Measuring Irrigation Subsidies in Spain: An application of the GSI Method for quantifying subsidies

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LIST OF ACRONYMS

AC	Autonomous Communities
ACA	Catalonian Water Agency (*Agencia Catalana del'Aigua*)
EU	European Union
FEOGA	Fondo Europeo de Orientación y Garantía Agrícola (*European Agricultural Guidance and Guarantee Fund*)
GIS	Geographical Information System
GNP	gross national product
ID	irrigation district
MARM	Ministry of Environment and Rural and Marine Affairs
NHP	national hydrological plan
O & M	operations and maintenance
OECD	Organisation for Economic Cooperation and Development
PNR	National Plan for Irrigated Areas (*Plan Nacional de Regadío*)
RBA	River Basin Authorities
SEIASAs	*Sociedades estatales para la ejecución de obras e infraestructuras de modernización y consolidación de regadíos*
SWS	State Water Societies
TRLA	Consolidated Text of the Spanish Water Law
TST	Tajo-Segura Transfer
WFD	European Union Water Framework Directive
WUAs	water user associations

GLOSSARY OF TERMS

€/m³: Euros per cubic meter of water (1 m^3 = 1,000 litres = 10^{-6} Hm^3)

Annual equivalent cost: annual cost of owning and operating a piece of infrastructure during its life cycle

Cost recovery rate: proportion of the cost component that is recovered by the Water Agency through charges collected from water users

Equivalence coefficients: coefficients used to determine the share of water storage and transportation costs among multiple water users for a single infrastructure project

Full cost recovery: (in the system used to charge for water supplied to the irrigation sector) the complete and full recovery of all costs related to supplying water to the farm gate

Linear amortization: a process of depreciating the value of a piece of infrastructure over time through regular, equal fixed payments until its value is zero

Post-transfer: Water that has been transferred from the Tajo Basin to the Segura Basin using the Tajo-Segura Transfer infrastructure is stored in dams in the Segura Basin. This water is later transported to the different areas of the Segura Basin using the so-called "post-transfer" infrastructure.

Regulation works: infrastructure constructed to support the abstraction and storage of water and for the regulation of river flows (e.g., for flood prevention)

SEIASA: acronym for *Sociedades estatales para la ejecución de obras e infraestructuras de modernización y consolidación de regadíos*, state companies responsible for the development and modernization of infrastructure for water distribution in irrigated areas that are included in the PNR

Subsidy rate: proportion of the cost component not recovered through charges collected from water users. It is the inverse of the "cost recovery rate."

Taxable base: public investment in infrastructure whose value can be amortized and is used to compute fees and tariffs to be paid by water users

Transportation infrastructures: infrastructure such as canals and large pipelines used to transport water from rivers and dams to areas where it will be used

1. INTRODUCTION

1.1 EXECUTIVE SUMMARY

The Spanish government is reforming its water policies. This reform will have major implications for water economics, the price of water for end users and the level of subsidies provided to the irrigation sector. Spain has inherited water policies that have prevailed for over 150 years. During much of the twentieth century, the State contributed funds to expand the use of irrigation in order to increase agricultural production. As a result, its present stock of water-related projects and capital infrastructure are among the most developed in the world (about 30 dams per million inhabitants and a storage capacity of 48 per cent of the natural water run-off flows).

During the 1990s an analysis undertaken by the Ministry of Agriculture of Spain's water infrastructure revealed poor amortization and depreciation provisions. Some of the irrigation districts, which accounted for about one third of the irrigation acreage in Spain, contained irrigation infrastructure that was aging and originally built on blueprints developed in the 1900s and earlier. To try and address this situation and improve outdated irrigation infrastructure, successive Spanish governments embarked on a series of policy initiatives to rehabilitate and modernize about 1.4 million hectares of irrigated land (out of 3.8 million hectares of irrigated land in Spain). Adopting similar approaches used by earlier governments to create new irrigation projects, a new era of government intervention in the irrigation sector began in 1997 and continues presently. The new era has seen an increased call for farmers to provide greater financial contributions for water provisioning.

This report has reviewed data and subsidy policies for a variety of geographical areas and from a range of political and institutional sources. It provides a national perspective on the use of irrigation subsidies that relies heavily on information that Spain is required to report to the European Union. As a Member State, it is also required to submit progress reports on the process for implementing EU's water policy.

This report also has a regional and basin perspective. Some of Spain's river basins span several regions (legally defined as Autonomous Communities) and have a unique River Basin Agency (RBA) that depends on the National Government (through the Ministry of Environment, and Rural and Marine Affairs). River basins entirely contained within the political boundaries of an Autonomous Community are managed by the regional government, with the exception of the Andalusian government, which administers and manages the Andalusian section of the Guadalquivir Basin.

Subsidy data provided by the RBA's, Ministry of Environment, Rural and Marine Affairs, and some regional governments was analyzed to generate subsidy data for the different components of irrigation subsidization, such as capital investment. These components were used to generate the aggregate subsidy estimate.

The study is an attempt to develop the most detailed estimates of water subsidies to irrigated agriculture. All relevant and public data sources have been reviewed and analyzed. Most available information originates from two sources, whose domains and representation do not overlap: the Autonomous Communities and the RBAs. Various water service costs with different criteria have been compiled, organized and compared to water charges applied to farmers. This forms the core of the project and is the basis of its conclusions. To the extent that various water service costs are not equally defined and do not refer to exactly the same the domain or even time frame, the conclusions should be interpreted with caution.

Because of the discrepancies in information, the research team has concluded from this study that it is currently not possible to obtain completely accurate estimates of subsidies to the irrigation sector in Spain.

The necessary information required, such as annual data on projects' investment and operations, was not publicly available to researchers. The information that is available is incomplete, poorly organized and poorly presented. The data available lacks detail for lower levels than the river basins, and generally little detail is given about how cost figures have been calculated.

For capital costs of diversion, storage and transportation of surface water, subsidization rates vary across projects and basins. They are generally set at a rate ranging from between 30 per cent to 50 per cent of the capital costs. Costs recovery rates for O&M are much higher and easier to calculate. They range from 90 per cent to 99 per cent of O&M costs.

In total, subsidies to irrigated agriculture may be between €906 million per year (as this report has evaluated under conservative assumptions), and €1.120 million per year (a 55 per cent per cent subsidy rate—costs not recovered), which is the Ministry's own evaluation. This range of subsidies applies to the period 1998–2008, which has seen the development of large modernization projects with broad financing support from various administrations (European, national and regional). Two-thirds of the subsidies correspond to specific programs financing the modernization of distribution infrastructure. After 2008, government programs are less ambitious, and subsidy levels most likely smaller, because the bulk of irrigation modernization projects have already been carried out and economic crisis has reduced the financial capacity of the all Spanish administrations to provide the subsidies.

Based on the information put together by various administrations (national, regional and for specific infrastructure), it is clear that significant progress has been made to compile and issue information on the water sector's finance and economics. More transparent accounting systems are being adopted by all administrations. With a few exceptions, this study was able to generate estimates for subsidy rates for water supply to irrigation in all Spanish river basins. National and regional governments believe the irrigation sector should have preferential treatment. The farm sector has undergone serious financial and economic downturn in 2008 and 2009. Consequently, no government in Spain, either national or regional, is currently eager to put pressure on the farm sector by reducing support to irrigation.

1.2 PROJECT OVERVIEW

The Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD) has developed a methodology for assessing irrigation subsidies[1] with a goal of developing internationally comparable national estimates of irrigation subsidies. The methodology (GSI, 2009) adopts the perspective of the irrigation water-supplying agency. Using the "Net Cost to Supplier" approach, an irrigation subsidy is defined as the net cost to the (government) supplier in making irrigation water available. An irrigation subsidy is conceptualized as the difference between the cost of making irrigation water available and the revenue received as payments from the beneficiaries of irrigation water.

The GSI's interest in irrigation subsidies stems from several broad observations. Irrigation subsidies can distort decisions about which crops get produced, and can artificially increase the volume of output. The GSI aims to generate accurate and reliable information on the environmental and trade impacts, and perceived benefits, of irrigation subsidies. Such information can support national and multilateral policy-makers in their decisions while increasing public awareness of this issue.

[1] See http://www.globalsubsidies.org/en/research/irrigation-subsidies for further information.

The ultimate outcomes of this work are expected to be twofold: the development and strengthening of capacity to undertake analysis of support policies in a number of countries, and changes in government policies and international disciplines. The establishment of standardized and regular reporting on subsidies to irrigation could have a tremendous influence both on national policies and international subsidy disciplines. Awareness of the size, extent and effects of subsidies to irrigation—especially those encouraging the depletion of fossil aquifers—is still not adequately appreciated by policy-makers. Greater awareness of these consequences should help policy-makers to avoid initiating poorly designed irrigation subsidy regimes, and place pressure on them to reform existing ones.

The GSI is publishing a case study on India in 2010. These reports will form part of a series consistent in structure, format and presentation (as much as is practical) to aid comparability.

1.3 FRAMEWORK OF THE ANALYSIS

Several different methodologies for measuring subsidies to irrigation have been adopted by researchers globally (Garrido & Calatrava, 2010). The Wateco Guidelines (EC, 2003) suggest irrigation subsidies be based on the difference between farmers' total payments for the provision of water and total water service costs. The different components of this approach should be clearly defined, such as financial (capital) costs and return on capital. Malik (2008) evaluates two approaches. The first is based on comparisons between the financial value farmers place on the supply of irrigated water (also defined as "willingness to pay") and total costs for the supply of water. The second approach, often referred to as the "Net Cost to Supplier" is based on the Wateco proposal. This report follows the Net Cost to Supplier approach as it provides a more policy-relevant dimension and permits comparisons with other countries and regions. Farmers' willingness-to-pay is dependent on commodity prices, farm policies and has to be elicited using methods (such as surveys, mathematical programming models, etc), which rely on a variety of factors that are challenging to estimate and monitor.

The idea of a "building-block" approach to measuring irrigation subsidies is considered in the summary of the 2006 December OECD meeting on *Measuring Support to Water in Agriculture and Sustainable Water Management* (OECD, 2006). The approach is based on the premise that different cost components have entirely different characteristics and some components may be included in an estimate depending on the situation. For instance, a first-level building block may be any subsidy or support granted for irrigators to reduce fuel or electricity costs; a second one could be subsidies to cover districts' personnel costs.

Often tariffs or charges paid by farmers are based on the sum of various components and levied by different institutions (such as a River Basin Authority, water agency, the irrigation district, or the water users association). These factors, in turn, will affect subsidy estimates. In the most complex water systems, farmers' water payments result from a summation of different components, each linked to a different institution. These institutions, in turn, incur O&M and capital costs. Therefore a continuum exists in terms of how subsidies are defined—ranging from very narrow to much broader subsidy definitions depending on the range of components included in the method used.

A VARIETY OF METHODS TO CHOOSE FROM

When estimating subsidies to irrigation water, several assumptions regarding what type of subsidies are considered can be made:

(a) Very narrowly defined subsidies: includes direct O&M costs incurred by the government that are not paid for by the farmers or end users. This may include energy costs, personnel costs or costs associated with repairing and maintaining irrigation infrastructure

(b) Narrowly defined subsidies: includes projects with preferential financing schemes involving low interest rates or inadequate annualization calculations—used to create new (or improve existing) irrigation infrastructure

(c) Broadly defined subsidies: includes subsidies defined in points (a) and (b) and applied to general infrastructures. Also, the provisioning of water in multi-user projects resulting in cross-subsidization between sectors or the state being responsible for any shortfalls in meeting the cost of the project (Malik, 2008, elaborates on the problems encountered with multiple-purpose facilities).

(d) Very broadly defined subsidies: includes those covered in point (c) plus null or low returns for capital investments for irrigation infrastructure

(e) Economically inefficient: prioritizing the use or access to water for the purpose of irrigation over uses that have a higher economic value. This would be equivalent to the opportunity cost of water, but not to a subsidy in strict sense.

This study attempts to evaluate irrigation subsidies in Spain using the approach proposed in the Global Subsidies initiatives (GSI, 2009) methodology for measuring irrigation subsidies.

THE STUDY AREA

The study was carried out using data from Spanish Government's Ministry of Environment, and Rural and Marine Affairs,[2] which is responsible for the oversight of river basin agencies (RBA) in charge of administering and managing water affairs in river systems that cross more than one boundary of an Autonomous Community (the legal name of a region in Spain).[3] River basins entirely contained within the political boundaries of an Autonomous Community (AC) are managed by the corresponding regional government.[4] This report attempts to provide the most detailed view and evaluation of water subsidies in Spain, and for this reason it relies on both national and regional sources. Spain has seven interregional basins (Duero, Tajo, Ebro, Guadiana, Guadalquivir, Júcar and Segura) and a number of regional basins. In addition, Portugal and Spain share four large basins (Miño-Lima, Duero, Tajo and Guadiana; see Map 1.1). This report does not refer to Portuguese water subsidies.

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[2] The Ministry of Environment and Rural and Marine Affairs (Ministerio de Medio Ambiente y Medio Rural y Marino, MARM) was created in 2008 by merging the Ministry of Agriculture, Food and Fisheries (Ministerio de Agricultura, Pesca y Alimentación, MAPA) and the Ministry of Environment (Ministerio de Medio Ambiente, MMA).

[3] The 1978 Spanish Constitution established a decentralized structure for the Spanish State. Political power is shared by the National Government and the 17 Regional Governments or Autonomous Communities. Responsibilities over each policy matter are transferred to the Regional Governments according to the agreements reached and established in each Region's Autonomy Statute (Estatuto de Autonomía). The Autonomy Statutes state that each Regional Government is responsible for the legislative development and implementation of, among many others, issues such as agriculture, forests and forestry, physical planning and development of infrastructures located solely within the region, water planning management in basins that are completely within the region's territory, environmental management, nature conservation, and economic development. All regional policy initiatives must be in accordance with national policies.

[4] In basins that comprise territories belonging to more than one Autonomous Community, water planning and management are the responsibility of the National Government through the corresponding RBA. Among other issues, RBAs are responsible for flood prevention, control of effluents discharge to water bodies, water infrastructures building and forest-hydrological restoration.

While the "basin" approach of the study will be followed to the largest possible extent, data referring to the Autonomous Communities will also be used occasionally. Map 1.1 includes both the basins' and the AC's boundaries.

TABLE 2.1: BASIC DATA OF THE STUDIED BASINS (SEE MAP 1.1 ON PAGE 13)

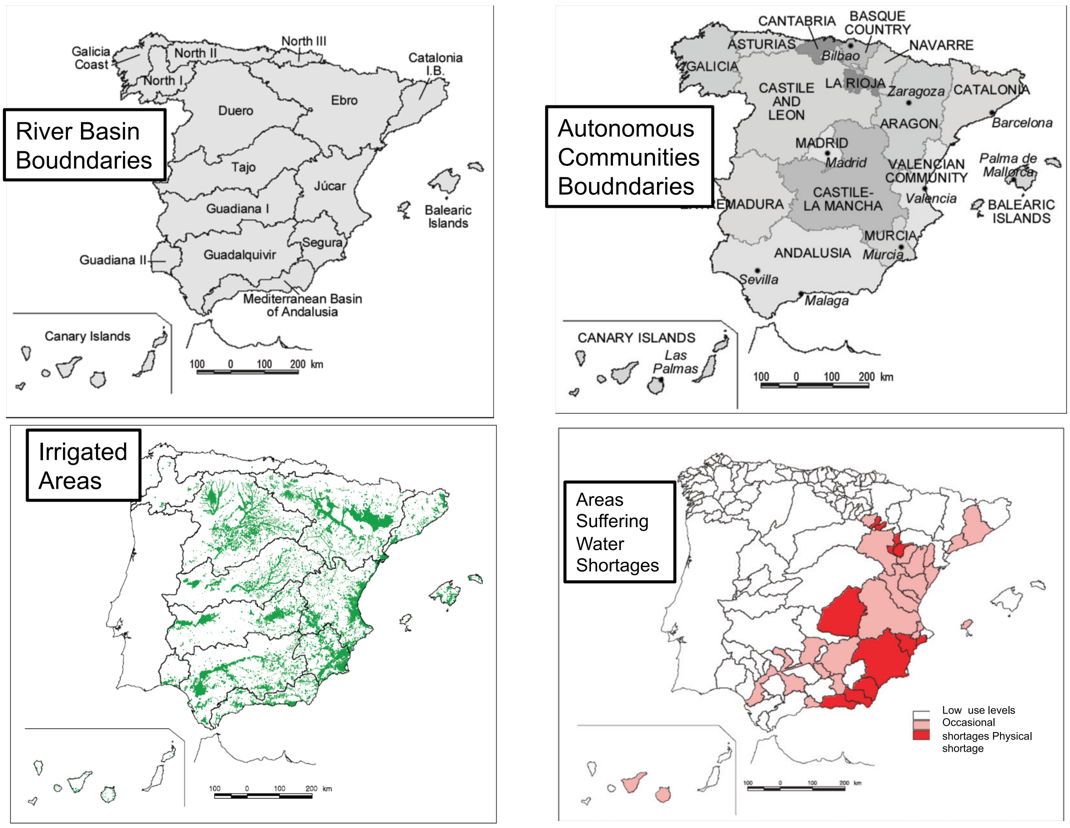
Basins	Surface (km^2)	Rainfall (mm/yr)	Usable rain (mm/yr)	Volume of generated water resources (mm^3/yr)		Storage capacity (mm^3/yr)	Theoretical availability of surface water (mm^3/yr)	Irrigated area (ha)	Water demand (hm^3/yr)
				Total	Groundwater				
Duero	78,960	625	173	13,660	3,000	7,463	6,095	447,576	3,292
Tajo	55,810	655	195	10,883	2,393	10,974	5,845	201,336	1,838
Guadiana	60,210	1,183	234	5,475	750	9,659	2,150	335,590	2,185
Guadalquivir	63,240	591	136	8,601	2,343	8,782	2,819	602,966	4,317
Segura	19,120	383	42	803	588	1,129	626	276,316	1,624
Júcar	42,900	504	80	3,432	2,492	3,346	2,095	384,802	2,452
Ebro	85,560	682	210	17,967	4,614	6,504	11,012	738,662	5,756
Total studied Basins	405,800			60,821	16,180	47,857	30,642	2,987,248	21,464
(%/total Spain)	80.12%			54.70%	54.10%	89.61%	76.81%	89.31%	91.13%
Total Spain	506,470	684	220	111,186	29,908	53,405	39,892	3,344,637	23,552

Source: MMA (2000) and MAPA (2001).

