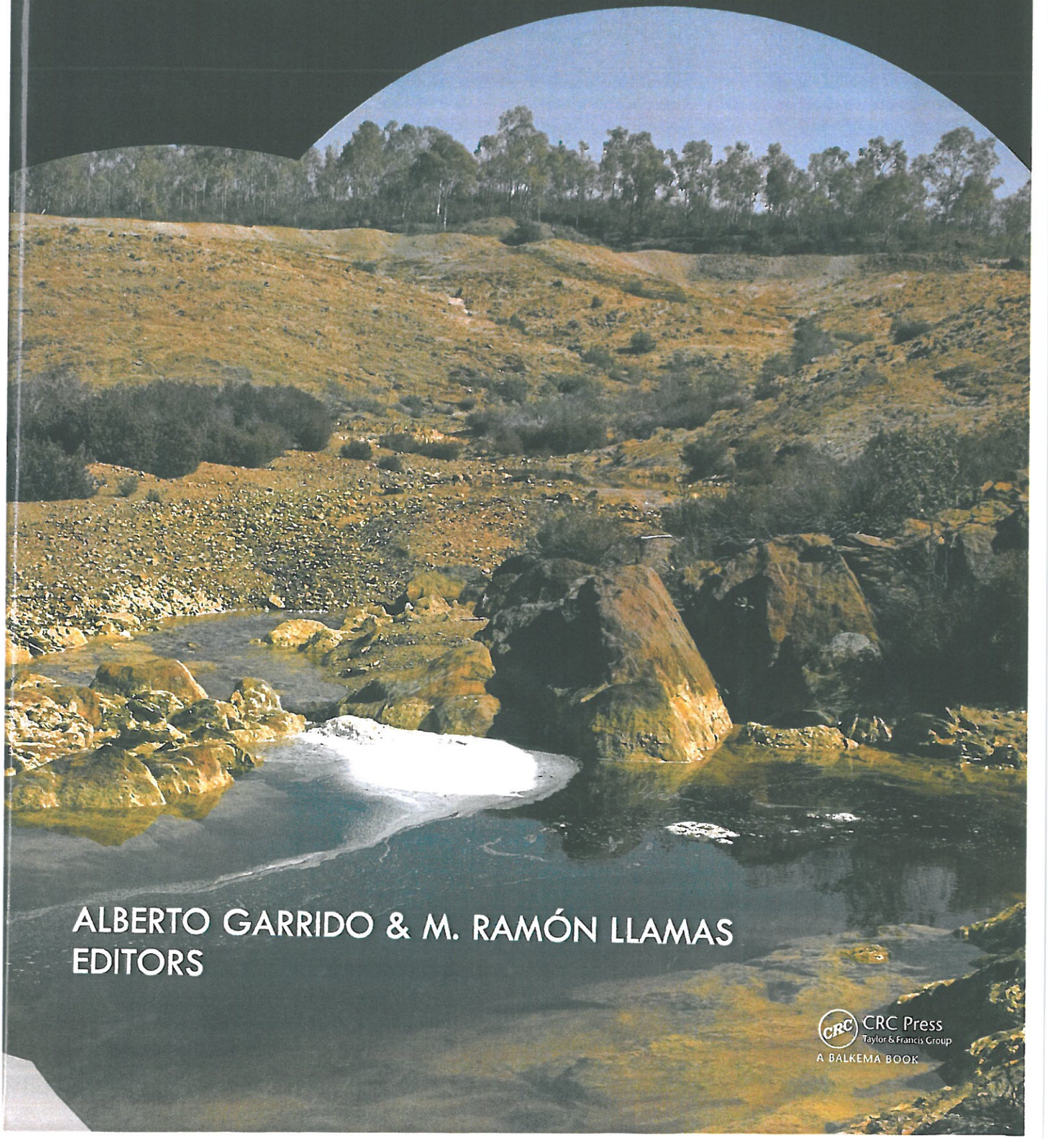
WATER POLICY IN SPAIN



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CRC Press
Taylor & Francis Group
A BALKEMA BOOK

CRC Press/Balkema is an imprint of the Taylor & Francis Group, an informa business

Typeset by Vikatan Publishing Solutions (P) Ltd., Chennai, India
Printed and bound in Great Britain by Antony Rowe (A CPI-group Company), Chippenham, Wiltshire

Published by: CRC Press/Balkema
P.O. Box 447, 2300 AK Leiden, The Netherlands
e-mail: Pub.NL@taylorandfrancis.com
www.crcpress.com – www.taylorandfrancis.co.uk – www.balkema.nl

Library of Congress Cataloging-in-Publication Data

Water policy in Spain / editors, Albert Garrido, M. Ramón Llamas.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-415-55411-4 (hardcover : alk. paper) 1. Water resources development–Spain. 2. Water–Government policy–Spain. 3. Water-supply–Spain. I. Garrido, Albert. II. Llamas, Manuel Ramón. III. Title.

