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TRANSITION TO FULL-COST PRICING OF IRRIGATION WATER FOR AGRICULTURE IN OECD COUNTRIES

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## PUBLISHER'S NOTE

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## **FOREWORD**

This report was prepared by Dr. Alberto Garrido of the E.T.S. de Ingenieros Agronomos, Spain, for discussion in the Joint Working Party of the Committee for Agriculture and the Environment Policy Committee.

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## EXECUTIVE SUMMARY

The analysis of water pricing policies in the irrigation sector is an essential element for judging resource and agricultural policies, identifying policy gaps and inconsistencies and suggesting guidelines to design legal and planning proposals. However, little progress can be made in this area unless proper irrigation cost valuations are carried out. This report shows that irrigators face private and communal costs, but can also impose significant costs to society in the forms of water pollution leading to ecosystems degradation and excessive use of scarce water resources. Irrigated agriculture also supports economic development in rural areas, providing jobs and supporting agro-food industries in areas which would otherwise become depopulated. In addition, irrigated agriculture helps maintain rural landscapes. Although significant progress has been made in the last decade to identify and define water subsidies, many OECD countries still promote growth in their irrigated acreage, and do so acknowledging that at least 50% of the development costs will never be recovered. In some OECD countries, we are witnessing a remarkable growth in the use of market incentives that perform with moderate success in water allocation services. In addition to providing a means to facilitate welfare-improving water exchanges, water markets in Australia and the US indicate that water is being exchanged at market prices one order of magnitude higher than the charges or levies that water right holders must pay to public agencies or water suppliers. This provides *prima facie* evidence that there exist two interrelated problems that perhaps require differing approaches: one is the allocation of scarce water and the other is ensuring proper cost recovery schemes.

Recognising this duality, this report shows that water pricing can perform two functions. One is to ensure that the service costs are completely borne by the users, allowing public water agencies to focus on actions and policies that reduce hydrological risks and restore water bodies' environmental quality. The other is to promote water use efficiency, narrowing the gap between private and social benefits and ensuring that irrigators make appropriate use of their water resources. However, very few examples are found across OECD countries in which water pricing policies are put in place to deliver benefits related to both functions. Often a combination of rates restructuring, water use quotas, market incentives and the application of 'best management practices' are implemented simultaneously. Although these policy mixes are complex and difficult to develop, the most successful experiences indicate that they are viable and perhaps the only way to achieve multiple-objective reforms. In this manner, synergies of instruments are exploited and policy consistency is promoted.

Subsidies and adverse incentives are still present in many OECD countries. While it is still difficult to measure them, most countries recognise that large social benefits would accrue if incentives were realigned to ensure that irrigators are made more responsible for their actions and infrastructure. For instance, agricultural policies in the European Union significantly distort both irrigators' selection of crops and incentives to invest in irrigation equipment. Similar disincentives come from flat rate schemes, which are overwhelmingly used in Spain, the US, Australia, Mexico and Canada, although it is not always possible or cost effective to shift to volumetric rates.

The implementation of full cost recovery prices is taking place at a different pace and follows quite differing criteria within the OECD countries. This report looks in detail at three distinguishable approaches to reform irrigation water pricing. First is the Australia's reform put in motion in 1994. Among other

objectives, it sought to make irrigators responsible by 2001 for all running costs and responsibilities hitherto in the hands of the States. Although pricing reform has faced in some States several unanticipated difficulties, significant progress has been made primarily in the Murray-Darling Basin. Secondly, the European Union approved a much more ambitious water pricing reform, through a broad definition of service costs including financial, environmental and resource costs. The timetable for full implementation is much longer, allowing member states a transition period of ten years ending in 2010. Thus, one key difference between the EU and Australia is that, in Europe, pricing reform objectives are broader but will take more time to come into force. Another is that, in Australia, less efficient irrigators, identified as those unable to pay full-cost charges, are offered the option to trade in water markets either to leave the sector or to restructure their farms to become more efficient. Spain – with the largest irrigated acreage among the EU States – has amended in 1999 its water law to allow for water exchanges.

The US is following the third reform model. Its main federal agency, the Bureau of Reclamation, has the mandate to reformulate the terms of the contracts with its water district customers, including new definitions of cost recovery, implementation of incentive pricing and ‘best management practices,’ and a number of additional details. The reform thus proceeds at the same speed that water service contracts mature, and enter in the renewal process. Another difference is that expectations from water markets in the US have been moderated, while in Australia market transactions are growing with the support of federal and state agencies. Factors such as recognition of third party effects and environmental impacts, and the need to restore the water rights of Indian nations and tribes may give rise to market restrictions and higher transaction costs. In sum the US seems to follow a case-by-case process, whereas in Australia and the EU, states are or will be responsible of implementing laws and policies that must deliver objectives fixed at higher administrative and legislative levels of the Federal Government in Australia, and the European Commission, Council of Ministers and the European Parliament. Mexico’s water pricing reform also results from federal policy, but implementation proceeds case by case, similarly to the US.

Among the lessons to be drawn from these distinctive approaches are: (1) that benchmarks are needed to track progress, identify targets, increase accountability and implement the reforms; (2) pricing policies can be accompanied by other instruments such as water tradability, quotas, rehabilitation projects and the definition and application of ‘best management practices’. A balanced mix of policies enhances policy consistency and distributes the costs and benefits of reforms among water users and stakeholders. (3) Other sectoral policies, such as agricultural or environmental policies, have a role to play in the reform process, hindering or reinforcing any effort in the water sector. (4) Though this analysis focuses on water allocation issues primarily in arid and semi-arid regions, significant progress can be made in the field of international comparisons if OECD deepens the co-operation in areas such as identification, definition and valuation of irrigation costs.