The institutional scope of the report includes national and regional policies, including single agencies with key roles in running the economic and financial affairs of providing irrigation water. These include SEIASAS (state water companies responsible for the development of infrastructures, the modernization and the consolidation[5] of irrigated areas included in the PNR), the Tajo-Segura Transfer (Acueducto Tajo-Segura or ATS), which includes the transfer and the distribution system used to transport water from dams in the Segura Basin where water that has been transferred from the Tajo Basin (referred to in this report as "post-transfer").

[5] Consolidation is used in the PNR as a synonym for the improvement of equipment and infrastructures of irrigated districts.

MAP 1.1: BOUNDARIES OF SPAIN'S RIVER BASINS, POLITICAL BOUNDARIES, IRRIGATION AREAS AND AREAS SUFFERING PERMANENT OR TEMPORARY WATER STRESS IN SPAIN



Source: Libro Blanco del Agua (MMA, 2000).

2. OVERVIEW OF IRRIGATION DEVELOPMENT IN SPAIN

2.1 POLICY OBJECTIVES FOR SUPPORT TO THE IRRIGATION SECTOR: HISTORICAL ORIGINS

The history of irrigation development in Spain has some similarities with other semi-arid countries, such as Israel, Mexico, Western United States and Australia. As noted by Garrido and Llamas (2009), surface irrigation systems were developed in many regions of Spain and almost exclusively on the flood plains of many rivers.

Projects that supplied water and rejuvenated reclaimed land were seen as a way of helping Spain overcome high levels of poverty and illiteracy. These projects could not be carried out purely through private initiatives. Public or government-led initiatives were required and many politicians and intellectuals supported these ideas.

The era of modern Spanish water legislation began in 1985 with the enactment of the Water Act, which replaced the 1879 Water Act. The 1879 Act was further expanded by the 1911 Irrigation and Land Reclamation Act. Together they provided generous economic support for irrigators who benefited from the development of state-funded water projects. Agricultural users were asked to repay less than 50 per cent of the project costs. Twenty-five-year reimbursable loans were provided with an interest rate of 1.5 per cent. At the time, this was considered necessary and did not entail serious financial disruption if inflation ran below

5 per cent. But in the 1970s and 1980s, inflation rates run well over 10 per cent, reaching 23 per cent in 1978. The cumulative effect of these inflationary periods on the cost recovery rates of capital infrastructure was significant. Overall, fees charged to farmers' for the provision of water ended up being about 10 to 20 per cent of the costs for setting up the project. Expanding irrigation, and food production, and advancing the rural economies topped the government priorities for decades. Financial sustainability or self-financing projects were considered minor issues. Operation and maintenance costs were seldom recovered in full from the end users.

In 1902 the Ministry for Development prepared the "Gasset Plan," named after the engineer commissioned to draft this National Waterworks Plan. This first comprehensive national plan was first and foremost an inventory of dams and canals primarily meant to provide water for irrigation.

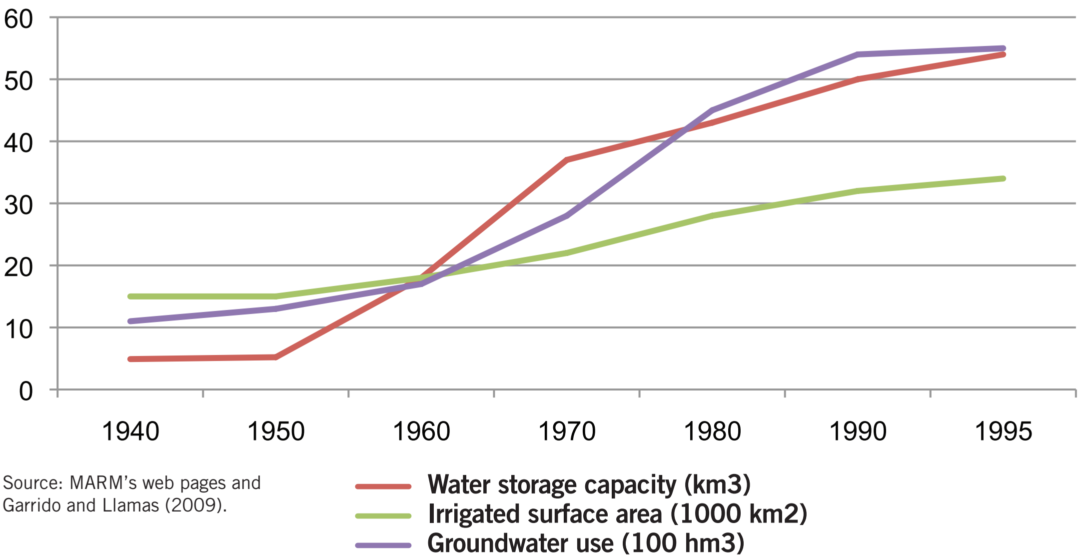
In 1926 the Government set up the *Confederacion Hidrográfica del Ebro* (Ebro River Basin Authority) to promote the integrated management of water in Spanish. In less than two decades all surface water in Spain was managed by these ground-breaking institutions (River Basin Authorities). Present-day water management institutions are still founded on the basin authorities, the Ebro River Basin Authority being the first among the dozen currently existing in Spain.

The 1879 Water Act was to remain in force until the 1985 Water Act was passed. The duration of the 1879 Act attests to its importance. Surface water rights for irrigation, urban water supply and hydropower could be soundly established using the framework of the 1879 Water Act. In Spain, groundwater is under private ownership, as it is in other countries like the United States (California and Texas), India or Chile.

Between the end of the Spanish Civil War in 1939 and the restoration of democracy in 1978, the country experienced an intense rate of construction in water-related infrastructure. Spain almost doubled the area that was irrigated by surface water, reaching 2.5 million hectares by 1975. The result of a steady pace of construction from 1950 to 2000 (during which about 20 dams per year were put into operation), is that Spain today has about 1,200 large dams. In terms of dams per capita, Spain is fourth largest in the world.

Figure 2.1 shows the remarkable growth of a) reservoir capacity, b) irrigated area and c) groundwater usage.

FIGURE 2.1: THE GROWTH OF BASIC WATER-USE VARIABLES IN SPAIN IN THE 1940–1995 PERIOD



Source: MARM's web pages and Garrido and Llamas (2009).

Spain has 3.75 million hectares of potentially irrigable land (MAPA, 2001). Crops vary significantly across basins and regions, but winter crops (cereals, legumes, forage and oil crops) have the largest acreage at the national level. Other Mediterranean crops (olive, winter grapes, citrus, other fruit and vegetables) total a little less acreage than the winter crops, but represent a larger proportion of production value.

While analysts and commentators were beginning to think seriously about the pressing water problems and unrestrained provision of cheap water for irrigation, the 1985 Water Act maintained the policies that provided cheap water for hundreds of thousands of farmers. Government subsidies and other incentives, such as houses, farming vehicles like tractors and other capital goods were provided to many farmers to encourage them to settle in semi-arid and depopulated areas. Water allocation in these areas was governed by engineering constraints and, in times of droughts, rationed through strict administrative rulings.

Prior to the 1960s, hydrological plans were prepared exclusively by civil and agricultural engineers. In the 1960s, for the first time, project documentation included cost-benefit analyses, but this had little or no impact at all on decision-makers.

Evaluating the financial performance of projects requires clear assumptions and supporting information. Direct calculations using financial statements and records provided by government agencies involved in financing water or irrigation projects are also needed. Policies from as early as the 1900s recognized that farmers should be financially responsible for the provision of water and irrigation infrastructure, contributing as well to the Operations and Maintenance (O&M) costs of the River Basin Agencies (RBAs) managing water provision.

The 1985 Water Act ushered in a new period focusing on water-use planning. The 1993 draft of the National Water Plan attached little importance to undertaking economics of irrigation projects. Carrying out environmental impact assessments for infrastructure projects was practically nonexistent. The National Water Plan (NWP) approved by the Spanish Parliament in 2001 did contain some provisions to use economic and environmental assessments when determining suitable investments. However, these assessments were strongly criticized as being unsound by many scholars and conservation groups, especially members of the New Water Culture Foundation.

A "revolution" in the way groundwater was used and managed during the late 1960s and early 1970s quietly resulted in the most intractable problem facing Spanish water policy in the mid-1990s. By the time the 1985 Water Act was passed, the Spanish Constitution already provided the umbrella framework for the government to administer the public hydraulic domain (all surface and ground water) and to intervene in cases of groundwater "overexploitation." Yet, the enforcement of the provisions from the 1985 Water Act relating to groundwater resources failed on most accounts. Where aquifer overdraft has become a serious problem, the administration in charge of implementing and enforcing a management plan to reduce this problem often failed. There are very few examples of sustainable groundwater management in Spain (see López-Gunn, 2009; Custodio et al., 2009).

Spanish water policy changed drastically with the enactment of the European Union Water Framework Directive (WFD) in December 2000. The WFD calls on Member States to implement water charges consistent with the concept of "cost recovery," by 2010. This report will go on to review the history of Spanish pricing policies and discusses the impact the WFD's pricing guidance is likely to have.

2.2 FINANCING WATER SERVICES TO IRRIGATION

2.2.1 ENTITIES RESPONSIBLE FOR WATER SUPPLY TO IRRIGATION

There are a variety of public and private organizations that participate in the different phases of supplying irrigated water to Spanish farmers.

RIVER BASIN AUTHORITIES AND STATE WATER SOCIETIES

The Water Law states the storage and transportation of surface water is the responsibility of RBAs and State Water Societies (SWS) in the case of interregional basins (that is when a river basin spans more than one political administrative region). In the case of river basins that are located within a single political or administrative region they are the responsibility of the Regional Governments. There are eight interregional basins (Norte basins, Duero, Tajo, Guadiana, Guadalquivir, Segura, Júcar and Ebro) and six intraregional basins (Galicia Costa, Internal Basins of the Basque Country, Internal Basins of Catalonia, Balearic Islands, Canary Islands and the Mediterranean Andalusian).

RBAs are autonomous governmental bodies that depend on the Ministry of Environment and Rural and Marine Affairs (MARM). SWS (*Sociedades Estatales de Agua*) are government-owned public companies that build and manage specific water infrastructures in basins that are the responsibility of the national government.

WATER USER ASSOCIATIONS AND GROUNDWATER MANAGEMENT

Groundwater is mostly extracted by water user associations (WUAs) or directly by individual farmers. WUAs in Spain are mostly collective organizations, irrespective of whether they are served by publicly owned water concessions (either surface or groundwater) or from private groundwater rights.

WUAs governing irrigation districts have an instrumental role in implementing water policy and water management functions. According to the Spanish Water Law, irrigation districts (there are more than 6,500 registered *Comunidades de Regantes* covering 2 million hectares) must have their statutes and bylaws approved by the RBAs. They also must perform a number of key water management tasks. For example, on behalf of the RBAs, they collect fees paid by farmers for irrigated water. They have also approved procedures to solve conflicts between irrigators and to develop and co-finance rehabilitation irrigation projects.

THE TRANSPORTATION OF WATER ACROSS REGIONS

The transportation of water to areas where it will be used for irrigation is the responsibility of either the RBAs and SWS, or the relevant regional governments. The distribution and allocation of irrigation water to farmers is then managed by WUAs who are also responsible for the building and maintenance of collective water distribution networks. Different entities collect different fees, tariffs and taxes to finance the water services they provide. This will be discussed further in Section 3.

2.2.2 AGENTS FINANCING WATER INFRASTRUCTURES

The majority of infrastructure investment for water diversion, storage and transportation is implemented or financed by national and regional administrations with some participation by farmers.

THE EUROPEAN UNION AND THE SPANISH NATIONAL GOVERNMENT

The European Union (EU) finances water investments in Spain through its Cohesion and FEDER (European Fund of Regional Development) Funds. The Spanish Government, through the MARM, finances investments that are managed by the RBAs, the regional governments and the WUAs. Regional governments also allocate funds from their own budgets to finance some investments.[6]

RIVER BASIN AUTHORITIES (RBAS)

The RBAs are autonomous governmental bodies and manage funds from two different sources:

- their own budget (generated through the application of water tariffs and charges);
- funds provided to them by the MARM for specific investments they plan to undertake (MMA, 2007b).

These two sources of finance support the costs of the water services provided by the RBAs and they include subsidies to part of the capital costs for building infrastructure. These subsidies partly come from EU funds. Table 2.2 shows the level of funding provided by the MMA to the RBAs, and funding generated by the RBAs through tariffs and levies.

Investment capital is transferred to the RBAs from the MARM budget to finance infrastructure projects (first line in Table 2.2). These transfers of capital come from both national and EU funding sources (through the MARM). The portion of the investment capital transferred from the National Government's own budget (not from EU funds) must be recovered from water users through tariffs and fees. RBAs also receive funds from the EU directly for specific projects.

TABLE 2.2: INVESTMENTS BY THE MINISTRY OF THE ENVIRONMENT AND BASIN AUTHORITIES(1997–2003) IN CURRENT PRICES (MILLION EUROS)

Year	1997	1998	1999	2000	2001	2002	2003
Investments from MARM's budget for regulation and transportation infrastructures	429.46	496.30	300.12	360.97	385.45	295.55	37.44
Investments by the RBAs using funds from tariffs/levies	111.55	100.1	129.49	194.41	213.87	209.99	510.62

Source: MMA (2007b)

[6] A detailed description of the Institutional Framework for the financing of investments in water infrastructures can be found in MMA (2007b).

WATER USER ASSOCIATIONS

In terms of water distribution costs, the O&M and administration costs for WUAs are in principle paid solely by the farmers as the end user. This is irrespective of who may own the district's infrastructure. WUAs managing irrigation districts are usually non-profit associations with an official legal status. The investment costs for new schemes or to modernize or rehabilitate projects also receive significant subsidies from the EU and regional and national governments. New irrigation projects are presently limited and specific to areas where depopulation is occurring (these are called "social irrigation" projects). WUAs can choose to provide full finance for the development of some projects and only partial for others when public administrations participate.

NATIONAL PLAN FOR IRRIGATED AREAS AND WATER DISTRIBUTION

The main source of public investment in infrastructures for water distribution comes from the *Plan Nacional de Regadíos* (PNR, National Plan for Irrigated Areas). The PNR focuses on the development and modernization of irrigated areas and is jointly implemented by both the national and regional governments. Since 2001, 95 per cent of the overall budget for financing the irrigation sector in Spain is devoted to modernization projects covering 1.3 million hectares of irrigated area and coming to €4 billion (Barbero, 2005).

PNR infrastructure projects support water distribution within irrigation districts. Investments designed to improve irrigation technologies used at the farm level can be financed by different ad hoc policy measures set up by regional governments as part of rural development programs improving farm productive structures.

Overall in Spain, investments in water distribution are financed along the following lines:

- 19.98 per cent by the MARM:
- 19.98 per cent by regional governments:
- 39.95 per cent by farmers; and
- 20.10 per cent by the EU structural funds through the FEOGA (European Agricultural *Guidance and Guarantee* Fund).

Many investments are managed through the SEIASAs (*Sociedades estatales para la ejecución de obras e infraestructuras de modernización y consolidación de regadíos*), which are state companies responsible for the development of infrastructures, modernization and the consolidation of irrigated areas included in the PNR.

2.3 SUMMARY OF PROGRAMS AND SUPPORT FOR IRRIGATION

The last major program to expand irrigation was the 1993 National Hydrological Plan (NHP). It envisioned 600,000 new hectares of irrigated land requiring additional water supplies of 4,500 hm^3/year. Savings in water use through modernizing irrigation infrastructure were estimated to provide 1,000 hm^3/year. The overall net increase in demand for irrigation water was estimated to be 6,500 hm^3/year, an increase of 31 per cent from 1992 farm consumption levels. This plan was subsequently rejected in Parliament.

In 2001 the new National Hydrological Plan (NHP) considered an interbasin scheme from the Ebro Basin northbound to Barcelona and southbound to Valencia, Murcia and Almería. It was repealed by Spain's legislative body in 2004. Arrojo (2009) considered the economics of the plan. There were conflicting positions between subsidy-based supply-side strategies and the new economic rationale based on cost recovery models promoted in the WFD. The government eventually published a study containing information on the expected consumption levels and the tariff system that was to be applied (MMA, 2003). Financing for the project was to be provided as follows: 30 per cent of the financing from non-returnable European funds, 30 per cent from interest-free public funds with a repayment schedule of 50 years and 40 per cent from private lending markets with a 4 per cent interest rate applied to the capital. Since no interest or inflation rate was going to be applied to the public funds (30 per cent of the capital), the overall net subsidy may have increased by up to 60 per cent (Arrojo & Sánchez, 2004). This would have been contrary to the cost recovery principle recommended in the WFD.

2.4 HISTORICAL AND AVAILABLE DATA ON AGGREGATE SUBSIDY LEVELS TO THE IRRIGATION SECTOR

COST RECOVERY RATES

Comprehensive subsidy estimates or cost recovery rates for Spain irrigation projects are not currently available. The first reference to aggregate subsidy levels for the irrigation sector was prepared by Martín Mendiluce (1993). A subsidy rate for Andalusia of 80 per cent was estimated with farmers paying only 20 per cent of the cost of building and running the irrigation projects based on Martín Mendiluce's calculations (1993). Prior to the approval of the WFD, Sumpsi *et al*. (1998) generated the most comprehensive study of irrigation prices completed in Spain (it did not attempt to evaluate subsidy levels). Based on information available in the mid 1990s, a decade before the reform mandated by the WFD had begun, a comprehensive assessment of water subsidies was simply impossible.

The best reference concerning cost recovery of water services is contained in a report prepared by the Ministry of the Environment (MMA, 2007b). It is an initial evaluation of the costs of water services and the level of cost recovery applied. Table 2.3's right column shows the average cost recovery rates for the main river basins in Spain based on full supply cost principles.