HD1697.S7W38 2009

333.9100946—dc22

2009021770

ISBN: 978-0-415-55411-4 (Hbk)

ISBN: 978-0-203-86602-3 (eBook)

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CHAPTER 5

Water uses in transition

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1 GENERAL TRENDS OF WATER USE IN THE ECONOMY

Water abstractions to satisfy the requirements of economic activities put tremendous pressure on water ecosystems in Spain. Total abstractions represent 34.7% of available surface and groundwater resources. This rate is several times higher than in other OECD countries with greater water endowments or the potential for rainfed agricultural activities[1].

The quantity of water used by the economy and the resulting ecosystem quality reflects the types and importance of existing market and non-market economic activities. In this way, the composition and trends of water use in Spain can be interpreted as the result of the country's underlying economic transformations.

According to the Water Satellite Accounts published by the Spanish National Institute of Statistics (INE), the functioning of the national economy required the abstraction of 37,650 Mm^3 (million cubic meters) from the environment in 2001, and this volume had grown at an annual average rate of 1.6% over the previous five years. In spite of this increasing pressure on water ecosystems, the above figures need to be compared with the real Spanish GNP (gross national product) that grew at an average rate of 3.85% over the same period. This comparison reveals a positive trend in overall water productivity and a reduction in the quantity of water used per unit of final production. The steady trend of the Spanish economy towards higher water productivity is easier to appreciate when yearly water abstractions are compared with real GNP. Accordingly, there has been a clear dissociation between growth and overall water abstraction over the last two decades at least, meaning that increasing water demand and economic growth has somehow been made compatible with a constant or lower pressure on water resources (see also OECD, 2004). Over the last decade the water requirements per unit of GNP fell at an annual rate of 2.25%, reaching 24.7 m^3/€1000 in 2001 instead of the 27.6 m^2/€1000 required in 1997.

In other words, the effect of economic growth on water abstractions (or the scale effect that tends to increase water use at a rate proportional to production increases) has been counterbalanced by a number of factors (see Figure 1). First, the most water-intensive sectors and subsectors now have a relatively smaller share of GNP. Second, the use of water saving technologies by the faster growing production sectors (such as manufacturing and services) has increased, as has the diffusion of the best available techniques in more traditional activities (such as agriculture and livestock farming). Third, the conveyance efficiencies of all water supply services have improved. These services can now meet a substantially higher final water demand with a somewhat lower quantity of water abstracted from natural sources thanks mainly to technically sounder methods of water storage, transport and distribution. Total water abstraction in 2001 was 5% lower than in 1988. In 2001, the provision of one cubic meter required the abstraction of 1.75 m^3 from streams and underground sources. The combined national, and regional actions to enhance the technical

[1] See OECD (2004). The average intensity of water abstractions over available water resources is 14.2% in Europe and 19% in the United States.