## **1. The importance of irrigation in world food production**

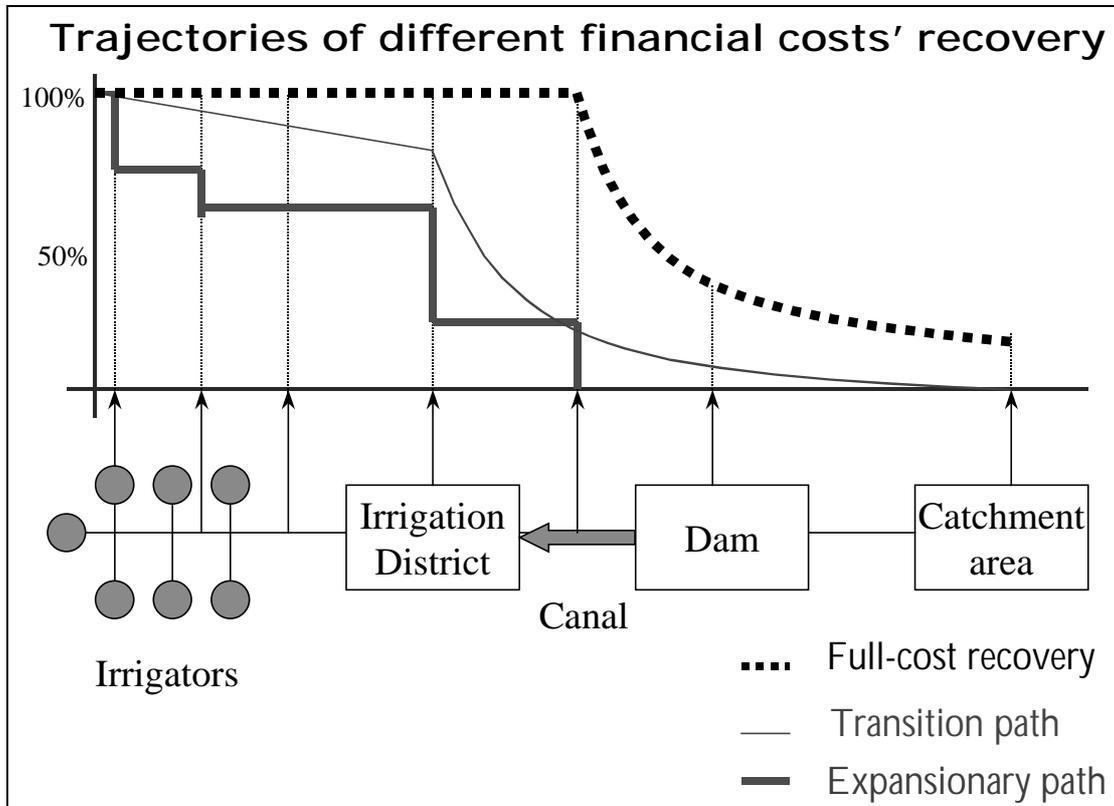
Irrigated agriculture provides about 40% of the world’s food supply, but occupies only 17 % of the planet’s cultivated land. The production of food and fibers under irrigation makes up 72 % of the world water abstractions (FAO, 1999). Both in Africa and Asia, irrigation water makes up more than 80% of the continents’ abstractions. In countries like U.S., Mexico, Turkey and Spain, more than 70% of their irrigated acreage relies on surface waters that originate from highly controlled river basins (OECD, 1999). Pinstrup-Andersen and Pandya-Lorch (1998) predict that, by year 2020, demand for cereals will likely increase by at least 40% from the current consumption level, adding more pressure to many catchment areas worldwide. In addition to increases in food demand, world’s irrigated agriculture will have to face the increasing uncertainty in water supply caused by global climate change.

**2. Costs of irrigation water: definition and valuation**

The costs of irrigation water use cannot be easily divided into clear categories. Part of the problem is that irrigation costs become more complex and difficult to measure with increasing degrees of water scarcity. For instance, in countries with abundant water resources, positive externalities in irrigation and drainage system are recognised and irrigation costs include those privately assumed by farmers and those related to environmental pollution caused by discharges. In contrast, in countries or regions with limited water resources, irrigation water supply is associated with a long range of intermediate costs in addition to those purely associated with private or social spheres. This section and most of this report will focus on situations germane to the latter case.

A synthetic view of a complex irrigation system that relies on surface water is depicted in Figure 1. It also displays different trajectories of cost recovery for countries undergoing irrigation expansion, approaching full cost recovery or applying full cost recovery prices. Vertical axis displays the percentage of the costs of each water supply and storage segment all the way from the catchment area to the most remote irrigator represented along the horizontal axis. What Figure 1 tries to portray is the fact that, in many large irrigation areas, even under strict conceptions of full-cost recovery, part of the costs should be borne by other project beneficiaries and other indirect users. The expansionary path reflects the cost definition and recovery typically associated with countries promoting irrigation and water use, up to the point of subsidising farmers part or all the investment and maintenance costs of the infrastructure up to the farm gates. The transition path may be the second-best or viable goal for countries whose situation is similar or closer to the one depicted by the expansionary path.

