stated in the sector programme and by comparing these with the available supply of finance.

The financing strategies hence fill a gap between sector policies that identify and analyse problems and set general long-term objectives, on the one hand, and feasibility studies, public budgeting and investment planning, on the other hand.

Figure 10 illustrates the position of financing strategies in the general planning process.

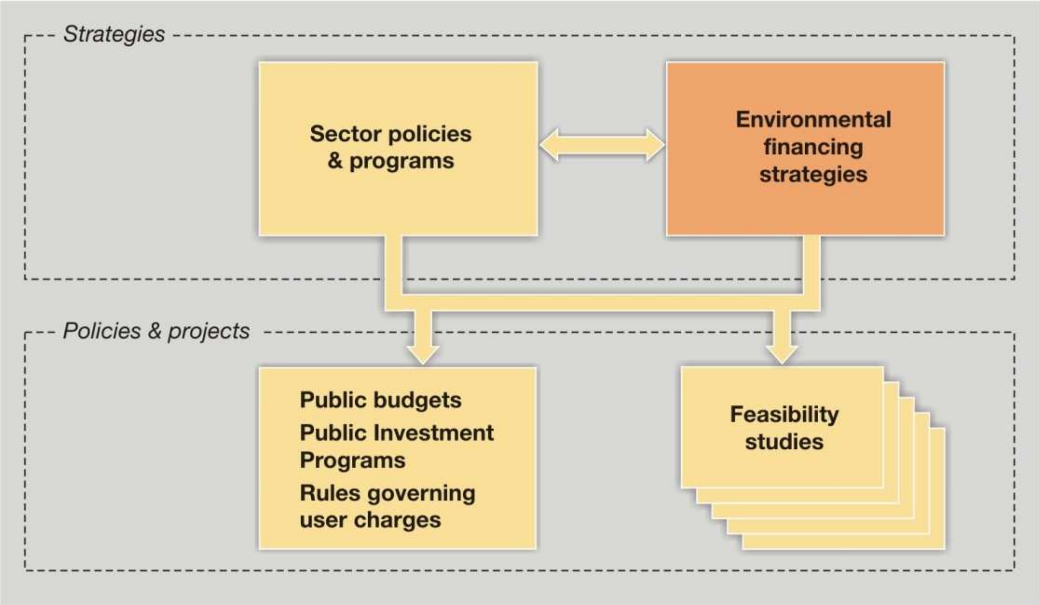


Figure 10 Position of financing strategies in the planning process (The term environmental can here include natural resources and environmental sectors such as water)

The key element in a financing strategy is the comparison between expenditure need and supply of finance. The result of this comparison is the financing gap (Figure 11), which expresses the difference (in monetary terms) between the expenditure need created by a given set of water resources and water service objectives and the amount of finance available.