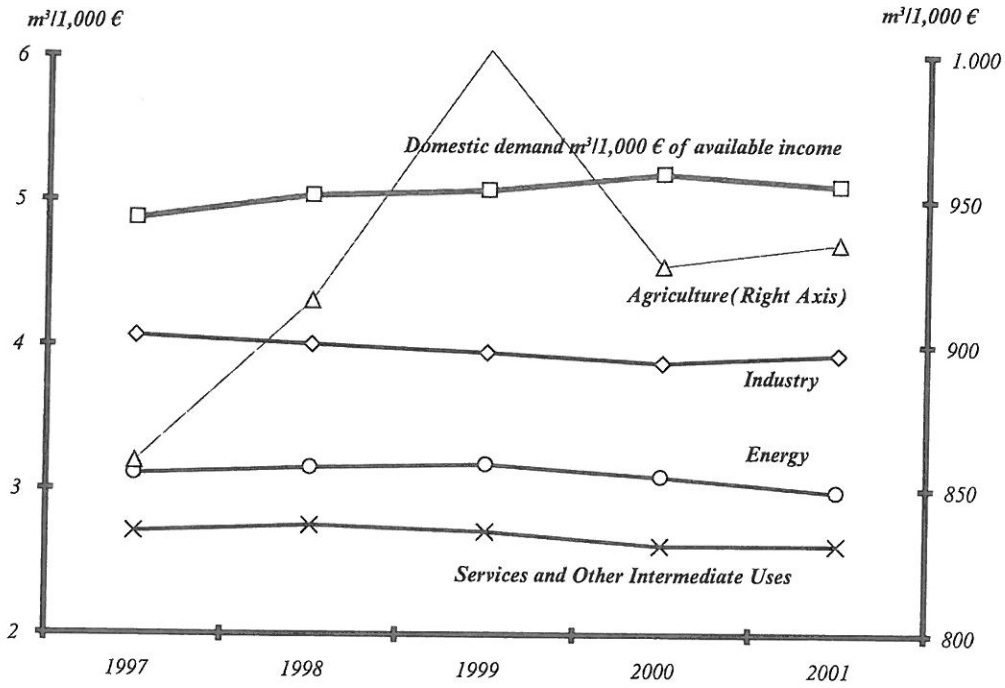

Figure 1. Water requirements by economic sector.
Source: National Institute of Statistics: Water Satellite Accounts; Economic Accounts.

Table 1. Water requirements and production growth 1997–2001 (Mm^3).

	1997	2001	Average annual rate of growth
WATER ABSTRACTIONS[a]	**34,735.9**	**37,652.9**	**1.61%**
For Irrigation Operations	21,423.3	22,183.6	0.70%
Rest of Agriculture, Livestock and forestry	1,975.8	2,367.7	3.62%
Rest of the Primary Sector	147.8	173.2	3.17%
Manufacturing Industry	1,149.2	1,373.3	3.56%
For Drinking Water Production	4,392.9	5,383.1	4.07%
Power Generation[b]	5,530.4	6,029.9	1.73%
Others	116.4	142.1	4.00%
Distributed to Water Users[c]	**21,319.1**	**22,486.3**	**1.33%**
Agriculture, livestock and Forestry[d]	18,279.6	18,460.9	0.20%
Rest of Primary Sector	29.2	31.9	1.72%
Manufacturing Industry	343.9	373.8	2.34%
Domestic Supply	2,322.8	2,508.6	4.66%
Energy (Consumptive use)	41.0	48.0	3.95%
Construction, Services and Others	792.6	935.6	4.66%

Source: INE: Water Satelite Accounts 1997–2001. Tables 6 and 7.
[a]Includes water withdrawn as a primary input.
[b]Water used for refrigeration of thermal and nuclear power generation plants.
[c]Includes all water considered as an intermediate input or as a final consumption good.
[d]Includes water distributed to Irrigation Associations (Comunidades de Regantes) and other drinking and non drinking water used by the sector. The differences with water abstractions for irrigation is explained by water losses in water transport from the withdrawal to the distribution point.

efficiency of irrigation distribution networks affecting 0.8 million hectares could have already saved 1,543 Mm^3. In Figure 1, the 1999 peak for agriculture was due to low agricultural output in money terms and large water availability due to unusually high precipitation in the 1997–99 period.

The main water user in the Spanish economy is irrigated agriculture. It uses more than four of every five cubic meters of total water abstracted. Nevertheless, the share of agricultural output and income in the Spanish economy fell from more than 5% during the early 1980s to around 2.6% in 2007. Agriculture's share in water requirements decreased from 85% to close to 80% of total water consumption from 1997 to 2001. Contrary to this, urban water consumption, although representing only one eighth of total water consumption, is growing at a much faster annual rate of 4.7%. The third most important activity demanding water is the manufacturing industry, with less than 2.5% of the total and an average growth of 3.6%. The rest of water demand is distributed across other uses, mainly the tertiary sector and the building industry (with less than 4%), and consumptive uses for power generation (with less than 0.3% of the total) (see Table 1).