**Figure 1. Trajectories of different financial costs' recovery**



From the irrigation standpoint, a complex environment is typically characterised by all or some of the following aspects:

- Over-appropriation of resources, meaning that the sum of the water rights exceed in normal years the amount of water available. This implies that downstream users make use of return flows generated by upstream users.
- As a result of over-appropriation, return flows must be taken into account in any demand management instrument, especially those that include water exchanges and investments in conveyance systems and irrigation equipment.
- Severe environmental problems caused by salinisation processes, water pollution caused by chemical discharges and sedimentation.
- Increasing water supply and treatment costs for irrigation and other water users.
- Significant reliance on taxpayers' contributions to cover part of the irrigation district's and official agencies' running costs.
- Increasing overexploitation of groundwater resources.

## **2.1 Basic principles**

Costs of irrigation water rarely appear independently of one another. As we will see, the interdependency of various sources of costs adds some complexity to the process of moving to full-cost recovery prices. An example of this complexity is the notion of resource costs. Usual notions of resource costs associate them with opportunity costs, which amount to the economic value of the opportunities forgone for allocating the resource to a given user. When water markets exist, resource costs can be assimilated to the market price of water, net of the costs incurred in abstracting or moving the water to its final destination. However, markets rarely function properly, if at all, although significant improvements have been made in Australia and in several large supply systems in the US.

Since in many cases water resources exist because large infrastructure works have been built, resource costs are inextricably linked to the costs of erecting and running the hydraulic works. Thus, unless the owner of the infrastructure is also given ownership of the water and permission to sell it in a competitive market, at a price that exceeds its water "production costs", it will be impossible to dissociate the resource cost from the production costs. This does not imply that resource costs do not exist; rather, it means that without markets, resource costs do not emerge with similar visibility to the case of petroleum, gas or many other natural resources. As will be illustrated below, resource costs have emerged well above the costs of delivery or infrastructures in places where water rights can be traded.

These two sources of ambiguity, together with others that will be addressed in this report, are related to the different definitions of "full-cost recovery" prices that each country appears to follow. From a narrow public policy perspective, it may suffice to have clear definitions and precise valuations of the water service costs that are not covered by irrigators' charges. However, more appropriate policy action should also recognise that irrigator's water use may entail additional social costs. These social costs may or may not be included in the definition of "full-cost recovery" rates, but it would certainly be in the interests of society to identify them and attempt to reduce them.

The following sections clarify these notions and provide cost evaluations found in the literature and recent reports.

## 2.2 Private costs

Private irrigation costs include those items for which the irrigator is entirely responsible. Viewed from the perspective of policy analysis, private costs may be irrelevant. On a closer look, they convey information which may be useful for designing water or irrigation policies. Furthermore, they are *prima facie* indicators of farmers' ability to pay for the water. For instance, irrigators using groundwater resources usually pay all costs, except for resource and environmental costs. Compared to irrigators operating under similar conditions but serviced with surface waters, their counterparts' ability to incur all groundwater costs provides an indication of the range of charge increases which the former could pay. This argument, which will be discussed later, originates from recent work conducted by Llamas *et al.* (2001) in Spain.

The magnitude of the investment and variable costs incurred by irrigators using groundwater resources is shown on Table 1.

**Table 1. Private costs using groundwater resources, excluding labour costs**

Well depth (m)	Pumping capacity (litres/second)	Cost of pumping equip't (US \$) <sup>1</sup>	Cost field irrigation Equipment (US\$) <sup>2</sup>	Total Energy Bill (\$) <sup>3</sup>	Annual Loan instalments (incl. Principal & interests) <sup>4</sup>	Total costs (US \$/m)	
						(0% Subsidy)	(50% Subsidy)
50	50	10,800	81,081	50,439	11,899	0.16	0.15
100	50	29,200	81,081	75,658	14,282	0.23	0.21
150	20	21,620	32,432	40,351	7,000	0.30	0.28
200	70	37,840	113,514	176,536	19,601	0.36	0.34
14	10	16,220	16,216	6,456	4,201	0.14	0.11
440	42	31,351	67,622	206,124	12,817	0.68	0.66
560	33	30,270	54,000	204,913	10,913	0.83	0.81
0	50	5,000	81,081	25,724	11,148	0.09	0.08

Source: Columns 1,2 and 3 from Hernández-Mora *et al.* (2001) based on various sources and locations in Spain, the others are calculations by author.

<sup>1</sup> These costs refer to actual projects carried out in Spain in different regions. They only include well drilling, electrical components and pumping equipment.

<sup>2</sup> Assuming 1 hectare per litre/second and 1620 \$/ha of investment in irrigation equipment.

<sup>3</sup> Assuming the lowest power tariff and pump usage of 12 hours and 180 days, and 0.4 kw/hour per 100 depth meters and cubic meter. 50 more meters of pressure have been added to the well depth to account for pressure at the sprinklers.

<sup>4</sup> Calculated with an interest rate of 5% and payable in 10 years.

The costs reported in Table 1 pertain to an individual irrigator with access to groundwater at different depths and for various well flows, as shown on the first and second columns. Although they have been collected from Spanish sources, the fact that the main items included, i.e. energy, equipment and investment costs, may not vary significantly across OECD countries suffices to provide valid costs references for irrigators using groundwater resources. The cost figures were calculated assuming zero and a 50% subsidy in the form of a capital grant to cover the investment costs. The results show that subsidies do not affect significantly the cost per cubic meter. This is an indication that irrigators using groundwater resources would not exhibit different behaviour with regards to their groundwater pumping rates as a result

of different levels of subsidies for investments. The last row of Table 1 is applicable to a farmer using surface water with pressurised conduits and application techniques.