TABLE 2.3: FARMERS' PAYMENTS FOR IRRIGATION WATER SERVICES IN SPAIN IN 2001–2002 (ONLY IN THE INTERREGIONAL BASINS), ALL FIGURES EXPRESSED IN EUROS

	Groundwater		Surface			Surface and Groundwater		
Basin	Cost per ha	Cost per m³	Distribution (paid to WUA	Per ha WUA and basin tariff	WUA and basin tariff per m³	per ha	per m³	Financial cost recovery rates
Duero	500	0.095	19.88	46	0.012	231	0.044	86.1%
Ebro	829	0.15	49	12	0.011	113	0.02	89.0%
Guadalquivir	744	0.15	101	70	0.035	400	0.081	97.7%
Guadiana	232	0.048	19	102	0.025	188	0.039	54.1%
Júcar	383	0.074	81	16	0.02	283	0.055	85.0%
Segura	789	0.163	34	151	0.038	463.8	0.096	n.a.
Tajo	541	0.1	36	67	0.02	199.3	0.038	n.a.
Total	500	0.09	50	56	0.021	263.5	0.051	87.1%

Source: MMA (2007b)

The MMA (2007b) compiles some data drawn from cost-recovery reports prepared by RBAs and regional governments. However, these reports are mostly based on incomplete data sets that are frequently not reported in detail. Data contained in reports provided by RBAs and regional governments are not uniform across reports. Differences result from the availability of data and the ambiguous and unclear guidelines provided by the Spanish Government concerning the content of the reports submitted to the European Commission as part of the WFD. Further analysis of these reports is provided in the "Irrigation information and data" section of this report.

Apart from MMA (2007b) and the individual RBAs' reports, very few available studies allow official criteria to be applied to cost evaluations and cost recovery rates (official rates reported to the European Commission). Pérez and Barreiro (2007) carried out a detailed evaluation of cost recovery rates in the Gállego Basin (a tributary of the Ebro River) by applying the rate specified by Spanish Water Law. A number of crucial assumptions included: (a) capital replacement costs were not incorporated into the calculations; (b) canals were 25 years or older and amortization rates were set at zero; and (c) 50 per cent of costs of the project were allocated to irrigation (allocation rates for other activities were: 12 per cent for flood control, 32 per cent for hydropower production; 5 per cent for urban and commercial water use). Pérez and Barreiro (2007) estimated that to achieve full financial cost-recovery, a unit charge for water equivalent to 0.0077 €/m^3 was necessary. The actual unit charge in the Gállego Basin was 0.00403 €/m^3, equivalent to a cost recovery rate of 52 per cent.

NATIONAL ESTIMATES FOR IRRIGATION SUBSIDIES

Recently Valsecchi et al. (2009) estimated total water subsidies to agriculture in Spain to be about €165 million per year. Subsidies per cubic metre are calculated as the difference between the full cost recovery (FCR) price (0.06 €/m^3 according to Gómez-Limón & Riesgo, 2004) and the average water price for Spain (0.05 €/m^3 according to MMA, 2007b). This is multiplied by total irrigation water use in Spain. This subsidy estimate for irrigation water supply must be taken with caution due to several methodological issues. First, the FCR price calculated by Gómez-Limón and Riesgo (2004) is valid for the Duero Basin, not for the whole country. Furthermore, water price considered is the national average for both surface and groundwater resources, when in the Duero Basin the use of groundwater resources in irrigation is quite reduced. Average water prices for groundwater are much higher than prices for surface resources; meanwhile, groundwater resources are barely subsidized, which results in a clear underestimation of subsidies. Second, capital subsidies to water distribution (e.g., the National Irrigation Plan) are not considered in the calculation of subsidies.

2.5 OVERVIEW OF SECTORIAL WATER USES, WATER DISTRIBUTION, CROPPING PATTERNS AND WATER SCARCITY

Table 2.4 shows the distribution of water use in Spain by sectors, illustrating the different components for levels of total consumption among the river basins, and water productivity ranges.

TABLE 2.4: WATER REQUIREMENTS AND PRODUCTION GROWTH 1997–2001 (mm³) (FROM MAESTU & GÓMEZ, 2009)

	1997	2001	AVERAGE ANNUAL RATE OF GROWTH
WATER ABSTRACTIONS[a]	34,7356	37,653	1.61%
For Irrigation Operations	21,423	22,184	0.70%
Rest of Agriculture, Livestock and Forestry	1,976	2,368	3.62%
Rest of the Primary Sector	148	173	3.17%
Manufacturing Industry	1,149	1,373	3.56%
For Drinking Water Production	4,393	5,383	4.07%
Power Generation[b]	5,530	6,030	1.73%
Others	116	142	4.00%
Distributed to Water Users[c]	21,319	22,486	1.33%
Agriculture, Livestock and Forestry[d]	18,280	18,461	0.20%
Rest of Primary Sector	29	32	1.72%
Manufacturing Industry	344	374	2.34%
Domestic Supply	2,323	2,509	4.66%
Energy (Consumptive use)	41	48	3.95%
Construction, Services and Others	793	936	4.66%

Source: INE: Water Satellite Accounts 1997-2001. Tables 6 and 7.

[a] Includes water withdrawn as a primary input for all economic sectors.

[b] Water used for the refrigeration of thermal and nuclear power plants.

[c] Includes all water considered as an intermediate input or as a consumer good.

[d] Includes water distributed to Irrigation Associations (Comunidades de Regantes), and drinking and non-drinking water uses by sector. The differences in water abstractions for the irrigation sector are a result of water losses occurring during transportation between the withdrawal and distribution point.

TABLE 2.5: WATER USES (HM³) FOR THE IRRIGATION SECTOR ACROSS RIVER BASINS BASED ON PRODUCTIVITY RANGES*

RIVER BASIN	PRODUCTIVITY RANGES (IN €/m³)							
	<0.02	0.02–0.2	0.2–0.4	0.4–0.6	0.6–1	1–3	>3	TOTAL
Duero	495	1,202	334	113	11	1	0	2,156
Ebro	401	1,499	768	675	45	23	0	3,411
Guadalquivir	733	1,151	1,012	443	155	21	16	3,531
Norte	1	2	0	8	0	0	0	11
Guadiana	1,001	496	78	256	62	157	0	2,050
Júcar	119	581	391	583	206	12	8	1,900
Segura	54	272	174	271	171	51	19	1,012
Andalusian Mediterranean Basins	97	42	38	11	39	11	93	331
Tajo	299	463	16	47	24	104	0	953
Canarias	7	1	0	0	36	32	0	76
Total	3,208	5,710	2,812	2,407	751	412	137	15,437
% of consumption[a]	21	36	18	16	5	3	1	100
% of gross value added[a]	0.1	5	11	9	9	20	45.9	100

Source: MIMAM (2007).

*River Basins represent 78 per cent of the irrigated acreage of Spain. Productivity of water is the value of farm produce sold per m³ of water used.

[a] Rounded to sum up to 100.

WATER DISTRIBUTION

Groundwater users generate about 50 per cent of irrigation supported agricultural production and use 25 per cent of the total water consumed by the agricultural sector. Areas in the southeast of the country have the highest levels of productivity based on water consumed. They are also the most vulnerable to serious water scarcity, water pollution and groundwater depletion.

Table 2.6 shows the surface area with access to irrigation land for each of the 17 Spanish Autonomous Communities (see Map 1.1). The actual area of irrigated land is slightly smaller for most regions, as not the entire area with access to irrigation land is effectively irrigated. In many cases, information on the size of the irrigated land, productivity per unit and water charges are based on regional boundaries or basin boundaries (Maps 1.1 illustrate the different regions, Autonomous Communities, and river basins). The declines in Galicia, Asturias, Extremadura and Baleares are due to different reasons. In Galicia and Asturias, North and Northwest, irrigation is unimportant. In Baleares, there is a lot of competition for water resources from the tourist sector.

TABLE 2.6: IRRIGATION LAND (THOUSAND HA) AMONG AUTONOMOUS COMMUNITIES

Autonomous Community	1996	1998	2000	2002	2003	2004	2005	2006	2007	1996–07 Change %
Galicia	112.80	67.35	47.40	82.30	82.32	73.63	80.78	79.25	76.53	-32.2%
Asturias	3.63	3.72	3.76	5.77	5.66	4.02	3.68	2.71	2.38	-34.4%
Cantabria	1.35	1.35	1.35	1.36	1.36	1.36	4.75	2.06	2.06	52.7%
País Vasco	8.51	10.72	10.10	10.17	9.65	9.74	9.64	9.22	9.07	6.6%
Navarra	81.66	85.54	87.79	87.78	93.65	93.76	92.12	100.14	100.14	22.6%
Aragón	418.33	444.87	439.96	445.18	439.25	478.26	477.12	485.76	473.21	13.1%
Cataluña	258.04	265.60	272.08	271.13	271.45	271.20	270.81	269.85	267.69	3.7%
Cast y León	518.19	551.55	560.15	524.20	527.83	532.01	539.48	545.22	544.65	5.1%
La Rioja	46.05	44.51	44.20	95.50	43.77	43.06	42.86	42.49	42.41	-7.9%
Madrid	30.33	32.26	32.23	27.70	28.11	28.60	28.60	28.60	28.60	-5.7%
Cast Mancha	455.95	457.13	476.49	500.02	514.51	531.15	518.39	538.84	548.54	20.3%
C.Valenciana	360.01	368.00	366.52	354.26	349.89	336.94	342.22	339.35	340.32	-5.5%
Baleares	21.20	21.97	17.04	16.64	20.17	16.18	18.16	12.83	13.59	-35.9%
Extremadura	243.46	206.29	224.19	206.97	190.94	190.54	193.98	181.45	182.61	-25.0%
Andalucía	827.27	871.36	937.27	944.44	973.80	970.07	1,017.17	986.41	968.82	17.1%
Murcia	188.48	189.77	191.07	193.91	193.91	193.91	190.78	188.70	188.51	0.0%
Canarias	27.13	29.15	22.96	23.19	25.27	25.82	27.21	27.36	27.54	1.5%
Spain	3,602.39	3,651.13	3,734.57	3,790.51	3,771.53	3,800.23	3,857.74	3,840.23	3,816.67	5.9%

Source: MAPA (2001)

CROPPING PATTERNS

The Spanish irrigation sector has become increasingly globalized and exports produce to a variety of countries. This has partially been due to the decoupled support measures of the EU Common Agriculture Policy (CAP). The 2000 and 2003 CAP reforms have eliminated most sectorial programs granting specific subsidies to crops like cotton, tobacco, sugar beet and maize, which are quite water-demanding crops in Spain. These reforms have meant farmers are now more responsive to market signals, but more vulnerable to changes in the prices of inputs such as fuel, energy and fertilizers.

The economics of agricultural water use show a very slight increase in water and land productivity varying markedly by region. Farm gate crop prices have increased less than other products within the economy, and much less than the increases in farm input costs. Typical Mediterranean crops, such as olives, fruit, vegetables and wine grapes, still show healthy growth rates at the expense of crops receiving subsidies primarily from the European Union farm programs. Spain has a comparative advantage in specialty crops, especially fruit and vegetables, and this market is expected to expand, favouring the competitive growers who are able to generate returns similar to urban uses.

Table 2.8 shows the area of irrigated land used for growing some of Spain's most important crops and the quality of water provided. It also distinguishes between rainfed and irrigated areas.

TABLE 2.8: THE AREA OF IRRIGATED LAND FOR GROWING MAJOR CROPS, AND LEVELS OF WATER CONSUMPTION AND QUALITY (2004)

Crop types	Area (ha)		Water (mm³)	
	Rainfed	Irrigated	Green water[a]	Blue water[b]
Cereals	5,341,501	1,086,016	5,462	4,980
Industrial crops	742,358	380,957	530	2,557
Vegetables	28,897	307,595	273	1,699
Citrus	4,773	295,187	318	1,861
Olives	1,981,826	309,560	2,263	1,154
Fresh	82,626	203,069	1,163	126
Nuts	781,965	59,451	350	477
Vineyard	1,002,863	132,029	489	441
Forage crops	767,461	272,812	776	1,045
Potato	30,168	84,958	523	63
Other crops	542,610	77,908	1,224	869

Source: Rodríguez et al. (2008)

[a] **Green water** is the rainwater stored in the soil as soil moisture, also referred to as soil water. Over time the precipitation evaporates or transpires through plants. Green water can be made productive for crop growth (but not all green water can be absorbed by crops, and evaporation from the soil will always occur as not all areas are suitable for crop growth all months of the year).

[b] **Blue water** is the volume of freshwater absorbed by a crop, taking into account water that evaporates or is used in the creation of a product. It includes water extracted from surface or groundwater sources in a catchment area and transferred to another catchment or the sea. It is measured as the amount of water extracted from ground or surface sources not returned to the catchment area where it was withdrawn.

Changes in the way the irrigation sector uses water has been the result of scientific analysis and international commodity markets. Virtual-water trading[7] has shown that trading international commodities improves how farmers can adapt to variation in the climate. During years with low rainfall, the importation of cereal equates to about the same amount in terms of virtual water as the total blue water used in the entire irrigation sector. This means that, with its international trade, Spain imports a lot of water embedded primarily in cereals and animal feeds, for which Spain is not very competitive (Garrido et al., 2010). Commodities' trading has alleviated the pressure on scarce water resources and has helped farm economies to concentrate on producing the most profitable crops. The increasingly globalized nature of Spanish agriculture has indirectly affected water-use patterns, encouraging farmers to adapt to climatic conditions.

[7] Virtual water is the volume of water that is used to produce a commodity (Allan, 1998). When this commodity is exchanged through international trade virtual water "flow" takes place. The term virtual water adds a new dimension to international trade, and brings along a new perspective about water scarcity and water resources management. In this sense, virtual water is linked to water productivity, geographical location and to the site-specific socioeconomic setting.

3. ANALYSIS OF FEES AND TARIFFS FOR IRRIGATION WATER IN SPAIN

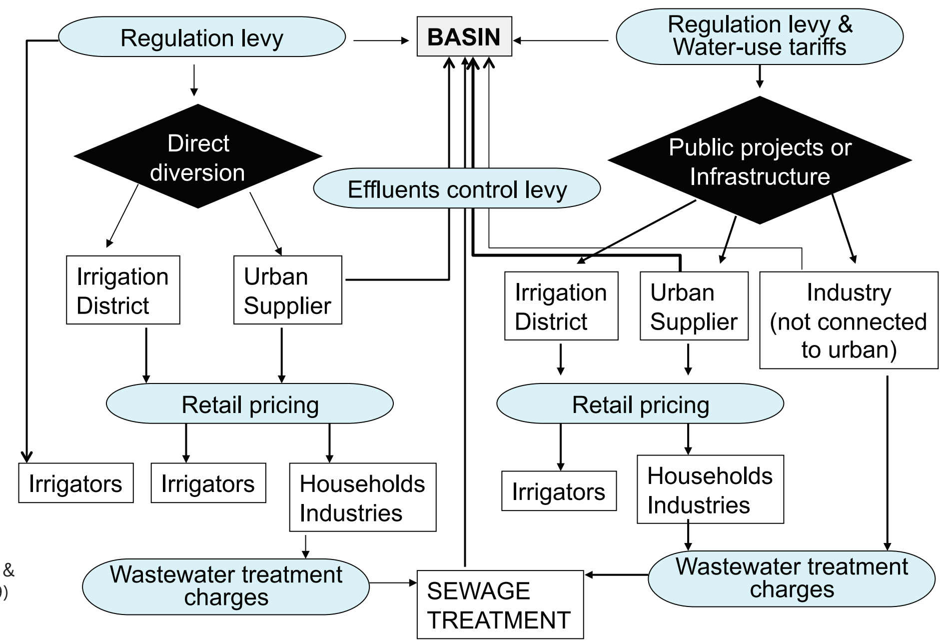
3.1 EXISTING FEES AND TARIFFS

Water pricing systems in Spain vary significantly. The main model used is based on the 2003 Water Act. Figure 3.1 outlines the model governing surface water only (as most groundwater developments are privately administered).

Water users pay different types of fees and tariffs depending on the water services they receive:

1. Users of the public hydraulic domain are charged a levy designed to protect and improve the condition of the domain. The levy is charged on the occupation or use of land belonging to the public hydraulic domain, riverbeds and river flows, but not on water consumption.
2. An effluent control levy of 0.012 €/m³ for urban sewage and 0.03 €/m³ for industrial wastewaters is applied. This may vary depending on the pollution levels of the discharged effluents.
3. The "regulation levy" (*Canon de Regulación*) compensates RBAs for costs associated with water regulation works they have constructed (costs relating to the extraction and storage of surface water) and to cover their O&M costs. It is paid by users that receive water stored in dams belonging to RBAs.
4. The "water-use tariff" (*Tarifa de Uso del Agua*) is designed to compensate RBAs for investment, and operation and management costs for specific infrastructure. Infrastructure includes main canals, interbasin transfers, diversion schemes and any other elements supporting these projects. It is paid by the end users of infrastructure providing water, but does not include regulation works. The 1999 Water Act (see Section 2) introduced a system of increasing or decreasing levies and tariffs charged to irrigators when their level of water consumption was above or below a set reference point. A factor ranging from 2 to 0.5 (increasing the cost of the water per unit) was applied to water extracted or used above the reference consumption level. However, there is no documentation of this factor ever being applied.

FIGURE 3.1: SCHEME OF TARIFFS FOR SURFACE WATER USERS



Source: Garrido & Calatrava (2009)

When calculating the "regulation levy" (point 3) and "water-use tariff" (point 4) the following components were added together: (i) the expected O&M costs; (ii) the administration costs directly attributable to the management of the infrastructure, and (iii) 4 per cent of the total value of the investment to construct the infrastructure. The investment component is affected by amortization rates, which Spanish law defines as realistic, implying that they conform to sound accounting practices for capital investments (Embid Irujo, 1996). In 1997 almost one third of the funds collected for all Spain were from a single project, the Tajo-Segura Transfer (TST), which represents only 2 per cent of all water users in Spain (MMA, 2000). The total average levy or tariff on a volumetric basis was approximately 0.005 €/m^3.

The main water-pricing scheme described above is applicable only to those basins that are the responsibility of the National Government. The fees and tariffs systems are different for intraregional basins managed by regional governments. Regional governments develop their own environmental policies and some of them have related water charges. Catalonia, for instance, charges all final consumers a water levy (*canon del'aigua*), irrespective of the type of agency servicing end users or if it is a public-private institution. Rates vary across sectors and farmers are exempt from the levy. Most regional governments have enacted similar levies.

In terms of special water projects, one of the most significant waterworks in Spain is the Tajo-Segura Transfer (TST) (see a detailed description in Arrojo, 2009). Its financing is based on a specific law (Act 52/1980), which ensured it was separate from, and not under the authority of, earlier water legislation. This meant its financing and charge-setting structures are independently managed from other waterworks. It envisaged the recovery of 60 per cent of all project costs; the remaining 40 per cent was not applicable because of the excess capacity with which the project was designed by Spanish authorities in the 1960s.[8] A surcharge was applied to generate revenue for specific waterworks being developed in the Tajo basin—the area providing the water. While this second provision may not have been sufficient to fully financially compensate the area where the water came from, it set an important precedent for new self-financed infrastructures. It has never required additional finances or funds from any administration, and has been running optimally for two decades.