2 WATER IN AGRICULTURE

The comparative advantages of Spanish agriculture derive from its weather and location. In a context where sunlight, soils and market proximity are suitable for farming, the availability of water storage and irrigation facilities becomes a key factor for guaranteeing the financial viability of Spain's Mediterranean agriculture. The income from a typical irrigated hectare is six times greater than that of an average rainfed hectare. For this reason, incentives for developing new irrigation projects and modernizing the existing irrigation infrastructure have been a factor explaining the constant growth of the irrigated area (3.4 million hectares in 2008) for at least the last 100 years.

According to the National Institute of Statistics' Regional Accounts, agriculture accounted for 2.6% of Spain's total GNP and 4.5% of employment in 2007. Ten years earlier agriculture's share of GNP had been 4.7% and of total employment, 7.1%. There are two important points here. First, in spite of its declining importance, agriculture is still the main economic activity in many rural areas, producing the main input for other transformation activities, such as the agro-industry[2]. Second, the above trends do not only reflect agriculture's declining importance in the Spanish economy, but also the effects of an important underlying shift towards more productive agriculture (as shown by the fact that the fall in employment was higher than the decrease in production, meaning that labor productivity has so far increased). This trend is more marked in regions such as Andalusia, where farming is the economic activity with the greatest productivity gains in the regional economy.

While labor productivity increased in the Spanish economy, water productivity exhibited the opposite trend. Between 1997 and 2001, the intensity of water use in agriculture increased from nearly 800 m^3 to 875 m^3 for every 1,000 euros of agricultural production (see Figure 1).

These trends could be better interpreted in terms of the dual Spanish rural economy, where highly competitive and market-driven agriculture exists side by side with traditional and institutionally driven production. The significant differences in water productivity across crops and regions are a noteworthy indicator of the importance of this dualism. As shown in Table 2, crops with a high yield compared with the water applied can achieve from 2 to 43 euros of gross added value per cubic meter (mainly for irrigated flowers and greenhouse vegetables in Catalonia, along the East Coast, and in Spain's Southeast). By contrast, with a few rare exceptions, the gross value added per cubic meter for crops with a low yield per water applied is less than 0.04 euros or even goes into negative figures (mainly cereals and other EU Common Agricultural Policy subsidized products).

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[2]There are, however, sizeable regional differences because agriculture's share of value added in most regions is higher than the average for the whole country. In regions such as Extremadura and Andalusia, for example, agriculture contributes an important part of total value added (10–13%).

Table 2. A sample of lower and higher productive water uses in agriculture in southeast Spain in 2005.

Crop	Region	Surface (hectares)	Average irrigation efficiency[a] %	Water requirements[b] m^3 per hectare	Gross value added € per m^3
Wheat	Andalusia	44,733	78%	3,057	–0.15
	Murcia	3,434	83%	3,232	–0.26
	Valencian Community	3,126	66%	3,974	–0.02
Maize	Andalusia	54,969	75%	7,789	0.01
	Murcia	186	66%	7,156	–0.02
	Valencian Community	1,930	66%	6,010	0.00
Pepper	Andalusia	13,243	64%	5,379	0.45
	Murcia	1,736	87%	4,757	4.70
	Valencian Community	1,249	76%	4,994	2.75
Green Beans	Andalusia	5,148	80%	5,346	30.66
	Murcia	62	78%	5,346	2.97
	Valencian Community	737	82%	3,556	4.19
Tomatoes	Andalusia	17,293	80%	6,607	3.85
	Murcia	2,364	80%	7,347	2.71
	Valencian Community	1,373	90%	5,367	7.50
Pepper (Greenhouse)	Andalusia	3,504	90%	5,367	6.08
	Murcia	297	90%	5,367	9.78
	Valencian Community	684	90%	5,367	6.34
Flowers (Carnation)	Andalusia	582	90%	7,132	21.00
	Murcia	170	90%	7,661	25.61
	Valencian Community	136	90%	6,084	43.05
Flowers (Roses)	Murcia	25	90%	7,187	31.45

Source: MAPA, Recopilación de Datos de Superficies Ocupadas por los Cultivos Agrícolas (Hojas 1T). Group of Economic Analysis, Ministry of Environment, and MMAMRM (2008).

[a]The Average Irrigation Efficiency measures the water that reach the crop as a percentage of the quantity of water introduced in the irrigation system.

[b]Water requirements is a measure of the volume of water that need to be applied at a farm level. This measure does not take into account water lost in transport from the withdrawal point to the irrigation association and in the distribution from the irrigation association to its members.