The conclusion of these evaluations is that once subsidies are in place, irrigators would face the same type of incentives resulting from new water pricing schemes as those that assumed the entire investments costs. However, in taking the decision to become a groundwater user, the existence of capital grants to cover part of the equipment may induce more farmers to undertake the project.

In addition to energy and equipment costs, irrigators use labour specifically to operate the equipment and manage the irrigation systems. While these labour costs are intrinsically linked to irrigation, they can also be attributed to the costs of the irrigated crops. Labour costs vary significantly across irrigation techniques, crops, labour market conditions and land-holding structure. However, in countries such as Japan, where farmer-participatory management prevails, labour costs are not negligible, which means that omitting them would potentially give rise to biased comparative analyses.

A final note about the costs shown in Table 1 will provide a useful comparison of water costs across OECD countries. One reference is the market price of water in an interstate water market project in Australia, which shows that since 1998, exchange among irrigators has occurred at an annualised price of US \$ 0.035-0.040 per cubic meter (see Box 3, below).

### 2.3 *District costs*

District costs are those borne by the irrigators associations, and result from running and maintaining infrastructure and facilities that exclusively serve a clearly identified set of irrigators. These costs are paid by farmers irrespectively of the kind of ownership of the district's infrastructure. Nevertheless, there is abundant evidence of better recovery of district costs in private associations than in state-run or publicly owned water infrastructure.

In this report, district infrastructures are associated with those managed by irrigation districts, which usually are non-profit associations with legal status<sup>1</sup>.

In the US, Spain, Turkey and Mexico, among other OECD countries, irrigation districts are assigned an instrumental role in water policy implementation and water management. According to Spanish Water Law, *Comunidades de Regantes*, must have their statutes and bylaws approved by the Basin Agencies' and perform a number of key tasks in water management. For instance, they collect charges and levies issued by the Basin Agencies' from farmers and transfer the revenue to the Agency. They also have approved procedures for resolving conflicts among irrigators, organising irrigation turns, and developing and co-financing rehabilitation projects.

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<sup>1</sup> Irrigation districts in New Zealand have been privatised and now act as private companies, owned by the irrigators themselves. Irrigation schemes developed and run by the New Zealand Government were sold to users in 1989-90 following a general policy shift to divest assets and liabilities and provide greater commercial opportunities. The schemes were sold to users at a favourable price after fair valuation, recognising their value derived from past investments by both the State and the irrigators. The price took into account future contingent liabilities that may have fallen on the government but was constrained by the lack of competitive bidders. Farmers are now meeting all the costs of running the schemes through established irrigation companies or incorporated societies. Analysis has shown that some schemes are being run at lower costs than they were under Government. In Valencia (Spain), there are numerous private associations owned by irrigators that have common facilities to pump and convey groundwater resources. Throughout this report, water user associations or irrigators associations will be referred to as irrigation districts.

A study by McCann and Zilberman (1999) examining water districts in California shows that districts' institutional arrangements may explain managers' resistance to water usage charges and plans that require infrastructure investments. Apparently, decision making by popular votes gives rise to managers' incentives to focus on economic development and equity goals, whereas value assessment-weighted voting schemes mimic typical firms, that are generally more eager to focus on efficiency goals.

As stated at the outset, the need to build large and complex common facilities is linked to the degree of water scarcity or aridity suffered in each area. They may not be very important in France, UK, Denmark and some Canadian Provinces, but they are irreplaceable organisations in situations where water must be stored and transported over long distances, and distributed through complex networks.

Irrigation districts' running costs are entirely borne by the irrigators. However, in many countries, investment costs are significantly subsidised, either in new schemes or in modernisation or rehabilitation projects. Most large irrigation infrastructures across OECD countries, irrespective of when they became operational, have been built with capital grants. Presently, irrigation districts projected to be developed in the next decade in Spain, Canada, Portugal and Turkey will require variable capital grants based on national legislation, reaching as high as 75% of capital costs in Canada (Hoppe, 2000).

In previous OECD reports, costs of irrigation districts have not been treated separately from those of purely private and State agencies (OECD, 1999). Recent work in the field of water institutions and irrigation management suggests that irrigation districts' role and performance warrant specific analysis (Dinar, 1999; Saleth and Dinar, 1999; García Mollá, 2001).

Unfortunately, most available documents do not distinguish clearly between State water levies and irrigation district charges. The former may or may not be collected by the irrigation districts, but as we will see in Section 1.4 they are meant to recover State costs, which would otherwise fall on taxpayers. In contrast, district charges are set by the irrigators themselves, through co-operative decision making processes, and are meant to cover the district's costs, which in turn are defined by the actions, plans and strategies that each district pursues. Australia has solved this circularity by obliging irrigation districts to realise financial returns on capital assets and to insure appropriate O&M costs recovery.