Two decades after the principle of self-financing was established, the government questioned the rationale of this system's compensatory payments (MMA, 2000). Although users were charged "full cost recovery prices," the government diverted a fraction of these proceeds to finance water investments in the area where the water came from. This meant that TST customers pay for the cost of the project but their payments are used to finance the development of other infrastructures. The TST tariffs for raw water are among the most expensive currently paid in Spain (traditionally in the range of 0.09 to 0.12 €/m^3, although they were increased to 0.17 €/m^3 in 2009). But even in this instance, TST farmers' tariffs are approximately 80 per cent of the tariffs for urban water supply. And yet urban customers have priority of over irrigators, so the difference could account for the greater supply guarantee of the former.

Despite the innovative tariff system adopted by the TST project, subsequent interbasin transfer schemes, such as the Guadiaro-Guadalete (1995) and the Tajo-Guadiana (1995) interbasin water transfers, followed the principles of the 1985 Water Act. Instead of setting up an independent financial scheme for these projects, they followed the previously adopted approaches embodied in 1985 Water Act.

[8] The TST was designed to transfer 600 hm^3/year on its first phase and 1,000 hm^3/year on a second phase. The government never approved the initiation of the second phase and therefore assumed the burden of the capital cost of the excess capacity of the infrastructure. When the project became operational, technical studies in the headwaters of the Tajo Basin indicated that run-off had been overestimated, which means that project's capacity will never be utilized in full. Average water transferred since 1978 is 330 hm^3/year.

3.2 WATER FEES AND TARIFFS PAID BY THE AGRICULTURAL SECTOR

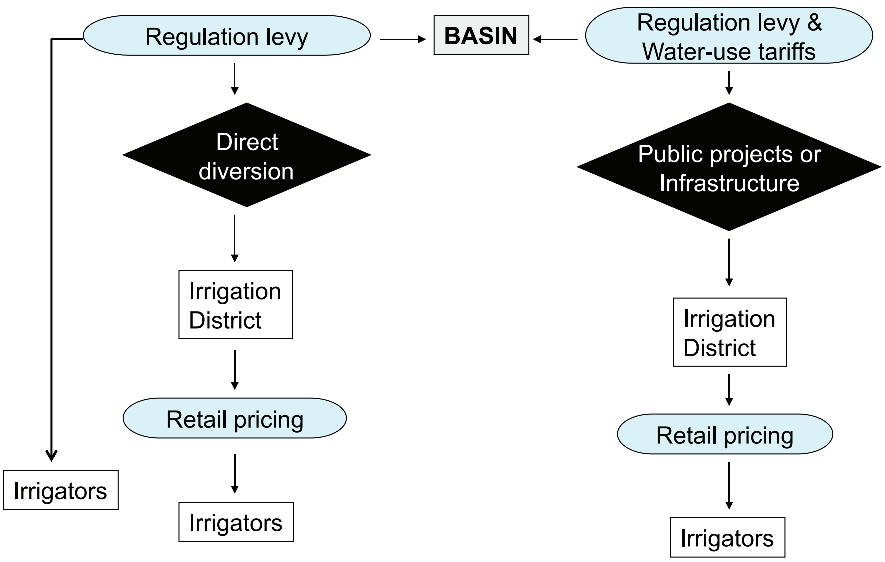
The cost of water provision borne by farmers depends on the type and origin of the water resources used. A simplified description of the charges involves four main types:

1. The regulation levy;
2. The water-use tariff;
3. The *derrama* tariff (WUA charge), for water distribution costs met by the irrigation districts or WUAs that farmers belong to. It can include the WUA costs for pumping groundwater; and
4. Costs farmers pay for pumping water from rivers or aquifers, including maintenance of pumping equipment, energy and labour costs.

Farmers using surface water from specific irrigation works pay the regulation levy and the water-use tariff to the RBA via the irrigation districts administration (WUA) plus the *derrama* tariff (point 3 above) (Figure 3.2). If the irrigation district (ID) abstracts water directly and uses publicly funded regulation infrastructures, farmers pay only the regulation levy and the *derrama* tariff.

Farmers not belonging to a WUA and diverting water directly from a surface body of water pay the regulation levy directly to the RBAs and bear the abstraction costs themselves.

FIGURE 3.2: TARIFF STRUCTURES FOR AGRICULTURAL SURFACE WATER USERS



Source: Own elaboration from Garrido & Calatrava (2009)

Generally, water charges or levies are not applied to groundwater users. Although users must have access rights for water resources, most groundwater resources are still under private ownership. They are responsible for the cost of drilling wells and ongoing O&M costs. Groundwater users incur extraction and distribution costs—paying their financial, energy, operation and maintenance costs themselves. A recent study (CHJ, 2004) indicated that in the Júcar basin, where most customers are groundwater users, about 90 per cent of expenses relating to surface and groundwater use are controlled by the private sector and not by the RBA.

However in Catalonia, groundwater users (excluding irrigators) are charged the regional levy, which is also applied to surface water users.

An exception to the situation outlined above is the case of **historical users**. These are users who can provide evidence of having used irrigated water prior to any major modern infrastructures being built in their area. Some of these access rights may date back to medieval times and it is difficult to assess historical users' abstraction patterns or separate their activities from the services provided by modern waterworks. They are, in principle, subject to the regulation levy charged by the RBA. However, a number of traditional water associations (WUAs) that own their water infrastructure fought a legal battle to be exempted from the regulation levy. Their legal case was based on the claim that their use was independent of the basin's regulated waterworks. The administrative courts set a precedent and ruled in their favour. These traditional WUAs are currently exempt from tariffs and levies. It is not clear whether the full application of the WFD will result in a requirement for these users to pay resource and environmental costs.

Average tariffs paid for irrigation water in areas where water is supplied by RBAs is 0.02 €/m^3, except for agricultural users serviced by the TST project who pay approximately 0.09 €/m^3. In areas using groundwater, recipients pay an average price of 0.04 to 0.07 €/m^3, which is based on extraction and other O&M costs.

These per-unit charges for water are well below the publicly funded costs incurred to supply the water. In Andalusia (Guadalquivir, Guadiana and Sur basins), where irrigation water comes predominantly from surface resources, average water tariffs for surface water are approximately 0.01 €/m^3. Final cost for farmers, including other water-related variable production costs (such as the costs of applying irrigation water to crops), comes to a unit cost of 0.04 €/m^3. However, it costs the administration approximately 0.12 €/m^3 on average to supply water (Corominas, 2001). The total cost for farmers using groundwater ranges from 0.13 to 0.5 €/m^3. Most costs are covered by the farmers themselves or by the WUAs they belong to.

Conversely, in the region of Valencia (Júcar Basin), where the use of groundwater is intense and the predominant form of supply, the unit cost of water for farmers ranges from 0.04 to 0.22 €/m^3 for surface and groundwater respectively. The average price for all water consumption is 0.11 €/m^3 (García, 2002; García et al., 2004).

Most WUAs in Spain have opted for one of the following water pricing schemes (MAPA, 2001):

- A fixed per-hectare tariff: calculated as the total costs attributable to farmers divided by total irrigated area. It is the most common option in traditional districts (those built before 1950) served from surface resources. Fixed rates are applied across 82 per cent of the national irrigated acreage
- A volumetric tariff: more frequent in districts served by groundwater or incurring significant energy costs
- A binomial (with both fixed and volumetric components) tariff combining a volumetric rate covering variable costs and a fixed per-hectare rate for investment and management costs. This tariff system is applied across 5 per cent of the national irrigated acreage. Binomial tariffs are predominant in private or modern publicly financed irrigation districts, where water-metering devices exist and energy costs are substantial.

The charges paid by farmers in a selection of irrigation districts and RBAs is reported in Table 3.1. These figures are generally only applicable to 2008.

TABLE 3.1. TARIFF SCHEMES FOR A SELECTION OF SPANISH IRRIGATION DISTRICTS AND RBAS

District	Basin	Type of district (surface in ha)	Irrigation system (F:Furrow S: Sprinkler D: Drip)	Average allotment (m³/ha)	Water supply	Type of tariff	Per hectare tariff (€/ha)			Volumetric term (€/m³)	Reference+
							Regulation levy + water use tariff (a)	District tariff (b)	Total (a+b)		
Guadalmellato	Guadalquivir	Old private district (6,129 ha)	F/S/D	6,000	Surface	Fixed per hectare			150	–	1
B-XII (Bajo Guadalquivir)	Guadalquivir	Old public district (11,900 ha)	F/D	6,000	Surface	Fixed per hectare			165*	–	2
Genil-Cabra	Guadalquivir	Modern public district (15,000 ha)	S/D	4,000	Surface and groundwater	Binomial			85	0.025	2
Fuente-Palmera	Guadalquivir	Modern public district (5,260 ha)	S/D	4,200	Surface (pumped)	Binomial	52	39	91	0.06	2
El Viar	Guadalquivir	Old private district (12,000 ha)	F/D	7,000	Surface	Fixed per hectare			103	–	2
Riegos de Levante (MI)	Segura	(26,399 ha)	F/D	7,200 to 9,600	Surface	Binomial	–	45	45	0.105**	2 & 3
Riegos de Levante (MD)	Segura	Traditional public district (4,183 ha)	F/D	5,100	Surface	Binomial			25	0.184**	3
Com. de usuarios de Novelda	Segura	Private, specialty crops (2,056 ha)	F	6,000	Groundwater	Binomial	–	85		0.151**	2 & 3
Acequia Real del Júcar	Júcar	Historical district (21,736 ha)	F/D	12,600	Surface	Fixed per hectare			211**	–	2 & 3
Canal Cota 220,Onda	Júcar	Modern district (2,179 ha)	F/D	7,200	Surface and groundwater	Binomial	3	–	3	0.1**	2
Vall D'Uxó	Júcar	Private district (2,882 ha)	F/D	7,500	Groundwater	Binomial	–	210		0.121**	2 & 3
Callosa d'En Sarriá (part)	Júcar	Traditional district (2,083 ha)	F	9,000	Surface	Fixed per hectare	–	332-764		–	3
Callosa d'En Sarriá (rest)	Júcar	Traditional district (2,083 ha)	D	9,000	Surface	Volumetric	–	–	–	0.11	3

CONTINUED...

TABLE 3.1. TARIFF SCHEMES FOR A SELECTION OF SPANISH IRRIGATION DISTRICTS AND RBAS (CONTINUED)

District	Basin	Type of district (surface in ha)	Irrigation system (F:Furrow S: Sprinkler D: Drip)	Average allotment (m³/ha)	Water supply	Type of tariff	Per hectare tariff (€/ha) Regulation levy + water use tariff (a)	Per hectare tariff (€/ha) District tariff (b)	Per hectare tariff (€/ha) Total (a+b)	Volumetric term (€/m³)	Reference+
Canal Cota 100	Júcar	Modern district (3,352 ha)	F/D		Surface and groundwater	Binomial	3	–	3	0.05**	3
Babilafuente	Duero	Old public district (3,570 ha)	F/S	13,000		Fixed per hectare	66	6	72	–	2
Villoria	Duero	Publicly developed district (5,220 ha)	S	4,000		Fixed per hectare	138*	12	150	–	2
Villalar	Duero	Modern public district (510 ha)	S	Unlimited	Groundwater	Volumetric	–	–	–	0.06	2
Canal del Páramo	Duero	Old public district (15,500 ha)	F/S	7,500		Fixed per hectare	66	9	75	–	2
Canal de la Retención	Duero	Publicly developed district (3,514 ha)	F/S	7,000		Fixed per hectare	33	12	45	–	2
Daimiel	Guadiana	(19,000 ha)	S/D	Depending on size	Groundwater	Binomial	–	–	–	5 €/ha + 9 €/well + energy cost	2
Bajo Carrión	Duero	Modern public (6,600)	F / S	4,500	Surface	Per hectare	26	12	38	–	4
Loma de Quinto	Ebro	Modern public district (2,606)	S	5,850	Surface (pumped)	Volumetric	–	–	–	0.034	5
Monegros-Cinca	Ebro	Public (100,000)		10,000	Surface	Per hectare			60	–	6
Canal de Aragón	Ebro	Public modern (105,000)		5,700	Surface	Volumetric	–	–	–	0.05–0.07	6
San José	Sur	Private, fruit (189 ha)	S/D	5,045	Groundwater	Binomial			144 (36 €/ share)	0.14	7

All volume-related tariffs (per number of times the farm is irrigated, per volume of water applied or per duration of irrigation) have been converted to per-volume amounts. Binomial tariffs have both fixed per-hectare and volumetric components. (*) Includes the cost of labour for irrigation district employees who manage the system.

+References: 1: Calatrava (2002); 2: Sumpsi et al. (1998); 3: García (2002); 4: Gómez-Limón et al. (2002); 5: Dechmi et al. (2003); 6: Arrojo (2001); 7: Calatrava and Sayadi (2005). This table was first published in Garrido and Calatrava (2010).

3.3 CALCULATION OF FEES AND TARIFFS

The calculation of fees and tariffs in interregional basins is performed according to Royal Decree 849/1986 regulating the Public Hydraulic domain (RD 849/1986, *de 11 de abril, por el que se aprueba el Reglamento del Dominio Público Hidráulico*). Article 300 defines how the regulation levy is calculated. The calculation of the water use tariff is established in article 307 of Royal Decree 849/1986.

The regulation levy is calculated as the summation of the three following components:

1) The forecasted O&M costs for infrastructure regulating run-off in the basin. This also includes the difference between the forecasted and final O&M costs for the previous year. O&M costs are calculated for each piece of infrastructure or groupings of infrastructure.
2) The RBA's administration costs for managing infrastructures that regulate run-off. They are calculated in the same fashion as the O&M costs in component (1).
3) Four per cent of the value of total public investments to develop infrastructure regulating run-off and river flows. Realistic amortization rates need to be used in the calculation, ensuring they are technically sound and based on appropriate accounting procedures. Actual investment values are discounted, taking into account both the technical amortization of the infrastructure, and inflation rates. A few examples of investment costs include expenditure for project design, building the main and complementary irrigation works, and the required compulsory purchase orders (e.g., land legally taken by the government from its owners to build dams or canals in it).

In calculating the investment cost component, the amortization period for infrastructure projects is 50 years. Water users should pay the capital component (component 3) of the regulation levy during this 50 year period, starting from the year after the infrastructure became operative. A series of equations are applied to the cost components of the project in order to determine the levy that should be applied to the end user. Below are the equations and a short explanation for them.

Calculating charges to be paid by users begins by calculating the annual value of the Taxable Base in year n. This is the part of the public investment left to be amortized in year n. Taxable Base in year n (TB_n) is calculated by deducting the linear amortization from the total public investment to be recovered (TI) during the 50 year period. The equation follows:

$$TB_n = \frac{50 - n + 1}{50} * TI$$

The TB_n should be discounted using a rate that subtracts 6 per cent (set arbitrarily to account for inflation rates of 6 per cent) from the annual Legal Interest Rate (an interest rate fixed annually by the government). This is illustrated in the following formula:

$$ATB_n = TB_n * \left[1 + \frac{LIR_n - 6}{100}\right]^n$$

Where ATB_n is the Actual Value of the Taxable Base and LIR_n is the Legal Interest Rate in year n, the annuity to be recovered through the regulation levy is 4 per cent of ATB_n.

For those infrastructure projects with an economic cost recovery model set up prior to the 1985 Water Act (Ley 29/1985 de Aguas), the annuity to be paid by users (AA_n) from 1985 onwards is the discounted value of the annuity set when the infrastructure was built (A_n). An is discounted considering the amortization rate and the currency depreciation according to the following formula:

$$ATB_n = TB_n * \left[1 + \frac{LIR_n - 6}{100}\right]^n$$

Where A_n is the initial annuity calculated with the pre-1985 economic cost recovery model, and b is the amortization rate that is set to 4. With both systems, AA_n cannot be lower than the initial annuity A_n, that is to say, if the value of [$(LIR_n\text{-}6)\text{-}b$] is negative it should be set to zero. Most analysts, including Pérez and Barreiro (2007) and Bielsa, Cazcarro, Groot and Sánchez Chóliz (2009), believe this formula should be revised.

The water-use tariff is calculated through combining exactly the same components and definitions of the regulation levy. The only difference is that the water use tariffs are applied only to specific infrastructures servicing a well-defined set of users and that the amortization period used is 25 years. The regulation levy is applied to all river basin users. It may therefore be common to have users paying the same regulation levy but a different water-use tariff as they receive water from and/or through different waterworks or infrastructure.

3.4 IMPORTANT ISSUES IN THE ESTIMATION OF CAPITAL COSTS

3.4.1 EVALUATION OF CAPITAL COSTS

There are numerous ways to define and evaluate the capital costs of irrigation infrastructure (Garrido & Calatrava 2010). The EU's WATECO guidelines (EC, 2003) define three areas in classifying and estimating capital infrastructure:

- **New investments:** includes investments in the development of new projects and associated costs (such as site preparation costs, start-up costs and legal fees). In the case of infrastructure projects that are planned but have not commenced, the cost of sunk capital should be expressed as an Annual Equivalent Cost. A standard annualization method should be adopted.
- **Depreciation:** the annualized cost of current infrastructure assets being replaced in the future, due to the reduction in its value because of wear and tear, age or obsolescence
- **Opportunity cost of capital:** for example, an estimate of the rate of return that could be generated by investing the capital into alternative investments. While accounting guidelines find the use of non-commercial rates of return acceptable, it is recommended that a rate of return other than zero should be adopted and subsidies to capital should be accounted for.

3.4.2 VALUATION OF EXISTING ASSETS

A critical methodological issue is the valuation of existing assets and how depreciation is calculated for existing infrastructures. The WATECO guidelines (EC, 2003) offer a choice of several methods for the valuation of existing assets:

- **Historical value:** the value of the asset is based on its cost when originally purchased. As a result of inflation, this value often has little or no relationship to what it would actually cost to build and replace the infrastructure based on present prices or costs.
- **Current value:** is the historical value of the asset multiplied against a suitable inflation index for the country.
- **The replacement value method:** the current value of an asset is determined by estimating the current cost of replacing the asset in order to generate the same level of service as provided by the existing infrastructure.

The GSI methodology recommends using the "current value" or "replacement value" approaches, not the "historical value" approach. In Spain, using historical values in cost recovery models is generally accepted for most of the large public infrastructure projects. Many water infrastructure assets, such as large dams, were built over 50 years ago and the users (farmers and urban users) have theoretically fully paid for the asset. This may occur even when there is a positive salvage value (the current market value of the remaining infrastructure) and the asset is currently still in use. The capital replacement cost model is not often used. By the time the infrastructure asset is obsolete or fully depreciated, the amount of charges paid during the lifetime of the project would never be sufficient to build an identical replacement piece of infrastructure.