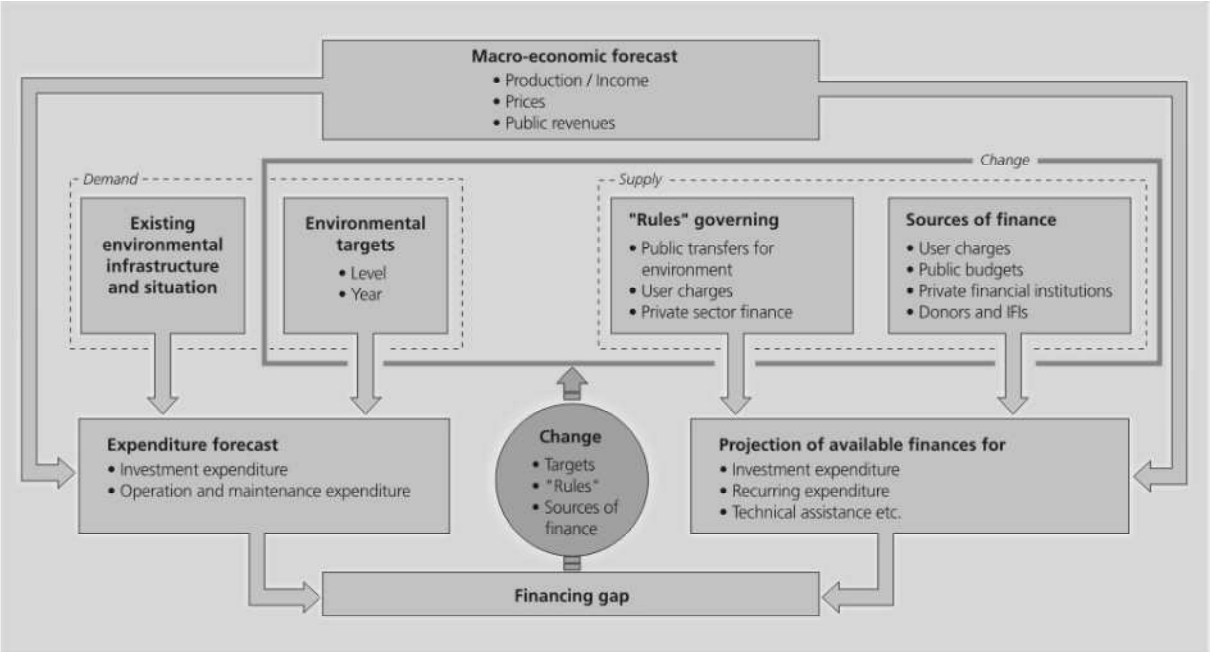


Figure 11 Process to identify and quantify financing gaps. Source: OECD (2001)

The existence of a financing gap implies that:

- the assumed future supply of finance from user charges, public budgets and donors is insufficient for the planned future water resource and water service targets

- the planned future water resource and water service target is too ambitious in view of the available future supply or finance
- a combination of both.

To close the financing gap, either the policies that determine the available supply of finance, the objectives or both will have to be revised.

The development of an environmental financing strategy encompasses the systematic analysis of alternative environmental targets and financing options with the aim to achieve a set of SMART (i.e. Specific, Measurable, Agreed, Realistic and Time-bound) targets and a corresponding set of financing proposals that will close the financing gap (i.e. causes it to be at least zero every year). Such a combined set of targets and financing proposals is said to constitute a sector financing strategy..

The financing strategy is the result of an iterative process towards coherent and realistic planning of the future water resource and water service targets and the financing of the sector from user charges, public budgets, and repayable financing mechanisms. The financing strategy, therefore, provides an overview of the financing envelope for the sector and the trade-off between different service targets. Thereby, it can be used as a common frame of reference for all relevant stakeholders in the discussions and negotiations on the development of the sector.

The financing strategy, furthermore, provides a framework for systematic costing of the water resource and water service targets and for aggregating the consequences for liquidity and household affordability.

Financing strategies may address issues such as the sustainability of the current level of maintenance and re-investment, the affordability of full-cost-recovery user charges and the realistic time frame for service level improvements.

Financing strategies can be used to:

- Bring about down-to-earth implementation programmes given what the economy and the households can afford
- Identify investment projects and build short- to medium-term project pipelines
- Identify which policies and measures are necessary to ensure effective financing of these project pipelines
- Support claims of water resource, environment and other ministries responsible for municipal services on the public budget
- Measure and report progress in the implementation of programmes and policies.

The steps in developing a financing strategy, include 1) estimation of the demand for finance (= costs of the infrastructure) and 2) the supply of finance.

Demand for finance

The value of the infrastructure will gradually decrease over the lifetime of the infrastructure (Figure 12). The value should be understood as the annual benefit that is received from the service of the infrastructure. The re-investment is the annual amount that is necessary to maintain the value of the infrastructure. If it has depreciated over a long period of time without the adequate re-investment, it might be necessary to renovate the system to restore its value and perhaps provide new investment to upgrade or expand the system (Figure 12).