Among the issues requiring further work is finding and testing proper accounting procedures that allow State agencies to judge whether a given irrigation district is charging its customers proper depreciation and capital replacement costs. While such methodologies have been laid down for water utilities in, among other, Offwat Documents (in the UK), Spanish Association of Water and Sanitation Companies, Eureau (European Union), National Association of Water Companies in the US, no parallel effort has been documented for irrigation districts. An illustration is offered by the comparison between the Alqueva Project (Portugal) and a large inter-basin water transfer included in the Spanish National Hydrological Plan. While in Alqueva, the *ex ante* evaluation has set annual maintenance costs of new irrigation districts at 2% of the total investment project, the Spanish government believes that a reasonable figure is 1.5%. At current development costs, 1% of the investment costs represents more than US\$160 per hectare, which gives an idea of the impact on farmers' profits of following strict O&M costs recovery rates that include capital depreciation and replacement costs.

A major implication of this gap is that, even if one has access to primary data collected from specific districts' financial and management records, no assessment of the soundness of its accounting principles will be possible unless a technical report describing the state of the infrastructure is accompanied. Another implication is that benchmark comparisons are hardly possible.

An indication of the ambiguity is associated with "Community Service Obligations", as defined in the Council of Australian Governments report on Water Policy (1994). The Council established that 'wherever

practicable' districts should attain non-negative rates of return on all assets. However, the difficulty in establishing an appropriate rate of return is due to the fact that the current price is used to determine the economic value while the rate of return on the economic value is used to determine the price. To solve this circularity, the Productivity Commission emphasised the need for a sound basis for future developments of water and proposes a pragmatic approach to improving cost recovery pricing for rural water (National Competition Policy, 2001).

Table 2 reports various irrigation district costs selected from a number of irrigation districts across OECD countries.

**Table 2. Irrigation district costs**

Country/region	Districts	Water origin	District's charges	Type of charges	Source
Spain (Valencia)	Traditional	S	81-650 US\$/ha	Variable based on the # of applications	García Mollá (2001)
	Traditional supported by State projects	S	23-40.5 US\$/ha	Variable on the # of hours of usage	"
	Traditional districts	S &G	26-584 US\$/ha	Variable on # of hours and # of applications	"
	State Projects	S &G	2.70-97 US\$/ha	Variable on # of hours and # of applications	"
	Private associations	S &G	65-184 US\$/ha	Volumetric rate	"
Italy	Bonificata (Capitanata)	S	13.51 US\$/ha +0.078 US\$/m <sup>3</sup>	Block rate pricing	Xiloyannis & Dichio (2001)
	Puglia	S	81 US\$/irrigator + 153 US\$/ha	Flat rate	"
Greece (Crete)	Large Irrigation Districts	G	0.0595-0.068 US\$/cm <sup>3</sup>	Volumetric rate	Chartzaloulakis & Angelakis (2001)
	Community projects	G	0.085-0.102 US\$/cm <sup>3</sup>	Volumetric rate	"
	Private projects	G	0.19-0.30 US\$/cm <sup>3</sup>	Volumetric rate	"
Canada	Alberta	S	41.7	Flat rate	Hoppe (2000)
	Saskatchewan	S	51.7	Flat rate	"
France	Charente	S	9.35 US\$/ha + 0.0048 US\$/cm	Volumetric rate	Montiginoul & Rieu (2001)

S: Surface; G: Groundwater.

The figures shown in Table 2 are difficult to interpret, as they ignore the district costs structures and the specific financing procedures used to fix them. It shows, however, that private districts tend to have larger charges. This may result from the fact that private districts primarily rely on groundwater resources, providing integrated water supply services which render on-farm investments unnecessary.

Table 2 suggests that irrigation districts display numerous pricing systems, and quite significant cost differences. The selected examples should be taken as complementary to those included in previous OECD work (OECD, 1999). Another caveat is that the figures shown in Tables 1 and 2 should not be summed up. Usually irrigators either face fully private irrigation costs (Table 1) or a mixture of purely private and other district costs (part of items in Table 1 plus charges in Table 2).

## 2.4 State or Water Authority costs

State costs include all cost items directly related to the supply of irrigation water which are either covered by water charges and levies, or borne by taxpayers. Typically, these costs originate from two sources:

- Operation, management and maintenance costs of multiple-user infrastructures owned by the State or government agencies.
- Investment and financial costs associated with construction of water works used to service farmers or those contributing to regulate river runoff.

Table 3 shows the proportion of State or water authorities charges out of total irrigation costs in various countries and districts. The figures indicate that district costs tend to be more important in regions or basins where water is more scarce.

**Table 3. District costs versus State or Water authority charges**

		District costs	Agency costs	% Agenc/Dist costs
		(US\$/ha)		
Valencia (Spain) <sup>1</sup>	CRR Almanzora	247.9	12.8	5.1
	Canal Júcar Turia	142.0	14.0	9.9
	CRR Levante M.I.	978.0	315.3	32.2
Andalucia (Spain) <sup>2</sup>	Genil-Cabra	194.6	45.9	23.6
	Saskatchewan	41.7	29.2	70.0
Canada <sup>3</sup>	Alberta	51.7	33.3	64.5

Sources: <sup>1</sup>García Mollá (2001); <sup>2</sup>Sumpsi *et al.* (1998); <sup>3</sup>Hoppe (2000).

Judging from the proportion of irrigators' contribution with respect to the State costs, a common conclusion across countries may be that irrigators have been and still are heavily subsidised. Numerous authors and reports provide evidence of such assertion (Rao, 2000; Cummings and Nercessiantz, 1992; MIMAM, 1998). The recognition of such subsidies dates from the mid-80's (Gibbons, 1986) in the US, and early 90's in Australia (COAG, 1994), Spain (Martín Mendiluce, 1993), Mexico (Johnston, 1996) and Turkey (Çakmak, 1997).