The use of marginal or replacement cost is not incorporated into the EU Water Framework Directive (WFD). In the 1990s, during a period of water privatization in the United Kingdom, the value of water assets were estimated based on the "present value of profit," or, in other words, the ability of people purchasing water to pay for it. The method determining the final value of water assets did not use either the historical value (deemed too low a price) or the replacement value (deemed an excessive price). Economic theory defines the capital value of an asset as being the present value of a future revenue stream or profit generated by the asset. Consequently, neither the historical value method nor the replacement value method was applicable. In practical terms, if the government privatized the existing assets, the higher the price they were sold at, the higher the charges for water and wastewater would be in order to provide a commercial rate of return on those assets.

In contrast, Spain has always defended using historical depreciation criteria when determining the application of full cost recovery rates for irrigation. As this has not been changed by the European Commission nor found in breach of the DMA, we could assume that it has been implicitly accepted by the European Union. This implies that using the replacement cost criterion would mean higher cost recovery rates than those being used. Whether a subsidy is generated or not as a consequence of the choice of method for the valuation of assets is subject to discussion. According to the GSI's methodology, it constitutes a subsidy. However, it can also be argued that publicly developed and constructed infrastructure should not get a capital return in the same way private assets should. In fact, public agencies do not sell water and do not collect revenue to have profits or market returns. Therefore, the absence of a capital return should not be counted as water subsidies and the historical value with a linear depreciation criterion should be used.

3.4.3 SUBSIDIES IMPLICIT IN THE CALCULATION OF CAPITAL COSTS

The main source of subsidization generated by the system used to calculate fees and tariffs for the regulation levy and the water use tariff comes from the interest rate used for discounting payments to obtain their actual values. The interest rate specified in Spanish law for the calculation of capital costs is the legal interest rate minus 6 per cent. The reduced rate was established when inflation and interest rates in Spain were above 10 per cent. This does not make economic sense, as current rates are usually below 5 per cent. It may have been more appropriate to use long-term inflation rates or fixed interest rates.

Several studies (Groot & Sánchez Chóliz, 2006; Bielsa et al., 2009) analyzed cost recovery rates for capital investment using Spanish legislation as the theoretical starting point. Inflation was assumed to zero. Based on this assumption, the regulation levy was found to have a recovery rate of 102 per cent for the publicly funded investment in water regulation works spanning a 50 years period. The water use tariff, when analyzed, generated a lower recovery rate of 52 per cent for the total investment in specific water infrastructures over a 25 years period.[9] With positive inflation rates, these percentages are smaller in reality. In Spain, inflation and legal interest rates set by the government have been below 6 per cent since 1991, and thus the assumption that inflation is zero is equivalent to inflation rates considered in the calculation of discounted annual payments.

This study compares the current system of calculating capital costs under the 1985 Water Act with the earlier system, which adopted fixed depreciation rates between 1.5 per cent and 2 per cent. Under the latter scheme, if inflation was not considered, the cumulative payments resulted in a cost recovery rate of 192.6 per cent for the initial investment in developing the infrastructure. For the initial investment in water regulation works, a cost recovery rate of 120.7 per cent was achieved. With positive inflation rates, these percentages are smaller in practice. The present system under the Water Act implies there is an additional subsidization for capital costs not present in the previous system.

Berbel (2005) showed the relevance of the depreciation system used to estimate capital costs and highlighted how the interest rate used affected cost calculations. The costs for the Guadalquivir Basin[10] were calculated using the current Spanish Water Law. The law's provisions adopt a cost recovery formula for calculating water charges using inputs from water agencies. These inputs would include O&M costs, plus the depreciation of the water infrastructure (the depreciation rate is based upon historical costs with no interest rate being applied). When the definition and criteria for cost calculation in the Water Law are applied, a 99 per cent financial cost recovery rate is achieved. When stricter accountancy criteria are applied, which includes depreciating assets at faster rates and the use of a 5 per cent interest rate, financial cost recovery rates are reduced to 71 per cent. Cost recovery rates may be further reduced if we compare the present average tariff in the Guadalquivir River (€0.0178/m^3) with the replacement cost of €0.06/m^3 (full recovery rates for La Breña-2 Dam presently under construction).

[9] If a 3 per cent rate is considered, the level of capital cost recovery for specific infrastructures goes down to 38 per cent (MMA, 2007b).

[10] The Guadalquivir Basin has a large amount of surface storage capacity (large dams and other infrastructure).

The Ministry of the Environment (MMA, 2005, cited in MMA, 2007b) assessed the effects of using different accounting systems for computing capital costs for two basins: the Jucar Basin and the Andalusian Mediterranean Basins (*Cuencas Mediterráneas Andaluzas*). The four following accounting systems (a) to (d) were compared:

(a) the current system used for the calculation of capital costs under the Spanish Water Act (see section 3.3);

(b) the current system without the 6 per cent reduction in the legal interest rate established by Spanish legislation (see section 3.3);

(c) a normal accounting system using a 3 per cent depreciation rate; and

(d) a normal accounting system using a 5 per cent depreciation rate.

When the current system of cost calculation (a) is used for the Júcar Basin, the calculated capital costs are 15 per cent less than the capital cost figure obtained using a normal accounting system with a 3 per cent depreciation rate (c), and 36 per cent less than the capital cost figure obtained using a normal accounting system with a 5 per cent depreciation rate (d). The reduction of the annual legal interest rate to 6 per cent (a) results in an overall reduction of the estimated capital costs by 13 per cent when compared with not applying such reduction (b).

In the case of the Andalusian Mediterranean Basins, when the current system of cost calculation (a) is used, the calculated capital costs are 43 per cent less that the capital cost figure obtained using a normal accounting system with a 3 per cent depreciation rate (c), and 52 per cent less than the capital cost figure obtained using a normal accounting system with a 5 per cent depreciation rate (d). The reduction of the annual legal interest rate to 6 per cent (a) results in an overall reduction of the estimated capital costs by 29 per cent when compared to not applying such reduction (system (b)).

These differences exist because infrastructure in the Júcar Basin is generally older and their life-cycles extend beyond 50 years, meaning they have been fully amortized and the cost of their construction has been recuperated. Many recent infrastructures built in the Andalusian Mediterranean Basins are specific projects with amortization periods set at 25 years, instead of the 50 years established for regulation infrastructures. Therefore, the system used for calculating capital costs results in lower figures when compared to standard accounting procedures (MMA, 2007b).

The estimated subsidy rates to investments in water regulation and transportation infrastructures are relevant in terms of capital costs but, as explained in previous sections of the report, are reduced in terms of total costs of water services to farmers (abstraction plus regulation, transportation and distribution). Wholesale water services (diversion, regulation and transportation of surface resources) only represent about 20 per cent of total costs of water services to farmers.

3.5 ALLOCATION OF COSTS AMONG WATER USERS

Accurately calculating irrigation subsidies depends on how the costs of multi-purpose projects are distributed among multiple users. In Spain, costs associated with the calculation of regulation levy and water use tariff are allocated to basin users based on very simple rules according to the benefit that the user obtains from water use. This has been termed as the "capacity to pay." Capacity to pay is based on the concept that water rates should be linked to the profits of water users.

Articles 301 and 308 of Royal Decree 849/1986 establish the system used for sharing the calculated annuities for both the regulation levy and water-use tariff among the different water users. For the regulation levy, O&M and administration costs are paid by those using the system, while the capital cost component is paid for by both current and future users of the infrastructure projects (dams, main canals). The three cost components of the water use tariff are paid for by those using the infrastructure.

The sharing of costs between different uses is managed by a "stakeholder's agreement" at the basin level. It is administered by the managing boards (*Juntas de Explotación*)[11] of RBAs and takes into account the following variables (Garrido & Calatrava, 2010):

a) Capital cost sharing

- Flood control: the State is deemed to benefit from a flood-prevention service provided by irrigation works. The percentage of the costs for an irrigation project allocated to providing flood control provisions may vary from 20 per cent (the majority of dams in Spain have this allocation) to approximately 70 per cent for some special Mediterranean cases (e.g., the Tous dam) (CHJ, 2004). Nationally, on average, 15 per cent of the total costs for infrastructure projects are assigned to flood control services (Table 3.2)
- Urban water use (domestic and industry) versus irrigation services: normally urban water users have varying levels of water quality supply (for example, daily, seasonal, yearly secured supply), while irrigation water is serviced only when more prior users' demand has been met.
- Energy (hydroelectric, refrigeration)
- Environmental use, including recreation activities, fishing and environmental flows.

b) Recovery of O&M costs: Water agencies have multiple functions, ranging from controlling abstraction and pollution reduction activities, to financing construction of water supply infrastructure. The Guadalquivir Basin Authority, for example, collects 75 per cent of its O&M costs for public infrastructures through tariffs, but the remaining 25 per cent is linked to the cost of environmental services (pollution and flood control, etc.).

TABLE 3.2. COSTS IMPUTED TO FLOOD CONTROL IN EACH BASIN IN 2001

Basin	Cost attributed to flood control services (thousand Euros)	Total costs of water regulation and transportation (thousand Euros)	%
Tajo	1,696	20,919	8.1%
Segura	1,341	2,609	50.0%
Norte	130	1,744	7.5%
Ebro	1,605	34,215	4.7%
Duero	0	24,812	0.0%
Júcar	1,087	10,554	10.3%
CM Andaluzas	5,009	21,545	23.3%
Guadiana	12,307	37,144	33.1%
Guadalquivir	11,212	59,126	18.9%
C.I. Cataluña	650	4,333	15.0%
Total	35,038	217,000	16.1%

Source: MMA (2007b)

[11] The Managing Boards of a RBA are formed by members of the RBA and representatives of water users of a given river, sub-basin or aquifer. Their function is to coordinate the use of water resources and infrastructures.

The methods used to calculate costs attributed to flood control services varies for each basin. For example, in the Tajo Basin it is calculated as a proportion of a project's capital costs, while in the Segura or Guadiana Basins it is calculated as a proportion of the sum of capital costs and O&M costs (MMA, 2007b). In the case of the Duero Basin, there is an assumption that all water controlled by regulation works is used and therefore there is no link to flood control services.

The cost sharing system is based on a set of "equivalence coefficients" linked to the presumed or expected average profit generated by each water service user (irrigation or domestic supplies, for example) (Table 3.3). The expected average profit for irrigation is calculated by each RBA on the basis of the difference between the average net profit per hectare made by irrigators and the average net profit per hectare obtained by non-irrigated agriculture (MMA, 2007b). The system of "equivalence coefficients" differs between basins, and even within basins. The average profit per cubic metre considered for domestic uses ranges between three to five times the values considered for irrigation (Table 3.3).

TABLE 3.3. EQUIVALENCE COEFFICIENTS FOR THE MAIN WATER USES IN INTERREGIONAL BASINS

Basin	Irrigation	Domestic	Industrial	Non-consumptive	Hydropower
Duero	1 l/s	5.41 l/s	5.41 l/s	0.1 l/s	0.1 l/s
Ebro	2 m^3	10 m^3	10 m^3	1 m^3	4 m^3
Júcar	1 m^3	2.5–4 m^3	2.5–4 m^3	1 m^3	0.96 kWh
Guadiana	1 m^3	1–5 m^3	1–3 m^3	0.6 m^3	0.6 m^3
Guadalquivir	0.25–3 m^3	0.75–5 m^3	0.75–5 m^3	0.3 m^3	0.96 kWh
Norte	2 m^3	10 m^3	10 m^3	1 m^3	3.6 kWh
Segura	1 ha	3 ha	3 ha	–	9.600 kw
Tajo	1 m^3	3 m^3	3 m^3	0.2 m^3	15% of the price of kWh

Source: MMA (2007b) using data from interregional RBAs. These coefficients are used to share the costs of water supply among water users. Water costs are shared based on water consumption but corrected using the equivalence coefficients. For example, in the Duero basin, domestic and industrial users in the Duero basin are charged per m^3 5.4 times what irrigation is charged and 54 times what non-consumptive users and hydropower generation are charged. In the Norte basin domestic and industrial users pay 5 times the price paid by irrigation and 10 times the price paid by non-consumptive users, whereas hydropower pays the same for 3.6 kWh generated than farmers for 2 m^3 used.

4. IRRIGATION INFORMATION AND DATA

4.1 COST OF WATER PROVISIONING

4.1.1 VALUATION OF CAPITAL EXPENDITURE OF IRRIGATION INFRASTRUCTURES

4.1.1.1 CAPITAL EXPENDITURE IN WATER ABSTRACTION, STORAGE AND TRANSPORTATION

The Ministry of the Environment provides some data on infrastructure investment for interregional basin authorities at a very aggregate level. The data is not provided on a project-by-project basis or for very long time periods. Table 4.1 shows capital costs estimated by the RBAs using the current legal system for calculating of fees and tariffs (MMA, 2007b). The total cost of capital has been estimated at €110 million for 2001. The costs that are not linked to any specific user and that correspond to the provision of public services are, on average, 13 per cent of this total figure. However, from the MMA report (MMA, 2007b), it was not clear which specific items or public services, such as flood control or river channelling, were not charged. The costs that are not recovered because of the system used to calculate the water use tariff are estimated at 11 per cent of the total costs—equalling approximately €12 million (Table 4.2). On average, 24 per cent of capital costs are not paid for by users and are financed by the national government: 13 per cent that finance the provision of public services and 11 per cent that are simply not recovered because the way fees and tariffs are calculated (and that would be the real subsidy).

The total capital costs calculated in MMA (2007b) include the subsidies to capital that resulted from the system used to calculate the water-use tariff. Subsidies to capital are estimated to be 48 per cent of the investments made in water infrastructures. These subsidies to capital investment are calculated on the basis of investments made in all irrigation infrastructures (the capital costs). The underlying assumption is that all water regulation costs and 52 per cent of specific infrastructures costs are accounted for in these estimates with no correction made for inflation costs.

TABLE 4.1: ANNUAL CAPITAL COSTS OF WATER REGULATION WORKS (ABSTRACTION PLUS STORAGE) AND WATER TRANSPORTATION INFRASTRUCTURE (THOUSAND EUROS)

Basin	Costs imputed by RBAs Before 1986	After 1986	Non-imputed costs	Non-recoverable water-use tariff costs	Total
Tajo	2,356	7,552	0	2,077	11,985
Segura	43	454	0	0	497
Norte	525	302	0	31	858
Ebro	4,261	4,010	4,006	2,570	14,848
Duero (2002)	3,203	4,991	3,304	2,261	13,759
Júcar	2,019	702	2,618	604	5,943
Guadiana	2,174	15,654	0	1,787	19,616
Guadalquivir	2,240	25,821	0	2,857	30,919
CM Andaluzas	1,428	5,823	4,550	n/a	11,800
Galicia Costa	n/a	n/a	n/a	n/a	n/a
CI País Vasco	n/a	n/a	n/a	n/a	n/a
CI Cataluña	n/a	n/a	n/a	n/a	n/a
TOTAL	18,249	65,309	14,478	12,189	110,224

Source: MMA (2007). Period refers to 2001 except Duero (2002).

TABLE 4.2: PROPORTION OF CAPITAL COSTS FOR WATER REGULATION AND TRANSPORTATION INFRASTRUCTURE (IMPUTED, NON-IMPUTED AND RECOVERED)

Basin	Proportion of total costs imputed by RBAs to some use	Proportion of costs that are not imputed by RBAs to any specific use	Proportion of non-recoverable costs because of the system used to compute fees and tariffs
Tajo	82.7%	0.0%	17.3%
Segura	100.0%	0.0%	0.0%
Norte	96.3%	0.0%	3.7%
Ebro	55.7%	27.0%	17.3%
Duero (2002)	59.6%	24.0%	16.4%
Júcar	45.8%	44.1%	10.2%
Guadiana	90.9%	0.0%	9.1%
Guadalquivir	90.8%	0.0%	9.2%
CM Andaluzas	61.4%	38.6%	
TOTAL	75.8%	13.1%	11.1%

Authors' own elaboration from Table 4.1. Period refers to 2001 except Duero (2002).

4.1.1.2 CAPITAL EXPENDITURE IN IRRIGATION WATER DISTRIBUTION

No single study looks at a national level at investments in infrastructure for water distribution carried out by WUAs in Spain. Available data for infrastructure projects are organized by programs that subsidize the development or modernization of irrigated areas. Most older infrastructures distributing irrigated water have been fully amortized, while the majority of those built recently form part of an irrigation development or modernization program.

During the last decade, there have been two public programs funding investments in infrastructure for the distribution of irrigation water. The National Irrigation Plan (PNR-Horizon 2008) and the plan confirmed by Royal Decree 287/2006. The PNR provides investment funding of €5,025 million for the period 2000–2008, and distributed among regions, as illustrated in Table 4.3. Farmers directly pay for 40 per cent of the project investments as noted in section 2.4. The returns to society from these investments can be measured, among other things, in terms of the amount of water saved from irrigation.

TABLE 4.3. PLANNED INVESTMENTS AS PART OF PNR-HORIZON 2008 BY REGION (MILLION EUROS)

Autonomous community	Public investment	Private investment	Total Investment
Andalucía	482.9	322.9	805.8
Aragón	467.9	257.1	725.0
Asturias	0.3	0.3	0.7
Baleares	35.7	18.9	54.7
Canarias	60.9	33.5	94.4
Cantabria	12.4	4.0	16.5
Castilla-La Mancha	264.7	143.3	408.0
Castilla y León	635.5	421.0	1,056.5
Cataluña	189.5	145.0	334.5
Extremadura	179.7	98.9	278.6
Galicia	20.4	12.0	32.4
Madrid	11.2	11.2	22.4
Murcia	131.9	131.9	263.8
Navarra	122.9	78.7	201.6
País Vasco	33.7	16.0	49.6
La Rioja	96.2	66.7	162.9
C. Valenciana	183.9	183.9	367.8
Region not specified	87.6	61.9	149.5
Total	3,017.3	2,007.2	5,024.5

Source: PNR-Horizonte 2008 (MAPA, 2001)

The execution of investments in the PNR was initially slow. MMA (2007b) reports that investment in irrigation infrastructure projects completed in the period from 2000 to 2004 amount to €733.4 million funded by public administrations (national and regional) and agencies (SEIASAS) (Table 4.4). At the end of 2007, all investments corresponding to the Ministry of Agriculture and the SEIASAS had been completed (MAPA, 2008). In fact, the Ministry of Agriculture approved Royal Decree 1725/2007 to establish an additional finance of €87.8 million to finish the projects planned within the PNR. Private funding by farmers amounted to €87.8 million, that is to say, the subsidy level is 50 per cent of the investment and 50 per cent of the costs of the project are directly paid by farmers. This additional finance aims at saving 134 hm^3/year (MAPA, 2008). No data was found about whether the planned investment funded by the regional governments within the PNR have been completed in the designated period.