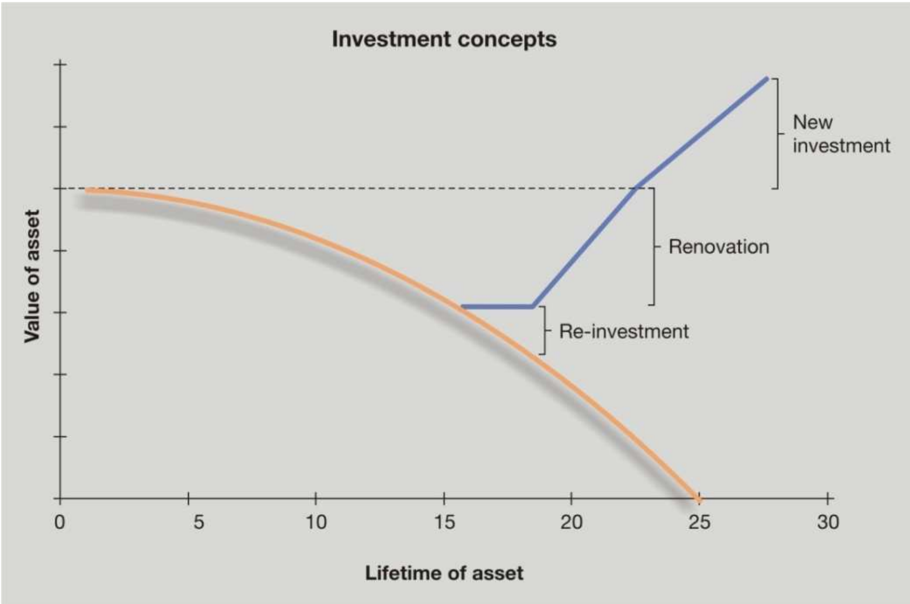


Figure 12 Deterioration of assets and needs for re-investment. Source: COWI FEASIBLE Documentation

Supply of finance

The supply side of a financing strategy will include a review of financing options - what is available and what are the advantages or disadvantages with different financing options

- Public subsidies from central government
- Public subsidies from regional and local government
- State bonds
- Other preferential loans
- Commercial loans
- User charges
- Direct private investments

The review of financing options should cover: Availability, financing conditions, institutional requirements, etc.

4.2.5 Outline of a financing strategy for the irrigation sector

A financing strategy assessment of the irrigation sector in China could include the following elements:

- Description of existing irrigation systems
  - Area covered
  - Irrigation technologies applied
  - Annual operational costs
  - Annual maintenance costs (what is actually spend and what should be spend to keep the infrastructure working)

- Assessment of options for new infrastructure and renovation of existing infrastructure
  - Input from a cost-benefit assessment of alternative options for improving the irrigation system
  - Estimation of total financing needs related to alternative options

- Assessment of current level of financing:
  - Central government subsidies
  - Regional government subsidies
  - Local government subsidies
  - Farmers own contribution (user charges or in-kind contribution)

- Projection of future level of financing:
  - Central government subsidies
  - Regional government subsidies
  - Local government subsidies
  - Farmers own contribution (user charges or in-kind contribution)

- Identification of financial gaps between projected financing and future needed financing

- Identification of options for closing financing gaps
  - Assessment of changes to the financing structures
  - New means of finance and how much finance would be available

4.3 Chinese context

In recent years the Chinese Government has released a round of policies to encourage capital from all aspects, like banks and social capital, to participate in water resources construction to change a relatively backward state of water resources construction in China, thus having initially established a water resources financing structure led by the government and supplemented by the society.

The 2011 No.1 Document requires the government to play a leading role in water resources construction, strengthen financial support for water resources construction and attract extensive social capital to be invested in water resources. In 2010 the State Council released Some Opinions on Encouraging and Guiding Sound Development of Private Investment (GF No. 2010-13), in which it is required to "encourage private capital to participate in water resources construction" and "attract private capital to be invested in such water resources projects as farmland water conservancy, inter-basin diversion, integrated utilization of water resources and water and soil conservation".

The No.1 Document lists a number of financing options: favourable loans and credits from banks, bonds issued by water enterprises and social funds from local governments, etc. Charges for water supply and wastewater services , however, are not listed as a financing option, which can be contributed to this finance currently accruing to municipalities or line-agencies of Ministry of Environmental Protection or Ministry of Housing, Urban and Rural Development, thus being out of reach of the Ministry of Water Resources.

Led by different positive incentive policies, the investment in water resources construction has grown rapidly in recent years, with more diversified sources of investment capital and a more optimized structure. The statistical data show that the national gross investment in water resources construction exceeded RMB340 billion in 2011, of which the government investment accounted for 70% approximately, the bank loans for 20% approximately and private capital 10% approximately.

4.4 Linking financing of water infrastructure to implementation of the No.1 Document

Based on the above and considering how financing mechanisms can support the implementation of No.1 Document the following can be noted:

- Financing of water infrastructure is often very challenging. It is capital demanding so the up-front investment costs are huge, while the lifetime of the infrastructure is very long. This leads to a need for careful consideration of how water infrastructure should be financed.

- The concept of a financing strategy which is about balancing the demand for finance and the availability of finance is a useful tool and can be suggested as an element of strategic planning. For example if more projects are initiated than can be financed, the result could be unfinished infrastructure projects, which provide limited or no benefit and the investment would be lost.