Two kinds of subsidies should be identified and perhaps inspire alternative policy actions.

First, subsidies exist when farmers' contributions to cover State or public costs are not updated to match the growth of some cost items or to reflect inflation. However, as will be detailed below, all countries in the process of reforming their rural water pricing policies have ruled out any attempt to increase the cost recovery rates resulting from insufficient updating of charges, and concentrate instead on increasing farmers' contributions with the sole objective to reduce current and future taxpayers' contributions. This is evident from the district privatisation process in New Zealand, which hardly realised positive financial benefits to the State (Farley and Simon, 1996), but clearly fulfilled the equally important objective of reducing government losses.

Secondly, subsidies exist when State agencies exhibit low cost recovery rates. This second source of subsidies multiplies the effects of the first one. Many governments, including the Spanish one, candidly accept that the low cost recovery rates of already subsidised charges are insufficient.

The extent to which this second source of subsidies is important is difficult to ascertain. In part, this difficulty reflects the fact that Basin agencies and public agencies have made intensive use of cross-subsidisation to recover their costs.

Several reasons are proposed to explain this situation:

- The Spanish Government indicated that about 50% of its irrigated acreage is irrigated without proper clarification and definition of water rights, preventing the State's Basin agencies from charging any tariff or levy on the farmers operating under unclear water rights.
- In the past, irrigators were given water rights to multiple-use infrastructures which provided other social benefits, such as flood prevention or hydropower. In most cases, these infrastructures required long construction periods during which farmers tended to become the last beneficiaries. Hence, by the time projects became fully operational, the State had already incurred most of the construction costs before even knowing who will be the beneficiaries. Although in principle nothing prevents governments from capitalising these costs into farmers' water levies, at the time projects become operational, anecdotal evidence in virtually all countries shows that this has not been the case.
- Barraqué (1995) points to the differing political economy in the French Agences de l'eau with respect to other basin agencies, such as the Spanish and US ones that are heavily influenced by farmers groups. According to this view, in France the major water users are the power generation industries that abstract water for cooling purposes. French irrigators have never had the leading position they still have in Spain, the US, Mexico or Australia. As a result of such moderate position in the water policy arena, Agences de l'eau do not deliver French irrigators any special treatment in fixing charges or relaxing revenue collection practices.

## 2.5 *Social costs*

Social costs caused by irrigation are those inflicted on third-parties or on the environment. In both cases, social costs originate from irrigators' use of valuable resources or from irrigators' polluting production systems. The first case is generally associated with the opportunity cost, and provides an indication of the value of the water allocated to alternative users. Irrigation can affect the environment through (European Commission, 2000a):

- Direct impacts upon water resources
- Direct impact upon soils
- Direct impacts upon biodiversity and landscapes
- Secondary impacts arising from the intensification of agricultural production through conversion of rain-fed land into irrigated acreage.

Recent work shows that social costs are far from negligible, and provides solid basis for urgent policy action. A selection of these studies is discussed below.

- Water pollution. For instance, groundwater contamination by nitrates is widespread across OECD countries. In many cases, irrigated agriculture is thought to be responsible of

increasing nitrate contamination, due to over-fertilisation. Examples of such direct effects have been found in the Adour-Garonne (France); in several Austrian regions such as the Marchfeld, the Pandofer plateau, and the Welser Heide and Eferding Becken areas; in a number of regions in Spain, mostly located along the Mediterranean coast, and in various nitrate vulnerable Geek zones such as Argolid, Kopas and Thesaaly plain, where large irrigated areas are located (European Commission, 2000a).

- Over-exploitation of water resources. The list of regions or basins where problems related with excessive irrigated water use have been identified would be very long. Most severe problems have been experienced during drought periods in South Spain (1993-95), California (1987-1992), Texas (1997-1999) and Mexico (1993-1996). The analysis of these drought episodes suggests that irrigated agriculture may be responsible of water shortages inflicted on other users, including urban and industrial ones (Garrido and del Moral, 2001).
- A wrong perception about the scarcity value of water resources. Significant evidence has been accumulated since the early 90s in Australia about remarkable misalignments of water marginal benefits among competing water users. These differences arose when trade with water entitlements became common practice. Musgrave (1999) mentions that permanent water transfers occurred at annualised prices that are considerably higher than any likely cost-recovery price. This means that in the absence of trade, full cost recovery prices would have never ensured that water is efficiently allocated. It also suggests that until we start to witness the market prices in Spain, it will be impossible to confirm whether or not the hypotheses about large efficiency losses resulting from misleading allocation are true.
- Salinity problems directly associated with irrigated agriculture have been identified in the Colorado Basin (US) and the Murray-Darling Basin (Australia). The mitigation and alleviation costs evaluated for these two examples are enormous. For instance, the National Action Plan for Salinity and Water Quality in Australia represents a \$756 million commitment over seven years (Agriculture, Fisheries and Forestry, Australia, 2000).

The number of economic valuations of the social costs of irrigation has grown in the five years. Yet doubts about the validity of the methods used to obtain these valuations persist. A few examples of these evaluations are shown on Table 4.