Even when irrigation's efficiency problems are recognized, government and society widely perceive the construction of new and the modernization of the old irrigation facilities is the main policy instrument for rural development. This can be put down not only to the above important rural income gains, but also to its role in the conservation of Spain's rural heritage and landscape, maintaining social capital, and as means of preventing the depopulation of marginal areas.

The increase in agriculture's water use intensity has been counterbalanced by at least two positive trends. On the one hand, agronomic vocation and the scarcity of water in a number of areas have driven farmers' responses to different types of institutional policies, incentives and market conditions. The recent rapid development of a highly intensive agriculture specialized in high value-added products, mainly in the South and the Mediterranean regions, has also helped to offset the overall average trends in productivity. On the other hand, improvements in on-farm watering techniques have also been a positive factor for improving productivity. Traditional gravity irrigation (flood irrigation) is still present across 60% of the agricultural area and is the prevailing technique in marginal agricultural areas. New irrigation areas have generally opted for sprinkle or localized (drip) irrigation. Sprinkle irrigation is the main form of irrigation on the inland plains,

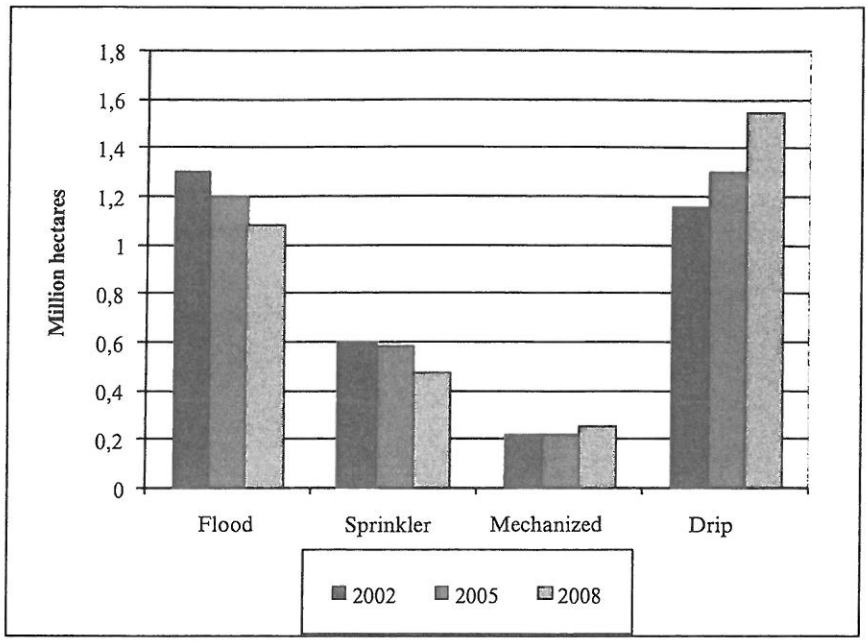

Figure 2. Trends in irrigation techniques Spain.
Source: Ministerio de Medio Ambiente y Medio Rural y Marino (MERMA, 2008).

whereas the more efficient localized irrigation has a greater presence along the Mediterranean coast and in the South. The trend away from gravity and flood irrigation and towards sprinkler and localized irrigation techniques is characteristic of market-driven agriculture, where yields and market prices rather than subsidies and institutional support are the key factor in the farmers' decision making (see Figure 2). The move from gravity to drip irrigation means extra investment and maintenance costs for farmers. On average sprinklers increase production costs by 130 euros per hectare, and the most efficient localized technique by 142 euros per hectare (Camacho, 2003). Improvements in watering techniques are only a sound option when the water price effectively paid by farmers is high enough for water cost savings to compensate for the extra investment needed to improve farm operations. This is more likely to happen in areas where water comes from groundwater sources at a cost greater than 0.08 €/m^3 to the farmer for an average use of 2,000 cubic meters per hectare.

There is some evidence of water prices (groundwater abstraction costs and prices charged to farmers by collective irrigation water suppliers) being correlated with the enhanced technical and economic efficiency of water use. Irrigation water prices effectively paid by farmers vary with the sources of water used (groundwater or surface water) and the state of conservation of supply infrastructures. There are important local differences in the costs of irrigation water services that are reflected in prices. In Murcia, Almeria and Valencia, where agriculture is specialized in high value added crops and aquifers, more than two thirds of water services cost farmers on average 0.08 euros per m^3 (and up to 0.39 €/m^3 in some aquifers). On average farmers pay from 0.01 to 0.02 euros per m^3 for surface water diverted from streams and large-scale infrastructures (dominant in areas with low value crops).