TABLE 4.4: PUBLIC INVESTMENTS WITHIN THE PNR-HORIZONTE 2008 IN 2000–2004 (THOUSAND EUROS)

				Financing agency
Basin	**Ministry of Agriculture**	**Regional governments**	**SEIASAS**	**Total**
Baleares	6,773	n/a	n/a	6,773
Canarias	30,100	n/a	n/a	30,100
CI Cataluña	1,550	n/a	n/a	1,550
CM Andaluzas	10,771	n/a	n/a	10,771
Duero	138,941	52,692	29,932	221,565
Ebro	74,934	n/a	24,000	98,934
Galicia Costa	854	n/a	n/a	854
Guadalquivir1	3,673	n/a	19	3,691
Guadiana	47,226	n/a	4,644	51,870
Júcar	7,248	80,480	57,309	145,037
Norte	45,502	n/a	n/a	45,502
Segura	40,811	57,182	4,000	101,993
Tajo	11,986	1,378	1,406	14,770
TOTAL	420,367	191,732	121,310	733,409

Source: MMA (2007b) using data from the Ministry of Agriculture.

The second source of funding comes from the Royal Decree 287/2006. The program aims to modernize irrigated areas to reduce the consumption of irrigation water by 1.162 hm^3 per year. The maximum planned level of investment is €2,409 million to be carried out between 2006 and 2007 and to be financed by the Ministry of Agriculture (€712 million), the Ministry of the Environment (€1.161 million) and private users (€536 million). At the end of 2007 investments in projects under completion and financed by the Ministry of Agriculture amounted to €560 million, although it was expected that the planned investments were completed during 2008 (MAPA, 2008). The study was unable to confirm if all the investments under this specific program finance have been carried out.

4.1.2 OPERATIONS AND MAINTENANCE (O&M)

4.1.2.1 O&M COSTS FOR WATER ABSTRACTION, STORAGE AND TRANSPORTATION

The annual running costs of the interregional basin authorities, not including investments in infrastructures, amounted to €172 million in 2001 and €222 million in 2002 (MMA, 2007b). Running costs were approximately 48 to 50 per cent of the total budget for both interregional and intraregional basins.

Table 4.5 illustrates the running costs for water regulation and transportation for the Spanish basins. Approximately 60 per cent of the running costs are linked to the provision of water regulation and transportation services, although large differences exist between basins (Table 4.5).

TABLE 4.5: PROPORTION OF RUNNING COSTS FOR WATER REGULATION AND TRANSPORTATION AS PART OF THE BASIN AUTHORITIES' OVERALL RUNNING COSTS (THOUSAND EUROS)

Basin	Running costs for water regulation and transportation	Total running costs	Percentage
Ebro	19,368	26,108	74.2%
Guadiana	15,684	18,191	86.2%
Norte	885	10,777	8.2%
Segura	2,112	11,908	17.7%
Tajo	8,934	21,420	41.7%
Júcar	4,611	12,490	36.9%
Duero (2002)	11,053	17,760	62.2%
Guadalquivir (2002)	28,207	33,455	84.3%
CM Andaluzas	9,744	17,003	57.3%
Galicia Costa	n/a	n/a	n/a
CI País Vasco	n/a	n/a	n/a
CI Cataluña	43,800	n/a	n/a
TOTAL	144,399	169,112	59.5%

Source: MMA (2007b), based on data from basin authorities. Period refers to 2001 except for Duero (2002) and Guadalquivir (2002).

4.1.2.2 O&M COSTS FOR WATER DISTRIBUTION

There are different sources of data relating to water distribution costs for irrigated areas, all of them based on sample surveys of different irrigation districts (MAPA, 2005; INE, 2004; FENACORE, 2004). These different sources are discussed in detail in MMA (2007b). There are also incomplete data sets provided by RBAs. The different sources of data provided different results in terms of per-hectare costs for water distribution. The Ministry of the Environment's estimates for water distribution costs for agriculture are discussed in section 4.2.1.2, along with revenues collected by WUAs for irrigation water services.

4.1.3 COST OF PROVIDING IRRIGATION GROUNDWATER THROUGH GROUNDWATER-BASED SYSTEMS

When the cost of groundwater provision is incurred by governmental agencies, it is included in the O&M costs (see previous subsection). When this cost is incurred in by WUAs or individual farmers, it is fully paid by them. The Ministry of the Environment (MMA, 2003) estimated the costs of groundwater pumping in the following basins (Table 4.6).

TABLE 4.6: COSTS OF GROUNDWATER ABSTRACTION PER BASIN AND BY END USES

	Pumped water (hm^3/year)		Average pumping cost (Euros/m^3)		Total abstraction cost (Thousand Euros)			Proportion of groundwater abstraction costs that corresponds to irrigation
	Domestic	Irrigation	Domestic	Irrigation	Domestic	Irrigation	Total	
Norte and CI País Vasco	54.1	0.8	0.11	0.18	5,734	133	5,868	2.3%
Duero	48.1	381.6	0.11	0.11	5,102	42,643	47,745	89.3%
Tajo	59.4	116.1	0.09	0.14	5,076	16,684	21,760	76.7%
Guadiana	34.6	462.7	0.06	0.1	2,208	44,036	46,245	95.2%
Guadalquivir	88.4	283.5	0.08	0.13	6,987	38,267	45,254	84.6%
CM Andaluzas	142.1	374.2	0.09	0.15	12,437	56,577	69,014	82.0%
Segura	13.5	437.6	0.12	0.21	1,571	91,513	93,085	98.3%
Júcar	286.6	1,301.7	0.06	0.09	18,287	74,677	92,965	80.3%
Ebro	128.6	157.4	0.07	0.18	9,522	28,827	38,350	75.2%
CI Cataluña	17.0	21.0	0.06	0.11	1,020	2,310	3,330	69.4%
Baleares	87.5	105.3	0.11	0.12	9,625	12,636	22,261	56.8%
Canarias	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Galicia costa	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Spain	959.8	3,641.9	0.08	0.12	77,571	408,305	485,876	84.0%

MMA (2007), based on MIMAM (2003) and data from the Catalonian and Balearic Governments, and own elaboration.

4.1.4 TOTAL FINANCIAL COSTS OF WATER ABSTRACTION, STORAGE, TRANSPORTATION AND DISTRIBUTION

The Ministry of the Environment (MMA, 2007b) provides an estimate of the total costs of water services in Spain for 2002 (reproduced in Table 4.7). Although it is based on incomplete data, it illustrates the importance of each cost component when estimating subsidies at the country and basin levels. In terms of agriculture, the main cost component for the provision of irrigation water is the distribution of water. While water regulation and transportation costs are 6.91 per cent of the total costs for water services and groundwater extraction costs are 8.36 per cent, the cost of distributing irrigated water is 20.3 per cent of the total. Domestic distribution and sanitation costs are 64.42 per cent of the total estimated costs.

TABLE 4.7: ESTIMATED ANNUAL COSTS OF WATER SERVICES IN SPAIN IN 2002 (THOUSAND EUROS)

Basin	Abstraction, storage and transportation of surface water[a]	Groundwater abstraction	Distribution costs for irrigation	Distribution costs for domestic uses	Sanitation	Total
Galicia Costa	11,075	n/a	n/a	81,350	67,567	159,992
Norte	1,744	5,868	n/a	232,267	185,087	424,965
CI País Vasco	n/a	–	n/a	110,198	n/a	110,198
Ebro	34,215	38,350	175,437	121,946	103,150	473,099
CI Cataluña	93,121	3,288	n/a	341,400	309,000	746,809
Duero	24,812	47,745	224,045	96,002	79,904	472,508
Tajo	31,179	21,760	42,807	467,628	–	563,373
Júcar	10,554	92,964	246,608	239,438	238,033	827,598
Guadiana	40,870	46,245	106,200	121,890	–	315,204
Guadalquivir	59,126	81,617	360,667	389,040	168,617	1,059,067
Segura	111,116	93,085	116,862	98,385	71,887	491,335
CM Andaluzas	20,100	69,014	12,453	89,321	84,792	275,679
Baleares	n/a	29,346	n/a	75,000	74,587	178,933
Canarias	n/a	n/a	n/a	199,216	32,675	231,891
TOTAL	437,911	529,282	1,285,079	2,663,081	1,415,300	6,330,652

Source: reproduced from MMA (2007), based on different official data sources.

[a] This figure is the sum of capital costs in Table 4.1 and running costs in Table 4.5, but including the TST and for 2002 instead of 2001. It includes what is referred to in MMA (2007b) as "capital subsidies," meaning the non-recoverable costs from the application of the system for the calculation of the water-use tariff. The figure for the Segura basin includes the costs for the TST and the MCT (Mancomunidad de Canales del Taibilla, the agency providing domestic water services to municipal water utilities).

The figures in the second column (Diversion, storage and transportation of surface water) in Table 4.7 are less than those contained in Table 4.9, as the costs of the Catalonian Water Agency (ACA) are not included. The groundwater extraction costs (third column) are larger than those in Table 4.6 due to the large differences in the groundwater extraction costs data shown in MMA (2007b) for the Guadalquivir River Basin. Reasons for such a discrepancy have not been identified. This suggests that the figures reported in these tables have been calculated with different methodologies and perhaps using different raw data.

The MMA (2007b) does not separate out abstraction, storage and transportation costs for either surface or groundwater users. According to calculations in Table 4.6, approximately 84 per cent of groundwater extraction costs relate to the provision of irrigation water. The MMA (2007b) calculate the total costs for irrigation water services in 2002 at €1,601 million. It is reported to include farmers' payments to WUAs and RBAs, and subsidies to water distribution infrastructures, but it is not clear where such figures are derived from.

4.1.5 COST OF SUPPLYING DISCOUNTED ELECTRICITY

This is not a relevant issue in the case of Spain for subsidy measurement. Preferential electricity tariffs for farming economic activities were eliminated July 1, 2008 in the wake of the process of liberalization of the Spanish electricity market. Discounted electricity is sought from the government by farmers and agricultural organizations but it is currently not subsidized.

4.1.6 COST OF ENVIRONMENTAL EXTERNALITIES

Very few studies have evaluated the environmental, job-market and gross national product (GNP) impacts of establishing tariffs for the use of irrigation water. A recent exception is a study completed by Castellano et al. (2008). The study applied Social Accounting Matrices and Geographical Informational Systems (GIS) in the region of Navarra, generating an environmental value for irrigation water of 0.0601€/m³. The environmental value internalizes some externalities (such as including nutrients losses, nitrogen leaching and other organic contaminants) generated by the consumption of irrigation water. The study concluded the economy of Navarra had the capacity to internalize the environmental and social cost of water consumption. Increasing the current cost of water for agriculture by 0.0375 €/m³, from a base charge between 0.01 and 0.03 €/m³—which is deemed an optimal social price—internalizes 65.67 per cent of the estimated environmental costs linked to water consumption. An increase of 0.0601 €/m³ would guarantee the complete internalization of environmental costs in the study. The increased price of water would allow for the maintenance of regional wealth and a loss of only 200 jobs. It is estimated a price increase of 0.0975 €/m³ would result in a reduction in regional GDP of -0.31 per cent (€16.88 million). Employment would decrease by around 400 jobs.

Other recent studies have generated estimates of willingness-to-pay for water quality increases. Martín-Ortega, Berbel and Brouwer (2009) found that willingness-to-pay for increasing water quality in the Guadalquivir Basin indicated that people would pay an additional 48 to €59.5 million per year (approximately 0.01 to 0.015 € per m³—a low rate for Andalusian water productivity standards).

Maestu and Domingo (2008) evaluated the marginal cost of reducing water consumption every year during the months of April and September in the Jalón River (tributary to the Ebro). It was estimated within a range of 0.5 €/m³, which is greater than the average productivity of the Ebro Basin in irrigated agriculture, but lower than those of the Jalón; however, the methods were not reported. It was found that increased environmental flows should be carefully designed to avoid incurring welfare losses.

These studies have used different methodologies and have evaluated different benefits and costs. Therefore, a direct comparison across findings and results is not warranted. They are presented here for the only purpose of offering examples and reference levels.

A summary table was compiled by Garrido et al. (2010) from a number of published studies to give a range of water values across basins and storage levels (see Table 4.8). These shadow prices represent the marginal value of water used for commercial uses. The sources vary in scope and methods, but the other magnitude of all of them is consistent. The prices vary with the stored amounts available. They are offered here as a comparative basis for the charges and tariffs actually paid by irrigators in Spain (see Table 3.1.)

TABLE 4.8. BLUE WATER SHADOW PRICE BY RIVER BASIN, PROVINCE AND SCARCITY LEVEL (€/M²)

River basin	Provinces	Scarcity level	Scarcity value1 (€/m³)	Volume stored (s) (in % over total storage capacity)
Duero	Ávila, Burgos, León, Palencia, Salamanca, Segovia, Soria, Valladolid, Zamora	1	0	s > 75.2
		2	0.06	63.2 < s < 75.2
		3	0.12	56.4 < s < 63.2
		4	0.361	s < 56.4
Ebro	Álava, La Rioja, Navarra, Huesca, Lleida, Zaragoza, Tarragona, Teruel	1	0.01	s > 80.2
		2	0.06	71.7 < s < 80.2
		3	0.09	71 < s < 71.7
		4	0.15	s < 71
Guadalquivir	Cádiz, Córdoba, Jaén, Sevilla	1	0.005	s > 66.2
		2	0.1	46.2 < s < 66.2
		3	0.25	18 < s < 46.2
		4	0.96	s < 18
Guadiana	Ciudad Real, Badajoz, Huelva	1	0.033	s > 65.8
		2	0.058	57.5 < s < 65.8
		3	0.137	16.8 < s < 57.5
		4	0.678	s < 16.8
Júcar	Castellón, Alicante, Cuenca, Valencia	1	0.07	s > 33.3
		2	0.19	23.2 < s <33.3
		3	0.35	18.6 < s <23.2
		4	0.52	s < 18.6
Segura	Murcia, Albacete	1	0.12	s > 22.5
		2	0.27	19.7 < s <22.5
		3	0.52	12.1 < s < 19.7
		4	0.61	s < 12.1

Source: Garrido et al. 2010, based on Albiac et al. (2006), Calatrava and Garrido (2005), Iglesias et al. (2003; 2007), Gómez-Limón and Berbel (2000), Pulido-Velázquez et al. (2008) and Varela-Ortega (2007); MMA (2008).

4.2 GOVERNMENT OR SUPPLIER REVENUE COMPONENT

4.2.1 REVENUE REALIZED ON THE SALE OF WATER

4.2.1.1 REVENUE FROM WATER ABSTRACTION, STORAGE AND TRANSPORTATION

Table 4.9 illustrates the revenue and cost recovery rates for water regulation and transportation services provided by RBAs (calculated by MMA, 2007b). The cost recovery rate is nearly 82 per cent. Water regulation and transportation costs are approximately 6.9 per cent of the total costs for water services calculated by the Ministry of the Environment (Table 4.7). This estimate includes subsidies to capital generated by the calculation of the water use tariff, but it does not consider inflation.

Figures in Table 4.9 are not separated by water uses. According to the MMA (2007b), total payments to the RBAs by farmers in exchange for water regulation and transportation services amounted to €98.27 million. This is 24.4 per cent of the total revenue generated by these services. Taking into account that, on average, agriculture uses 70 to 80 per cent of the total water consumed, the allocation of costs between uses clearly favours irrigation over other uses. This is due to irrigation being allocated a smaller proportion of the costs than their level of usage, as explained in section 3.5.

TABLE 4.9: REVENUE AND COST RECOVERY RATES FOR WATER REGULATION AND TRANSPORTATION SERVICES (THOUSAND EUROS)

Basin[a]	Revenue	Costs of water regulation and transportation	Cost recovery (%)
Galicia Costa (2004)	0	11,075	0%
Norte (2002)	1,389	1,744	79.7%
CI País Vasco	n/a	n/a	—
Ebro (2001)	24,899	34,215	72.8%
IB Cataluña (ACA) (2002)	37,739	54,853	68.8%
IB Cataluña (Other agencies) (2002)	92,004	93,121	98.8%
Duero (2002)	14,535	24,812	58.6%
Tajo (2001)	29,619	29,619	100.0%
Júcar (2001)	6,100	10,554	57.8%
Guadiana (1998-2002)	32,287	40,870	79.0%
Guadalquivir (2003)	53,480	59,126	90.5%
Segura (2002)	100,135	111,116	90.1%
CM Andaluzas (2002)	10,772	21,545	50.0%
Baleares	–	–	–
Canarias	–	–	–
Total	402,958	492,649	81.8%

Source: MMA (2007b)

[a] The data refers to the year indicated in brackets.

Among the regional water offices in Spain, the ACA has been at the forefront of evaluating the cost recovery rates in the agricultural sector. A review of this example is contained in Box 1.

BOX 1: COST RECOVERY RATES IN THE AUTONOMOUS COMMUNITY OF CATALONIA

The Catalonian Water Agency (ACA, 2008) provides more detailed data on cost recovery for water supply services in Catalonia, including those provided by the ACA to water users in the Catalonian part of the Ebro Basin. The data is summarized in Table 4.10. The other agencies providing wholesale supply are barely subsidized. The ACA recovers 69 per cent of its costs through water taxes and other revenue sources. The €113.7 million not recovered take the form of subsidies provided by the Spanish Government (€67.4 million) and through external debt (€46.3 million). These data do not include the costs of water distribution, and are not split by water users.

TABLE 4.10. COST RECOVERY FOR WATER SUPPLY IN CATALONIA IN 2003 (MILLION EUROS)

Water supplier	Financial costs	Revenue	Revenue minus costs	Environmental costs (wastewater treatment)	Cost recovery rate w/o environmental costs (%)	Cost recovery rate incl. environmental costs
ACA (Catalonian Inner Basins)	332.8	229.5	103.3	120.0	69.0%	50.7%
ACA (in Ebro basin)	25.1	14.7	10.4	9.0	58.5%	43.0%
Subtotal ACA	357.8	244.1	113.7	129.0	68.2%	50.2%
Other agencies	93.7	92.5	1.2	0.0	98.8%	98.8%
Total	451.5	336.7	114.8	129.0	74.6%	58.0%

Source: ACA (2008). Water distribution costs are not included.