**Table 4. Examples of valuations of non-financial costs associated with irrigation**

Case and source	Valuation	Method
Recreation values attached to lake water levels vs. Agri. use (Nevada, US) [Eiswerth <i>et al.</i> 2000]	Agric. value: \$ 0.1 - 0.035 /m <sup>3</sup> Recreation: \$ 0.14 – 0.525/ m <sup>3</sup>	Revealed preference and Contingent ehaviour surveys
Social pollution costs measured by water treatment costs (Texas, US) [Dearmont <i>et al.</i> 1998]	Due to sedimentation: \$0.02/m <sup>3</sup> Due to groundwater pollution: \$0.025/m <sup>3</sup>	Econometric analysis using urban suppliers cost functions
Groundwater over-exploitation, measured by costs of correcting strategies (Spain) [MIMAM, 2000]	\$ 0.22 – 0.50/ m <sup>3</sup>	Cost of water transfers to replace water taken from over-drafted aquifers (Cost effectiveness analysis)
Environmental compensation tax for inter-basin transfers (Spain) [MIMAM, 2000]	\$ 0.027 / m <sup>3</sup>	Environmental surtax imposed on water users to compensate regions (method not documented)
Salinity problems in the Murray River (Australia) [Mues and Kemp, 2001]	\$ 223 million	Net present value of the reduction in agricultural returns from high water tables.

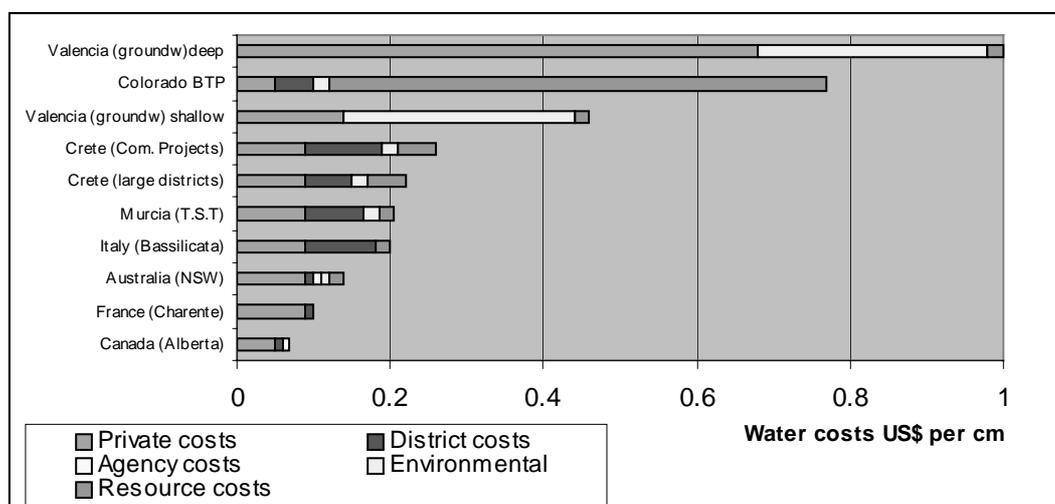
Another way to get an idea of the opportunity cost of water use in irrigation is to look at cost valuations of new supply projects for agriculture and other users. Table 5 reports recent data on projects that are under construction or under consideration.

**Table 5. New water supply costs (only investment costs)**

Alqueva Project (Portugal) <sup>2</sup>	\$ 0.135/ m <sup>3</sup>
Metropolitan Water District (Calif. US)	\$ 0.77 / m <sup>3</sup>
Los Vaqueros project (Calif, US)	\$ 6.25 / m <sup>3</sup>
Melonares (Seville, Spain)	\$ 1.62 / m <sup>3</sup>
Water transfer (Ebro – Almeria ≈800 km)	\$ 0.49 / m <sup>3</sup>
Desalinisation costs	\$ 0.7 –0.9 / m <sup>3</sup>

As the previous sections have shown, irrigators must incur differing water costs and categories. Direct comparisons are very difficult to come by because each case is characterised by an array of singularities, due to historical, technical, institutional and policy reasons. Figure 2 attempts to provide a graphical representation of the scale of different costs categories that may be present in a number of irrigation districts. Cost items for which no direct valuations have been found are replaced by cost “proxies”, based on mitigation costs (in both Valencian cases), water treatment costs (based on Dearmont *et al.* 1998), actual water market prices (in Australia - NSW, and Colorado CBTP).

**Figure 2. Cost references for different regions and costs' categories**



<sup>2</sup>

Recent sources indicate that the Portuguese government has decided to impose a charge of 0.057361 €/m<sup>3</sup> in 2002 (at prices of 2001) on Alqueva irrigators, which will be increased to 0.082302 €/m<sup>3</sup> in 2008 (at prices of 2001). While previous valuations had set the charges at 0.135 \$ per cubic meter, the Portuguese government decided to reduce farmers' charges to ensure adequate profitability. This required that “a large part of the investment in Alqueva will become non-repayable” (Portuguese Ministry of Planning” (<http://jornal.Publico.pt/publico/2001/09/04/economia/E03.html>).

## 2.6 *External benefits of irrigation*

In many countries, the use of water for irrigation is considered beneficial due to a number of external benefits. In Japan, irrigation and drainage canals support the urban infrastructure by letting in drainage from the city areas. Spain and Portugal perceive that the development of irrigation in isolated or rural and ageing communities helps to maintain active population in place and promote agro-food industries. In these countries, the presence of irrigated agriculture and the continuation of the farming activities have the associated benefit of landscape preservation and ensure that irrigation infrastructure is not abandoned. Irrigated agriculture constitutes in semi-arid countries a significant production and export sector.