In any case, for traditional and modern agriculture, farmers' decisions may be constrained in both cases by institutional arrangements regulating water property rights. Organized farmers using surface or groundwater for irrigation are required to have "concession rights" granted by the river basin authorities (RBAs). Apart from that, the effective volume of water available for any crop season depends on both legally prescribed maximum-per-hectare quotas defined by the basin authority and the availability of resources, which are subject to the rainfall. Maximum-per-hectare water allowances are the main instruments for preventing overexploitation of water resources, but

they also place constraints on farmers' possibilities for moving towards crops with greater water requirements. Additionally, they may also act as an incentive for improving technical efficiency, but do not necessarily imply reduced pressure on the water environment. In any case, the availability of water for crops is not only uncertain from season to season. Because the law gives priority to domestic and urban water uses over rural uses, the impact of drought on water availability is higher in agriculture than in other uses connected to urban water supplies.

The evolution of Spanish irrigated agriculture is primarily linked to trade barriers, production subsidies and the many public actions that determine the sector's financial incentives. The changes envisaged in these factors will determine the prospects of the rural economy. This way the size and composition of the agricultural product and the associated water requirements will depend on how the new CAP subsidies, at least partially decoupled from production, affect the different crops and how eco-conditionality is applied. Decoupling could have significant effects, at least on the production of cereals, olives and grapes. Indirectly, changes in relative prices could lead to a reallocation of land, water and other factors towards other more competitive products.

It is still uncertain what impact the progressive liberalization of agricultural markets, including the implementation of the World Trade Organization (WTO) and the Euro-Mediterranean convention agreements, as well as the enlargement of the European Union (some interim results are available from the European Union (EC, 2009)), will have. However, fewer incentives for traditional and water-intensive crops might not necessarily lead to lower pressures on water ecosystems, as excess water may be reallocated to profitable crops in the new context. Nevertheless, changes in structural policies and in the international environment are expected to result in increases in water use productivity.

An important aspect of agriculture as a water user is related to the use of pesticides, fertilizers and other chemical inputs that reach water bodies through surface runoff and leakage. The impact of diffuse pollution on the ecological quality of waters depends on many factors, such as the application of the right doses according to best practices, precipitation, soil slope, water irrigation techniques, and the availability of wastewater collection and treatment. Surveys carried out by the Ministry of Agriculture show important regional differences in fertilizer doses applied to different crops on farms. Taking into account the cultivated land registered in the 1999 census, the average dose of fertilizers was estimated at 67 kg, 37 kg and 28 kg per hectare of nitrates, phosphorus and potassium-based fertilizers, respectively (MAPA, 2004).

Nitrate pollution, from both current and past practices, has attracted much of the European water policy's attention. In 2000, 27 groundwater bodies had an anomalous nitrate concentration (MIMAM, 2000), and many areas of Spain are currently declared vulnerable to nitrate pollution from agrarian sources. Nitrate control programs need to be applied by the regional governments not only to agriculture but also mainly to animal farming.

3 URBAN WATER USE AND HOUSEHOLD CONSUMPTION

The different kinds of urban water consumption account for a small but growing share of total water demand that came close to 10% of the total in 2002 and is expected to reach 15% in 2015. Household drinking water consumption accounts for nearly 70% per cent of urban uses. Manufacturing firms, shops, restaurants, hotels and other services are responsible for 20% of urban water demand. The remaining 10% of water demanders are public organizations providing public goods (such as gardening and cleaning of public spaces). All these uses have been increasing at an average rate of 4.6% per year, and are, in one way or another, the consequence of the growth of the Spanish economy. Over the last two decades, per capita income increases were positively related to higher average household water consumption[3] but also to an increased demand for water

[3] Estimates of the drinking water demand function in the Júcar River Basin show that water responds negatively to water prices and positively to income increases. Price elasticity has been estimated at –0.6 and income elasticity at 0.4 in the Júcar River Basin (see Ministry of the Environment (2004) *Economic Characterization of Water Use in the Júcar River Basin: Pilot Study*).

Table 3. Trends in urban water consumption 1997–2001.