4.2.1.2 REVENUE FROM WATER DISTRIBUTION

The Ministry of the Environment (MMA, 2007b) provides specific data from multiple sources for the subsidization of water distribution. There are significant differences in the size of subsidy according to the data source used. The following section contains a series of tables outlying the revenue and cost recovery rates for water distribution.

The official estimates, which are based on data provided by RBAs in their WFD reporting on the Economic Analysis of Water Uses (Table 4.11), show an average cost recovery rate of 87.10 per cent across Spain. Data for some important river basins is not shown. The overall "costs" for irrigation water distribution services in Spain is smaller than that reported in Table 4.7 as data on some basins (e.g., Segura) was not available to be included in the estimate.

TABLE 4.11: COSTS, REVENUE AND COST RECOVERY RATES FOR IRRIGATION WATER DISTRIBUTION (MILLION EUROS)

Basin	Costs	Revenue	Cost recovery (%)
Galicia Costa	n/a	n/a	n/a
Norte	n/a	n/a	n/a
IB País Vasco	n/a	n/a	n/a
Ebro	175.43	156.14	89.0%
IB Cataluña	n/a	n/a	n/a
Duero	224.05	192.90	86.1%
Tajo	n/a	n/a	n/a
Júcar	246.61	209.62	85.0%
Guadiana	106.20	57.45	54.1%
Guadalquivir	360.67	352.37	97.7%
Segura	n/a	n/a	n/a
CM Andaluzas	12.45	11.47	92.1%
Baleares	n/a	n/a	n/a
Canarias	n/a	n/a	n/a
Total	1,125.41	979.95	87.1%

MMA (2007b), using data from the basin authorities' reports for the WFD.

The ACA (2008) provides data on costs, revenues and subsidies for WUAs in Catalonian Internal Basins (IB Cataluña) in 2003. Revenues were €9.94 million, costs were €9.99 million and capital subsidies from the regional government were €16.6 million. Costs figures include the costs of acquiring water. The official cost recovery calculation provided (99.5 per cent) does not include capital subsidies.

Table 4.11 was based on incomplete data. MMA (2007b) shows another subsidy estimate based on data from a study by the Ministry of Agriculture (MAPA, 2005), which looked at irrigation costs. The study provides data on the costs of irrigation for farmers, excluding on-farm and districts' water costs (Table 4.12). These costs include payments made by the farmers in the form of fees and tariffs, and the WUA's costs (*derramas*).

TABLE 4.12: FARMERS' PAYMENTS TO WUAS FOR THE WATER REGULATION, TRANSPORTATION AND DISTRIBUTION SERVICES IN INTERREGIONAL BASINS IN 2002 (EUROS PER HECTARE AND M³).

Basin	Groundwater		Surface water			Total	
			Per ha				
	Per ha	Per m³	Distribution	Fees & tariffs	Per m³	Per ha	Per m³
Duero	499.7	0.095	19.9	46.1	0.013	230.8	0.044
Ebro	828.9	0.149	49.1	12.3	0.011	113.1	0.020
Guadalquivir	743.8	0.150	101.2	69.9	0.035	399.6	0.081
Guadiana	231.6	0.049	19.1	102.5	0.025	187.9	0.039
Júcar	383.5	0.074	80.7	16.2	0.019	282.6	0.055
Segura	789.2	0.163	33.8	150.6	0.038	463.8	0.096
Tajo	541.2	0.104	36.5	67.0	0.020	199.3	0.038
Total	500.2	0.091	49.7	56.4	0.021	263.5	0.051

MAPA (2005)

Using data from the MAPA (2005), the MMA (2007b) calculated the total costs paid by farmers to RBAs and WUAs and the level of government subsidization of infrastructures (Table 4.13). The average level of subsidy is 4 per cent. This means farmers pay on average 96 per cent of the cost for water services and subsidization of investments in infrastructures for interregional basins.

TABLE 4.13: FARMERS' COST FOR WATER SERVICES AND SUBSIDIZATION OF INVESTMENTS IN INFRASTRUCTURES FOR INTERREGIONAL BASINS IN 2002 (THOUSAND EUROS)

Basin	Costs for groundwater	Costs for surface water	Total costs paid by farmers	Subsidies received for infrastructures (PNR)	Total costs	Subsidy rate (%)
Duero	79,941	17,158	97,099	11,078	108,177	10.2%
Ebro	27,693	34,536	62,229	4,947	67,176	7.4%
Guadalquivir	174,785	75,757	250,542	185	250,726	0.1%
Guadiana	58,428	20,186	78,615	2,593	81,208	3.2%
Júcar	83,797	11,472	95,269	7,252	102,521	7.1%
Segura	87,632	24,130	111,762	5,100	116,862	4.4%
Tajo	24,994	17,074	42,069	739	42,807	1.7%
Total	537,271	200,313	737,58	31,893	769,477	4.1%

Source: MMA (2007b), based on data from MAPA (2005), INE (1999) and unpublished data on the PNR. The costs paid by farmers include the regulation levy, the water-use tariff and the charges paid to WUAs (*derramas*).

However, the cost recovery and subsidy rates figures in Tables 4.11 and 4.13 can be misleading for several reasons. First, they are not appropriate rates for cost recovery of water services, as they include payments made to RBAs in exchange for water regulation and distribution services, but do not include the government subsidies provided to support these services.

The WUA's distribution costs, the fees and tariffs paid to RBAs and the estimated total costs paid by farmers for distribution of water and the recalculated subsidy rate have been separated out in Table 4.14. It can be observed that the increase in the subsidy rates is small and that the average subsidy rate for all the interregional basins does not reach 5 per cent. This is a result of payments for water regulation and transportation services being small in relative terms.

TABLE 4.14: FARMERS' COST FOR DISTRIBUTION WATER SERVICES AND SUBSIDY LEVEL FOR INTERREGIONAL BASINS IN 2002 (EUROS)

Basin	Costs for groundwater	Distribution costs for water	Fees and tariffs costs for water	Total costs paid by farmers for distribution services	Subsidies received for infrastructures (PNR)	Total distribution costs	Subsidy rate (%)
Duero	79,941	5,168	11,990	85,109	11,078	96,187	11.5%
Ebro	27,693	27,612	6,924	55,305	4,947	60,252	8.2%
Guadalquivir	174,785	44,820	30,937	219,605	185	219,790	0.1%
Guadiana	58,428	3,173	17,013	61,602	2,593	64,195	4.0%
Júcar	83,797	9,557	1,916	93,354	7,252	100,605	7.2%
Segura	87,632	4,426	19,704	92,058	5,100	97,158	5.3%
Tajo	24,994	6,016	11,057	31,011	739	31,750	2.3%
Total	537,271	100,772	99,541	638,044	31,893	669,937	4.8%

Source: Authors' own elaboration from Tables 4.12 and 4.13.

As commented above, these subsidy estimates are quite conservative, as they do not explicitly include subsidies to capital infrastructure for water storage and transportation (only payments from users for these services are included). A review of reports provided by RBAs show only a few examples where such costs have been included in the analysis. Their inclusion provides a more realistic figure for the subsidies provided in those basins. The cost recovery figures for irrigation services in the Duero and Guadalquivir Basins are shown in Table 4.15 and 4.16. Subsidy rates are greater than those in Table 4.14.

TABLE 4.15: COST RECOVERY FOR IRRIGATION WATER SERVICES IN THE DUERO BASIN (THOUSAND EUROS)

	Total costs	Revenue	Capital subsidies	Cost recovery	Subsidy rate
Distribution in IIDD	99,394	61,090	38,304	0.61	0.39
Storage and transportation	14,774	9,849	4,925	0.67	0.33
Total	114,168	70,939	43,229	0.62	0.38

Source: DHD (2005)

TABLE 4.16: COST RECOVERY FOR IRRIGATION WATER SERVICES IN THE GUADALQUIVIR BASIN IN 2003 (THOUSAND EUROS)

	Total costs	Revenue	Capital subsidies	Cost recovery	Subsidy rate
Distribution in IIDD	331,222	323,729	7,493	0.977	0.023
Storage and transportation	34,336	29,419	4,917	0.857	0.143
Total	365,558	353,148	12,410	0.966	0.034

Source: DH Guadalquivir (2005)

The second reason why these estimates may be misleading is that the costs of groundwater include pumping costs that are not specifically "distribution services." Nevertheless, they can be considered here as long as they are not accounted for again separately.

Finally, those subsidies included in Tables 4.13 and 4.14 correspond to 2002. It is likely than in other years the level of subsidization will change. Subsidies to capital included within the PNR vary each year affecting subsidy estimates and cost recovery rates. Table 4.17 shows how the cost recovery rate estimated by the Segura RBA for 2001 and 2005 varies significantly based on the annual amount of public subsidies to water distribution infrastructures. It should be noted that the estimates in Tables 4.13 and 4.14 are conservative as capital subsidies for water storage and transportation are not included.

TABLE 4.17: COST RECOVERY RATES FOR IRRIGATION IN THE SEGURA BASIN IN 2001 AND 2005 (THOUSAND EUROS)

	Total costs	Revenue	Capital subsidies to water distribution	Cost recovery	Subsidy rate
2001	159,312	144,804	14,508	0.91	0.09
2005	194,366	164,086	30,280	0.84	0.16

Source: CHS (2007)

4.2.1.3 THE CASE OF THE TAJO-SEGURA TRANSFER

A case study of the Tajo-Segura Transfer (TST) project has been carried out as its one of the largest multi-district projects in Spain. It is a recent project with a substantial amount of information available on it. The TST is managed by a specific State agency and provides an interesting example of measuring capital costs. Table 4.18 shows the total amount of funds invested in the construction of transfer and the post-transfer infrastructures[12] from the start of the project. Investment in this project amounted to nearly €269 million (present day value 2010, and not corrected for inflation) between 1970 and 2001.

TABLE 4.18: INVESTMENTS IN THE TST AND POST-TRANSFER TRANSPORTATION INFRASTRUCTURE (THOUSAND EUROS)

	1970–1980	1981–1990	1991–2001	Total
Transfer	68,777	54,842	1,330	124,948
Post-transfer (secondary distribution services)	15,046	110,879	18,068	143,993
Total	83,823	165,721	19,398	268,941

Source: CHS (2005)

[12] The post-transfer infrastructure is the distribution system used to transport water from the dams in the Segura basin where water from the transfer is stored to its different destinations.

Table 4.19 shows the capital costs for 2002 calculated by the main board of the TST. These capital costs are representative of the average annual costs of the infrastructure, and have been calculated based on the investment incurred in building the TST infrastructures. The TST has a maximum capacity of 1,000 hm^3 and presently uses only 600 hm^3 per year of the available capacity (1,000 hm^3 per year). As a result only 60 per cent of the project costs are considered in the calculation of capital costs, reflecting the level of usage. The remaining 40 per cent of capital costs have never been recovered by the State.[13] A reduction in capital costs based on the level of usage is not considered when calculating the capital costs of the post-transfer infrastructures. If all users of water supplied by the TST are considered when estimating the level of cost recovery through the application of the water-use tariff a 51 per cent rate is achieved. Agricultural users pay 45.5 per cent of the shared cost of capital attributed to the provision of irrigated water.

TABLE 4.19: CAPITAL COSTS FOR THE TST AND POST-TRANSFER (SECONDARY WATER DISTRIBUTION) INFRASTRUCTURES IN 2002 (THOUSAND EUROS)

Type of user	Capital costs imputed to each type of user (recovered through tariffs)	Total capital costs for each type of user	Percentage of total capital costs for each user type that are imputed to them
Irrigation post-transfer users	4,936	10,838	45.5%
Domestic post-transfer users	6,555	11,921	55.0%
Other domestic users	750	1,230	61.0%
Total	12,241	23,989	51.0%

*Source: Authors' analysis from data drawn from the Confederación Hidrográfica del Segura (CHS, 2005)

Table 4.20 shows the administration, operation and maintenance costs for the TST in 2002. The available data only includes those for post-transfer users (that means the transfer's wholesale and retail customers) but not other domestic users that take water but do not use the post-transfer infrastructures. The figure used in the calculation for components 1 and 2 in the water-use tariff is therefore slightly greater than the €36 million shown in Table 4.20, approximately €41 million (CHT, 2005).

TABLE 4.20: O&M AND ADMINISTRATION COSTS FOR THE TST IN 2002 (THOUSAND EUROS)

	Fixed costs	Variable costs	Total (fixed + variable costs)
Irrigation post-transfer users	7,911	16,915	24,826
Domestic post transfer users	3,605	7,594	11,200
Other domestic users	n/a	n/a	n/a
Total	11,516	24,509	36,026

Authors' own elaboration with data from CHS (2005). Only data for post-transfer users is available from government reports.

[13] It could be argued whether the users of the TST should pay for the excess capacicity with which the TST was built by the government or whether such costs should be considered a sunk cost and therefore paid by the government because of the erros made when designing the infrastructure.

Table 4.21 shows the revenues from tariffs for the TST in 2002. The available data only includes post-transfer users, who paid €47.5 million through levies and tariffs in 2002. A graph generated by CHT (2005) estimates the total revenue figure for all users to be close to €50 million. Subsidies provided to irrigation in 2002 amounted to €5.9 million with a subsidy rate of 16.56 per cent.

TABLE 4.21: REVENUES, SUBSIDIES AND COST RECOVERY FOR THE TST IN 2002 (THOUSAND EUROS)

	Total costs	Revenue	Subsidies	% subsidy	% cost recovery
Irrigation post-transfer	35,665	29,760	5,905	16.6%	83.4%
Domestic post-transfer	23,120	17,752	5,368	23.2%	76.8%
Other domestic	n/a	n/a	n/a	n/a	n/a
Total	58,785	47,512	11,273	19.2%	80.8%

Source: Authors' estimates using data from CHS (2005). Only data for post-transfer users is explicitly available from government reports. Total costs include capital, O&M and administration.

4.2.2 OTHER POTENTIAL SOURCES OF REVENUE

Other sources of revenue are considered in the GSI's methodology. They include the sale of hydropower, electricity for irrigation pumping and the imposition of pollution taxes. These sources of revenue are not relevant in the case of Spain. For example, hydropower plants belong to private enterprises, which pay their fees and tariffs to the RBAs. These tariffs and fees are already computed in the sale of water. The sale of electricity for irrigation is carried out by private enterprises and not by the State. Also, pollution taxes are not imposed on Spain's irrigation sector.

5. AGGREGATE SUPPORT FOR IRRIGATION

5.1 TOTAL SUPPORT TO THE IRRIGATION SECTOR

Based on the data contained in the previous Tables, an estimate of the total support provided in the most important basins is contained in Table 5.1.

TABLE 5.1: AGGREGATE SUPPORT TO THE IRRIGATION SECTOR IN INTERREGIONAL BASINS

	Regulation and transportation		(3) Water distribution subsidy rate (%) Table 4.14	(4) Subsidy rate (%)*	(5) Actual price (€/m³) Table 4.12	(6) Full-cost rate (€/m³)	(7) Subsidy (€/m³) (6)-(5)	(8) Total subsidy (Million Euros)**
	(1) Imputed costs (%) Table 4.2	(2) Cost recovery (%) Table 4.9						
Ebro	55.71	72.77	8.21	0.66	0.02	0.05	0.03	119.05
Duero	59.55	58.58	11.52	0.72	0.04	0.12	0.08	188.54
Tajo	82.67	100	2.33	0.17	0.04	0.05	0.01	7.29
Júcar	45.79	57.8	7.21	0.89	0.05	0.32	0.27	429.90
Guadiana	90.89	79	4.04	0.29	0.04	0.05	0.02	11.53
Guadalquivir	90.76	90.45	0.08	0.19	0.08	0.10	0.02	65.95
Segura	100	90.12	5.25	0.09	0.10	0.11	0.01	3.13
							Total	825.38

4) =((100-(1))/100+(100-(2))/100)((100-(3))/100))
**Based on estimated total water used in each basin (see Table 2.4), considering only surface waters

Subsidies to irrigated agriculture in the basins listed in Table 5.1 amount to €825 million per year. This estimate may be considered conservative for a number of reasons. First, it does not include some intraregional basins where irrigation is important and may receive significant government support (e.g., the Catalonian Internal Basins and the Mediterranean Andalusian Basins). Subsidies to irrigation can also be estimated for the Mediterranean Basins of Andalusia (€18.5 million per year based on data from tables 4.2, 4.9 and 4.11) and the TST (€5.9 million, Table 4.21). Subsidy data for irrigation in Catalonian Internal Basins was not available (total subsidies to the water sector in Catalonian IBs are estimated at €115 million). Irrigation subsidies will likely be reduced in absolute terms for the rest of the northern intraregional basins. The seven interregional basins in Table 5.1 account for 91 per cent of water demand and 89 per cent of the irrigated area in Spain. Based on the assumption that the average subsidy per cubic metre in intraregional basins is similar than in interregional basins, subsidies to irrigation in Spain would amount to €906 million.

The second reason is that subsidies to capital costs in storage and transportation infrastructures are calculated without taking into account inflation. However, it considers groundwater costs in the calculation of subsidies but not the volumes of groundwater consumed, which may perhaps reduce the total subsidy figure. It is difficult to obtain a more accurate figure given the available data, the methodology used by Spanish authorities to calculate costs and subsidies, and the different criteria used by each RBA.

The MARM has recently been working on a report[14] based on the analysis of the budgets provided by the RBAs and water agencies, but it has not yet been published. This report shows a provisional estimate of the annual subsidization to water storage and transportation services for all uses of 84 per cent (€680 million). Subsidies to irrigation water distribution are estimated to be €790 million per year (48 per cent subsidy rate). In total, the provisional estimate for subsidies to irrigation is €1,120 million per year (a 55 per cent subsidy rate). This includes all the investments related to the PNR. This is clearly an overestimate, because part of the costs computed in the budgets are not related to providing water supply services but to other services such as "protection of the landscape" or "urban water management." These other costs could be imputed to other commercial uses.

To reinforce the validity of our estimate, we have made an alternative rough calculation of the subsidies for the whole country:

(a) Subsidies to water abstraction, storage and transportation: €49 million per year

- Subsidies to capital costs for water regulation: €27 million per year for all users (Table 4.1); €21 million per year for irrigation (sharing based on percentage of water use)
- O&M and administration costs for water regulation (Table 4.5): No subsidies.
- Groundwater extraction costs (Table 4.5): No subsidies
- Tajo-Segura Transfer (Table 4.20): €11 million per year
- Correctly accounting for inflation in the calculation of the water use tariff and regulation levy would imply that the calculated annual capital costs for water regulation would increase by 15 per cent (according to calculations for the Júcar Basin, section 3.4.3). That is, it would imply an additional subsidy of €17 million per year (15 per cent of €110 million per year).