- Another key element of the financing strategy is to consider financing of the maintenance of existing infrastructure and of additional future maintenance when new infrastructure is built. If sufficient financing is not available the infrastructure could deteriorate and the original investment is lost.

- Public subsidies from central, regional or local government are likely to continue to be an important element of infrastructure financing, especially in China. This is particularly the case for water resource infrastructure, which can be characterised as a public good. If the water infrastructure that receives subsidies is subject to impact assessment and cost- benefit analysis, it might be possible to increase the benefit of the public subsidies.

- User charges and user fees could become an important source of financing. In particular for water supply and sanitation infrastructure, the use of user charges as financing mechanism is relevant. Affordability and other social issues need to be considered.

- Direct private investments in water infrastructure require well developed institutions for regulation of private operators. Private involvement in the water sector is more likely to be as operators than as direct investors.

5 Possible next steps

The analysis of economics and finance has shown that that economic assessments are valuable for improving water management and water infrastructure development as part of a modern and adaptive approach as set out in both the WFD and the No.1 Document. At the same time, further work is needed in order to better develop and integrate such assessments in the future.

Based on this result, possible next steps can be divided into 3 different groups of activities:

- Strategy development and supporting technical analysis
- Strategic analysis and decision-making in support of improving the regulatory regimes in the context of implementing the No.1 Document
- Scientific research work to advance the use of economic approaches un water management.

The proposals below provide suggestions to activities that could be undertaken in each of the three categories.

It needs to be noted that many of these activities can be supported by a future water management exchange programme between the European Union and China. There are valuable lessons to be learned from both sides, which can form the basis for common work on achieving sustainable water use.

5.1 Strategy development and supporting technical analysis

Strategy development and supporting technical analysis may include but not be limited to:

- Develop and publish technical papers in relevant journals and media on the importance of economic approaches in water management in order to build awareness and support for the concept and the need for implementation
- Develop water demand scenarios based on projections of the key indicators (population growth and distribution, economic development scenarios etc. etc.) based on the current situation but also on different scenarios for the future, linked to different decisions taken at the strategic level
- Link such water demand scenarios to clear water availability scenarios, including scenarios for future climate change
- Investigate the current availability of economic valuation studies, identify and conduct valuation studies based on the appropriate valuation method
- Conduct economic assessments of scenarios and options

- Develop an impact assessment framework for decisions at the strategic level, creating clarity of the consequences of action (as compared to non-action) by covering all relevant impacts (environmental, economic social) in a transparent manner
- As an example, investigate and further develop the use of economic assessment tools as part of the flood risk assessment for optimizing the investment of flood protection measures
- Investigate the incentive and cost recovery effects of water pricing in agriculture, as well as of possible future policy options, reflecting local and regional circumstances regarding water use and water rights, water availability, farm sizes and crops grown, possible alternative crops and marketing channels, alternative technologies to save water or change irrigation techniques and existing subsidies
- Analyse the current status regarding water metering and suggest improvements if and as needed
- Review existing financing mechanism and assess feasibility of financial instruments that currently are not applied in China.

5.2 Strategic analysis and decision-making in support of improving the regulatory regimes

Strategic decisions have to be taken from case-to-case either at the national, river basin or provincial level.

This may include but not be limited to:

- Evaluation and integration of demand management options in the overall planning, also based on systematic economic assessments Consider the use of the optimisation model BEAM to support the analysis
- Implement the No.1 Document based on economic assessment of scenarios and options
- Use an impact assessment framework as a basis for evaluating decisions at the strategic level
- Consider possible water demand management approaches for agriculture including options for water pricing.
- Support changes in the agricultural water pricing regime(s) considering subsidies to reduce/soften economic and social effects
- Develop a financing strategy for water resource investments. The financing strategy for water resource infrastructure should be developed with close link to an analysis of options to balance supply and demand based on the appropriate economic assessment tools (see section 2.4).
- Develop a financing strategy for water supply and sanitation sector potentially based on the use of the decision support tool FEASIBLE

5.3 Future research needs

Future research needs may include but not be limited to:

- Improving the estimation of costs and especially benefits of water management options
- Common work of engineers and economists on developing hydro-economic models
- Improve the reliability of valuation methods, including that of “benefit transfer” approaches.

References – further reading

Key references are marked in **bold**.
All recommended reading is available in the SDC Knowledge Repository.

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