Autonomous communities (reported only the most populated ones)	Population 2001	Per-capita water consumption lit/person/day 2001	Average rates of growth 1997–2001		
			Total urban water consumption	Population	Per-capita water consumption
Andalusia	7,403,968	171.15	11.21%	0.46%	10.63%
Aragon	1,199,753	121.13	7.49%	0.20%	7.23%
Castile and León	2,479,425	142.03	5.13%	–0.23%	5.42%
Castille-La Mancha	1,755,053	152.71	14.41%	0.49%	13.80%
Catalonia	6,361,365	235.70	6.89%	0.87%	5.80%
Valencian Community	4,202,608	150.46	5.42%	0.94%	4.24%
Galicia	2,732,926	151.90	10.25%	–0.07%	10.34%
Madrid (Community of)	5,372,433	173.00	4.78%	1.35%	3.10%
Basque Country	2,101,478	204.20	10.45%	0.03%	10.40%
TOTAL SPAIN	**41,116,842**	**184.61**	**8.02%**	**0.72%**	**7.12%**

Source: National Institute of Statistics and own elaboration.

to provide public goods, like water for cleaning public spaces, for public gardens and parks and for other urban amenities. On top of this, there is the growth of water demand from tourism, and a higher than average population growth over the last few years explained not so much by vegetative growth than by the influx of migration.

The impact on urban consumption is highly influenced by the urbanization process. This tends to concentrate water pressure along the Mediterranean coastline and in the metropolitan areas of the centre and the north of the country. Per-capita water consumption has increased since 1996 at an average annual rate of 2% and was estimated at 171 liters per day in 2004, with sizeable regional differences ranging from a maximum 200l/person/day in Castille-La Mancha to a minimum 142 liters/person/day in the Balearic Islands and the Basque Country (INE, 2008).

Recent and significant increases in water prices have slowed down the rapidly growing final water demand. Their effects on water abstractions have been partially offset by the efficiency gains in the domestic water supply system. Regional distribution of water consumption is positively correlated with water prices. Over the last decade water prices increased every year by more than 4% and averaged 0.98 €/m^3, again with sizeable differences between the higher prices paid in the Canary Islands (1.44 €/m^3), the Balearic Islands (1.44 €/m^3) and Murcia (1.53 €/m^3) and the lower prices in Castilla-León (0.67 €/m^3) and Castilla-La Mancha (0.9 €/m^3). Price differences are correlated with geographic differences in urban water provision costs, as reflected by the latest available estimates from 1996. In 1996, the cost was above 2.5 €/m^3 in the Canary Islands and under 1 €/m^3 in Galicia and Castilla-León[4]. The difference between the total water distributed and effectively received by final users fell from 32% in 1990 to 19.4% in 2000. Reductions in this unregistered water are explained partially by improvements in consumption measurements and fraud detection, but mostly by the technical improvements in water distribution networks.

4 SERVICES AND TOURISM

Service activities in the Spanish economy, growing at a yearly rate of 4.1%, account, as a whole, for 60% of Spanish production and only 3.5% of total water demand. Being the most dynamic

[4]Cost recovery for sewage collection and treatment services is lower than for drinking water distribution services. Its costs are 34% of the water provision cost but only 25% of the average price.

sector of the economy, its higher than average growth is one of the reasons why the overall water intensity of the Spanish economy has been declining over the last few decades. The most significant water use in this category is related to tourism and recreational activities. The opportunity for recreational activities explains the recent growth of houses for non-permanent residents (one of every three new dwellings built in the last ten years in a country where the number of new dwellings built in 2006 and 2007 was higher than in France, Germany and Italy together).

Although its share of overall water demand is lower than one per cent, recreational water uses are one of the most rapidly growing activities. This category includes swimming pools, theme parks, and mainly golf courses. Old and new projects to develop such facilities are viewed as a way to increase local revenue, as an alternative to the decline of traditional manufacturing activities. They are also looked upon as a means to increase returns on the tourism infrastructure by reducing the high demand seasonality, particularly in the Mediterranean areas, improving the quality of tourist packages by attracting high purchasing power tourists and increasing the demand for complementary services, like transport and restaurants. This explains the reasoning behind plans to develop 45 new golf courses in Murcia and Valencia, in spite of the extremely limited water availability (see Sanz-Magallón, 2005). The average water requirements of a Mediterranean golf course are similar to some cereal crops (between 6,500 and 10,000 cubic meters per hectare depending on rain and local conditions). Nevertheless, the financial return of a typical golf course is substantially higher and has been estimated at from €12,000 to €48,000 per hectare in Murcia and at 15 €/m^3 in the Valencia Region as compared to some eurocents for cereals (between 26 and 10 eurocents in the Júcar River basin and Extremadura, respectively) (see Sanz-Magallon *et al.* 2004).