(b) Subsidies to capital costs for distribution infrastructures through the PNR: €3,105 million on a 8-year period (Table 4.3 and the paragraph below that table); that is an average subsidy of €388 million per year. We have assumed that society does not receive anything in compensation for subsidies to investments in water distribution (e.g. water savings), which is certainly a limitation.

(c) Subsidies to capital costs for distribution infrastructures through the Royal Decree 287/2006 gave €1,873 million over 3 years to finance emergency investments in water distribution. That makes an additional €624 million per year for those 3 years, or €234 million per year if we consider the 8 years of the PNR. Once again, we have assumed that society does not receive anything in compensation for subsidies to investments in water distribution (e.g., water savings).

Summing up (a), (b) and (c), we obtain a total rough average subsidy estimate of €671 million per year (49 + 388 + 234).

(d) The subsidy component that would be missed, and that could explain the difference with the subsidy estimate in the report, refers to cross-subsidies among water users. Such subsidy would be considered only if we assume that the cost-sharing system based on the benefit arising from water use is not fair, and that another system based exclusively on water consumption should be used instead. We have no data available to compute exactly the subsidy estimate arising from the equivalence coefficients in Table 3.3. In any case, such coefficients affect payments made in exchange for water regulation

[14] MMA. (2009). *Análisis de presupuesto y estimación de costes e ingresos por la prestación de los servicios de agua en España*. Versión 1.2. Unpublished draft report. Madrid: Ministerio de Medio Ambiente, 2009.

and transportation services (€403 million per year for all water users, according to Table 4.9). Let us assume that irrigation should pay roughly 80 per cent of such costs on a per-water consumption basis. Let us assume, based on Table 3.3, that farmers pay, on average, one-fourth of what urban users pay. Then farmers should pay €320 million per year and are paying €80 million per year. That would imply an additional subsidy of €240 million per year.

Summing up this last value (d), the subsidy estimate would be €911 million per year (671 + 240), which is a similar estimate to the €906 million calculated from the data in Table 5.1.

5.2 SUBSIDY INTENSITY

Irrigation subsidies are not directly linked to specific crops. Subsidies to the capital costs of water storage and transportation are generated using formulae for computing costs and specific criteria for allocating these costs between users. For capital subsidies to investments in water distribution infrastructure, these are provided to irrigation districts and to specific irrigation projects, not to specific crops. All crops grown in a given area are subject to a similar degree of subsidization in absolute terms. In relative terms, irrigation subsidies benefit the less profitable crops, which in general are also less intensively produced. In irrigated areas where tariffs have volumetric components, subsidies to water storage and transportation costs favour more water-demanding crops.

The irrigation sector uses a variable proportion of available water resources in Spain. While the northern basins use less than 10 to 15 per cent, the largest irrigation basins use between 60 and 90 per cent of all the available water.

Water productivity varies significantly across basins and even within basins. High-value crops are primarily found in the southern and southeastern basins. However, there are also extremely valuable water uses in the other basins. For example, the wine sector and speciality crops can achieve very high productivity levels, even in the northern basins where these are marginal crops.

The technological and engineering factors connected to farmers' water use are also becoming crucial. At the irrigation district level, the government has completed modernization and rehabilitation projects in old districts totalling 1.3 million hectares (Barbero, 2005). In most cases, farmers have been requested to pay up to 50 per cent of the cost, although they were given preferential treatment in that they could borrow it back in the form of 50-year loans. These projects entailed, in many cases, a complete refurbishment of the irrigated districts, converting nineteenth-century design into twenty-first-century infrastructures. At the farm level, drip irrigation technology is now the most common in Spain, occupying more than 1.3 million hectares in 2005.

5.3 SCENARIOS

It is difficult to formulate future scenarios. The farm sector is politically powerful and governments are reluctant to address the issue of sustainable water consumption. The farm sector in the EU is undergoing a period of economic stress and is threatened by increasing international markets' liberalization and growing input prices (fuel, fertilizers and energy). A new extremely sensitive EU regulation, forbidding the use of many active matters (pesticides, weed killers) for crop protection, has added further challenges to the irrigator sector. Consequently, policy-makers are reluctant to introduce measures, such as increasing the cost of water provision, which would decrease the profitability of the sector.

Furthermore, this report has shown that while capital costs are highly subsidized, O&M costs are subsidized at a much lower rate. Spain needs to address the need for more efficient water-management strategies, and to cope with droughts and water scarcity, more so than to improve the cost recovery rates. While it is generally stated that if water were accurately priced, consumption patterns and cropping decisions would improve, in a semi-arid and water-stressed context, this is difficult to put into practice for various reasons. First, prices would need to vary significantly with time and geographically to be effective and responsive to scarcity situations. Nowhere in the world do public agencies have the capacity to alter their water rates to the extent that would be needed to work as efficient water allocation mechanisms. Secondly, it is perhaps easier to manage the allocations and introduce water-market arrangements to respond to water scarcity. Water laws provide sufficient instrumental menus for administrators to work with water users to cope with water shortages.

Since the EU's WFD only recommends that member states should take into account the "polluter-pays" principles and full cost-recovery prices, Spain's present position on irrigation water prices may not change significantly in the coming years. There seems to be other more pressing needs in the water sector, which will require political will and financial resources as well.

5.4 CONCLUSIONS

When analyzing the subsidization of irrigation water supply in Spain, a clear distinction must be made between capital and O&M costs, both in the way the cost components are evaluated and in the resulting subsidization rates. Another important distinction relates to surface water wholesale retail services (abstraction, storage and transportation), groundwater extraction and water distribution to farmers. Surface water wholesale activities are carried out by the government through RBAs and other national and regional water agencies. Groundwater extraction is done by users themselves and water distribution to farmers is carried out by water user associations.

O&M and administration costs are easier to calculate than capital costs. O&M and administration costs of surface water abstraction, storage and transportation were found to be fully recovered by the government through fees and tariffs paid by water users. O&M and administration costs of surface water distribution are fully paid by farmers. The costs of groundwater extraction are also fully paid by farmers. However, there is an implicit subsidy in the fact that farmers are not paying the full cost of non-renewable groundwater extraction if the associated environmental externalities are not being accounted for through a water abstraction tax.

Subsidization of irrigation water supply in Spain relates to the capital costs of supplying surface water. Capital costs of abstraction, storage and transportation of surface water are partly subsidized and the full costs are not recovered from users. There are several sources of subsidies to capital costs. Assuming the method selected to value existing irrigation assets is adequate (as implicitly recognized by the EU as acceptable), the main source of subsidization comes from the inadequate incorporation of inflation in the calculation of annual capital costs being recovered. Inflation has in practice not been considered in subsidy estimates at all during the last decade.

Some studies have assessed on a theoretical basis the cost recovery system for setting fees and tariffs established under the 1985 Spanish Water Act. These studies show that, with a hypothetical inflation rate of zero, the regulation levy generates a cost recovery rate of 102 per cent for all public investment in water regulation works, while the application of the water use tariff generates a cost recovery rate of 52 per cent for the total funds invested in individual water infrastructures. With positive inflation rates, these cost recovery percentages are smaller in practice.

The other main source of subsidization stems from the government's arbitrary method of defining projects as being of "general interest" or "public interest" and the criteria used to allocate costs among water users. Water and Agricultural Authorities are able to allocate a percentage of the costs for water provision to specific uses depending on whether it corresponds to "the interest of the public." The resulting percentage borne by tax payers is attributed to public services such as flood prevention or irrigation projects deemed to be of "interest to society." The allocation of costs for water provisioning among users is also based on the users' "capacity to pay" rather than on the volume of water used.

For capital costs of diversion, storage and transportation of surface water, subsidization rates vary across projects and basins. They are generally set at a rate ranging from between 30 per cent to 50 per cent of the capital costs. Cost recovery rates for O&M are much higher and easier to calculate. They range from 90 per cent to 99 per cent of O&M costs.

Regarding the capital costs of water distribution infrastructure, it is difficult to generate estimates for subsidy rates. Several programs have financed the improvement of water distribution infrastructures during the last decade in exchange for water savings and reductions in water right allotments. Public investments since 2000 amount to €4,978 million, whereas private farmers' contributions amount to €2,631 million. However, no data is available for other investments in water distribution infrastructure without public financing.

In total, subsidies to irrigated agriculture are over €906 million per year (as this report has evaluated under conservative assumptions), and below €1,120 million per year (a total 55 per cent subsidy rate); this the latter is the Ministry's own evaluation, which this study finds may overestimate subsidies with respect to using the "Net Cost to Supplier" approach.

Although surface water diversion, storage and transportation services are highly subsidized, in relative terms the level of subsidization is not as large when compared to water distribution and groundwater pumping, as their costs are comparatively small. In fact, subsidies to these storage and transportation services for irrigation have been estimated at €49 million per year (or €289 million if we consider that the system for cost allocation among users should be based on water use and not user's benefit). However, the increasing use of more expensive water sources like desalinization or treated wastewater may increase the costs of water abstraction.

Our subsidy estimate above can only be considered as representative of the last decade. A large share of the subsidy estimate corresponds to distribution infrastructure (€622 million per year on average for the last eight years). They correspond to specific programs that will be more modest in terms of public funding in the coming years.

Administration and governance of irrigation in Spain has multiple levels and involves a variety of institutions. In April 2008, the Environment and Agriculture Ministries were merged, providing an opportunity to pursue more integrated policies in a less adversarial mode between ministries. Regardless of national politics, the communal management regime of Spain's irrigation communities offers opportunities for adaptive management, focusing on the sustainability of irrigation systems. The role of communities to promote the modernization of their infrastructure cannot be sufficiently overstated: they mediate between the administrations and tens of thousands of farmers using irrigated water. The institutional arrangements that are in place, combined with modernization programs and significant private investments in water technologies, have contributed to the growth of productive land.

The following conclusions are based on the study's findings:

- Public finances of irrigation projects should be offered on a project basis, including cash-flows, from the inception of the project through its entire life. Financial records of publicly funded projects should be accessible and downloadable in spreadsheet format.
- In cases of multiple-use infrastructures, cost-attribution criteria should be defined on the actual distribution of benefits.
- Historical costs can be considered sunk costs, and provide means for ex-post profitability analyses. New irrigation projects, including modernization and rehabilitation projects, should have available detailed financial and economic information. For the moment, these financial reports are not available to the general public in manageable format for all projects.
- Historical costs must be attributed to past policies and political priorities. The global context in which agriculture operates now is very different. Subsidies' studies are politically meaningful and relevant if they can examine original project proposals and aims.
- Developing new irrigation areas at subsidized costs is difficult to justify.
- Subsidies used to modernize old and traditional irrigated areas are perhaps necessary and even desirable, as modernization may save water that would be available for other needs. If they entail large costs that farmers themselves cannot incur, they need to provide real public services, such as lower diversions of water and/or more accurate water pollution control.
- Data used in the report is considered reliable and accurate, although very aggregated and sometimes outdated.
- In the absence of more detailed and updated national-level data, further research would be necessary. A case-study approach using data for specific recent infrastructure projects would allow a deeper look into subsidization to irrigation water supply and into the GSI's methodology.
- This study did not set out to establish a causal relationship between subsidies and environmental degradation. The literature and previous studies show that low prices to farmers generate overconsumption of water and consequently environmental problems. And yet, subsidies are consequences of more general irrigation, land-use and agricultural policies. Focusing on and evaluating water subsidies inform the debate, and put agricultural production against other costs and benefits, including those related to environmental services. There is also an important body of literature that suggests that the potential benefits of water pricing to irrigation have been overrated (Molle & Berkoff, 2007).
- The financial records of irrigation projects should be kept with similar criteria as those used in other collective infrastructures.

6. OBSTACLES FACING SUBSIDY ESTIMATION USING THE GSI METHODOLOGY

6.1 OBSTACLES TO MEASURING SUBSIDIES

This report showed it is very difficult to estimate precise figures for subsidies granted to Spanish irrigators. For example, in meeting the mandate set down in Article 5 of the WFD, a massive study for the whole country and a completely new approach were required to analyze existing criteria with which water statistics were previously collected and recorded. Spain submitted its report under the WFD and was given a good mark by the EC (72 points, ranking 6th out of 27 Member States; EC, 2007). However inaccurate and questionable the Spanish data may be, the efforts made since 2005 to fulfil the Water Framework Directive mandates put the country at the forefront of other EU countries in terms of reporting on subsidies and meeting the requirements of the WFD.

The main obstacles in using the GSI methodology to estimate subsidies in Spain, and perhaps in many other semi-arid countries, are the following:

- In general, supply costs are not recorded and compiled with the notion of generating accurate assessments of the actual costs for specific activities. Information about specific payments made to contractors along the life cycle of a project is not available.
- Water projects have long maturity periods, with numerous additions, expansions and modifications, and become operative after prolonged periods. Precise cost attributions for different irrigation districts are also impossible.
- Basin agencies use accounting procedures that lump together payments for various elements of a project, which in turn may service different users. In the best cases, data publicly provided includes all capital disbursements made annually for the entire basin or for smaller management units.
- Accurate evaluation of the level of subsidy requires cost and revenue items be referred to at the specific moments in which they were effective. We harbour doubts about data being available in any country that permits such a time reference. Without it, any evaluation of subsidies, including those presented in this study, is subject to potentially large bias.
- The only way to avoid most of the information problems faced in this study and to apply GSI's methodology—or another—is for researchers to have access to accounting records for all irrigation projects, from the moment they were conceived and designed. Strict adherence to regular accounting rules and transparent access to the information would enable analysts to establish the level of irrigation districts' dependence on the use of subsidies.
- The GSI methodology recommends using the "Current Value" approach or the "Replacement Value" for the valuation of existing assets. Using the "Historical Value" approach would constitute a subsidy. However, it can be argued that publicly developed and constructed infrastructure should not get a capital return in the same way private assets should. In fact, public agencies do not sell water and do not collect revenue to have profits or market returns. In that case, the absence of a capital return to public investments should not be accounted as water subsidies and the historical value with a linear depreciation criterion should be used instead. This issue should be addressed by the GSI methodology.

6.2 POLICY RECOMMENDATIONS

The quality and accessibility of data provided by the Spanish governmental water agencies have some relevant flaws. Although the Spanish government has made significant advances in the analysis of cost recovery and subsidies to water services in general and irrigation in particular, there are still gaps that could be filled. Public participation in the design of water policies requires more and clearer information provided for public scrutiny and discussion. The following is a set of recommendations that could be considered:

- The Spanish Government should consider establishing legislation requiring water authorities to publicly provide information on water costs, revenues and subsidies in a more organized and usable manner. This would include establishing the minimum level of information to be provided, an adequate level of disaggregation, the methodology used to develop it and the formats in which information would be presented.
- More resources should be put into creating and/or improving publicly accessible government databases or websites that provide information on water costs and subsidies.
- Currently, the format of the data available is restricted to tables within PDF reports. Data needs to be made available in a format that allows entire data sets to be downloaded in a usable spreadsheet. Data availability should always be combined with usability. Clear indications should be given about the source of the data, the concept underlying each figure and the calculations carried out to estimate it. The format for data presentation should be homogeneous across public water agencies and RBAs.
- Some methodological inconsistencies have been identified in several of the government reports used in this study. Although some of these reports explicitly recognized most of them, more effort should be put in establishing a common and sound methodology for the analysis of water costs and subsidies to be carried out by water agencies. This should be based on methodologies established by European and international bodies to help provide guidance on these issues. This common methodology should be clear and unambiguous to avoid it being used ineffectively; developing software tools for data collection, analysis and presentation that agencies can use seems a logical step to follow.
- All of the above recommendations would allow academic and economics institutions to examine the underlying calculations put forward by governments. This external review of information and reports would double-check the quality of information and the reliability of the cost recovery calculations undertaken as well as the subsidy analysis. It will also allow civil society members to draw their own conclusions on the support provided by government to the irrigation sector.
- As regional government and regional water agencies have increasing responsibilities and capacity to subsidize water use, the Spanish National Government should ensure proper coordination of data collection and analysis, taking greater responsibility in centralizing the monitoring and provision of subsidy information. This would avoid subsidies provided by regional governments being miscalculated, double-counted or not taken into account.

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THE GLOBAL SUBSIDIES INITIATIVE (GSI) OF THE INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD)

The International Institute for Sustainable Development (IISD) launched the Global Subsidies Initiative (GSI) in December 2005 to put a spotlight on subsidies – transfers of public money to private interests – and how they undermine efforts to put the world economy on a path toward sustainable development.

Subsidies are powerful instruments. They can play a legitimate role in securing public goods that would otherwise remain beyond reach. But they can also be easily subverted. The interests of lobbyists and the electoral ambitions of officeholders can hijack public policy. Therefore, the GSI starts from the premise

that full transparency and public accountability for the stated aims of public expenditure must be the cornerstones of any subsidy program.

But the case for scrutiny goes further. Even when subsidies are legitimate instruments of public policy, their efficacy – their fitness for purpose – must still be demonstrated. All too often, the unintended and unforeseen consequences of poorly designed subsidies overwhelm the benefits claimed for these programs. Meanwhile, the citizens who foot the bills remain in the dark.

When subsidies are the principal cause of the perpetuation of a fundamentally unfair trading system, and lie at the root of serious environmental degradation, the questions have to be asked: Is this how taxpayers want their money spent? And should they, through their taxes, support such counterproductive outcomes?

Eliminating harmful subsidies would free up scarce funds to support more worthy causes. The GSI's challenge to those who advocate creating or maintaining particular subsidies is that they should be able to demonstrate that the subsidies are environmentally, socially and economically sustainable – and that they do not undermine the development chances of some of the poorest producers in the world.

To encourage this, the GSI, in cooperation with a growing international network of research and media partners, seeks to lay bare just what good or harm public subsidies are doing; to encourage public debate and awareness of the options that are available; and to help provide policy-makers with the tools they need to secure sustainable outcomes for our societies and our planet

www.globalsubsidies.org

The GSI is an initiative of the International Institute for Sustainable Development (IISD). Established in 1990, the IISD is a Canadian-based not-for-profit organization with a diverse team of more than 150 people located in more than 30 countries. The GSI is headquartered in Geneva, Switzerland and works with partners located around the world. Its principal funders have included the governments of Denmark, the Netherlands, New Zealand, Norway, Sweden and the United Kingdom. The William and Flora Hewlett Foundation have also contributed to funding GSI research and communications activities.

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