5 INDUSTRIAL AND ENERGY WATER USE

The manufacturing industry, which accounts for nearly 17% of total Spanish production, consumes only 1.5% of total water. In spite of a growth rate similar to Spanish production as a whole, this sector exhibits a positive trend in water efficiency, as revealed by the steady reduction of water requirements from 4 to 3.75 cubic meters for every 1000 euros of production from 1997 to 2001. This efficiency improvement is explained by both the faster growth of relatively low water user industrial activities and the enhancement of water productivity in many of the industrial water uses (see Figure 1).

The energy sector is also a significant water user, accounting for a mere 0.2% of water consumption, but with sizeable non-consumption water requirements. In the energy sector, water is used to cool nuclear and thermal plants and for hydropower production. Impacts relate to hydromorphological indicators and to temperature. There are 1,136 river stretches or sections housing hydropower facilities in Spain. There are also 1,200 dams used for hydroelectricity generation, which, depending on the hydrological year, store an average of 56,500 Mm^3. Of these, 30% are multi-purpose dams. It is estimated that dams for hydropower production have flooded 2,825 square kilometers (MERMA, 2008). Total hydropower capacity is estimated at 35,743 GWh/year. Apart from power generation, an average of 4,915 Mm^3 of water is abstracted every year from natural streams and dams to cool fossil fuel and nuclear-based power generation plants. This is an amount equivalent to 0.63 Mm^3 per MW of installed generation capacity (MIMAM, 2005).

At market prices, the production of hydropower was estimated (MIMAM, 2005) at €21,000 million in 2003 (valued at average market prices of 3.58 cents/kWh for flow energy and 4.31 for regulated energy). Hydropower is considered to play an important role in the stability of the Spanish electricity system given its flexibility for meeting peak electricity demands. The ratio of hydroelectricity production to existing water resources has been estimated at a pressure index of 0.32 GWh/year per Mm^3.

The economic analysis of water use for electricity generation should consider not only the benefits associated with the activity, but also the economic value of the forgone benefits. It is hard to put a price on forgone benefits because there is often no market value for natural areas and

landscapes; their recreational value or for the impacts of biodiversity changes due to alterations of natural flow regimes, etc. The private opportunity costs of the measures taken to compensate for or reduce impacts according to environmental impact assessments, and especially those related to the maintenance of minimum flows, have been valued by the power industry association (UNESA) to be equivalent to 1,200 GWh per year in Spain for installations of more than 5 MW. This is 3.3% of the production potential. At market prices, this amounts to €49 million per year. The substitution costs would be approximately €9,840 billion to build alternative installations and €1,430 billion per year in fuel costs. The sector estimates that hydroelectricity production saves about 2.8 million equivalent barrels of oil and helps avoid other forms of pollution that have negative effects on health and other effects via air emissions.

6 FINAL REMARKS

Overall sector water use reflects the trends of economic growth and has led to greater pressure on water ecosystems mainly through greater water abstractions or pollution emissions, as well as because of the changes in the water flow regime and morphology of rivers. Water use (and pollution emissions) has increased in all sectors. However, the share of water use by different sectors has changed because of the high growth rate of urban uses in relation to other users.

Water productivity has increased as a whole, as economic growth has decoupled from the use of water resources. This is explained by some positive trends, such as increased technical efficiency in water distribution services in cities and agriculture, and improved technical efficiency in water application on farms. This is often supported and promoted by the European Union and public funding in urban areas and for agricultural irrigation networks.

Improvements in water productivity have been clear in urban water use and industry, where income increases leading to higher per capita consumption have offset price increases (reflecting the higher costs of providing wastewater collection and treatment services). Technological innovation in industry and the decline of traditional and larger water-consuming sectors also explain greater productivity gains in industry.

Productivity of water use in agriculture has been declining mainly as a result of institutional factors and most likely because of the downward trend of agricultural product prices. Yet market-driven agriculture has contributed substantially to increases in productivity and is expected to continue to do so where new competitive markets can lead to crop substitution.

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