Unfortunately, literature reporting on valuations of external benefits associated with agriculture is very scarce. In part this is due to the consideration of irrigation as part of the rural heritage and social fabric in countries, such as Spain, South West USA or Japan, where water devoted to irrigation is still perceived as a cultural value.

In Alberta and Saskatchewan, for example, it has been estimated that 15-20% of the total benefits of irrigation go directly to the farmer with the remainder to society (Hill, 1985). These benefits are from economic activity and employment beyond the farm gate that is derived from irrigation activity. Farm benefits are often a small part of the total benefit and projects become feasible only when all the beneficiaries contribute to the cost. When methods are found to access the wealth created by indirect benefits, projects would become more viable (Tollefson and Hill, 1994).

## 2.7 *Adverse incentives*

Adverse incentives give rise to a number of situations of social welfare losses. Adverse incentives may exist in the form of subsidies, either implicit or explicit, but may also be identified in situations where they do not exist. The nature and history of irrigation development advise to make a clear distinction between the incentives guiding actions and strategies of already existing irrigators or irrigation districts, and the incentives that promote the development of new irrigated areas whose benefits can hardly compensate total development costs.

### 2.7.1 *Adverse incentives to existing irrigators and irrigation districts*

Adverse incentives may be associated with situations characterised by clear misalignments between farmers' private objectives and behaviour and more general social objectives. The presence of divergence between private and social objectives is manifested by various indicators. One is the widening of the gap between farmers' water marginal productivity and the sum of the costs incurred by society for making the resources available to them. Another is the confirmation that the water costs of competitor users' may be rising as a result of farmers' water use or polluting practices. Note that the manifestation of adverse incentives is perceived through time and not in snapshots. This implies that policy judgements should preferably be based on whether observed trends show improvements or worsening.

A list of adverse incentives are listed below:

- Agricultural policies that promote water consuming crops

Examples across the European Union of water demanding crops supported by Common Agricultural Policy (CAP) programmes are numerous. Corn is considered a water-demanding crop in temperate countries, and its EU growers are entitled to a direct subsidy of 54 € per Ton of yield, which usually exceed 10 Tons/hectare. Since the CAP direct subsidies were fixed to

deliver equivalent levels of income support to all cereal, oilseeds and protein crops, they favour crops such as corn, rice, cotton or tobacco that demand much more water than oil crops such as sunflower or colza. Work done by Calatrava and Garrido (2001) shows that CAP's Agenda 2000, as the reform was called, will tend to increase irrigators' water demand in the Spanish Andalusian region with respect to the pre-2000 situation. These authors show that the price support delivered to cotton producers in the region is largely responsible for the large marginal benefit of water in the region. Hence, if it were removed, it would be less costly to convince farmers to reduce water consumption either through water markets or through public buy-out actions to service other users' or environmental needs. However, Dono *et al.* (2001) showed that lower agricultural subsidies would make water demand in Italy more inelastic, which contradicts the results of Calatrava and Garrido (2001) and of Rainelli and Vermesch (1998).

– Per hectare water charges

Per hectare charges are perhaps the most adverse incentive affecting irrigation across OECD countries. Very few irrigated districts relying on surface waters have volumetric or other variable rate systems. The wide recognition of the need to change the tariff structures towards volumetric charges has not been accompanied by clear examples of policy implementation. To date, no rigorous evaluation has been made to measure the value of the efficiency losses resulting from per hectare charges.

In part this gap is explained because countries with regular or occasional water charges impose water use limitations or quotas. Montginoul and Rieu (2001) report that irrigators in Charente (France) are charged with two-part tariffs, but the fact that the variable rate is much lower than the marginal benefit of water use in the farms advised the managers to impose water quotas in years of scarcity.

This example, as many others that show similar use of quotas or allotments, suggests that efficient allocation can be made without prices, and that the combination of quotas and cost-recovery charges – not including the opportunity cost of water as the European Union foresees in its Water Framework Directive – may be a viable mix of instruments.

However, wide evidence suggests that the existence of variable rates explain the significant water use levels found in studies using a large number of cases. The comparison of water use levels of irrigators using surface water with others' relying on groundwater may provide an indication of the effects of wrong signalling caused by flat rates. Hernández-Mora and Llamas (2001) show that groundwater users tend to use between 25% to 35% less than surface water users. A dollar value of such water use differences is difficult to come by, but may be equivalent to a lower bound of 20 to 45 \$ per hectare, with the most conservative assumptions. A non-valued recognition is also made by the US Department of Interior (1998) of these differences.

As will be argued below, numerous obstacles prevent making progress in replacing flat rates with volumetric rates. Among them is the fact that it may not be efficient to do so, under broad range of realistic situations. Work done by Tsur and Dinar (1997) illustrate the efficiency gains may not justify the costs of restructuring tariffs. Chakravorty and Roumasset (1991) and Hafi *et al.* (2001) show that volumetric charges would have wealth re-distributive effects in large districts with network losses. Furthermore, the simulations done by Hafi *et al.* in several irrigation districts in Australian Murray-Darling Basin show that the efficiency gains are very small, as the river diversion reductions will be at most equivalent to 12%. This

maximum gain would result from the combination of efficient pricing and a reduction of conveyance losses.

– Subsidies to invest in irrigation technologies

Investment in irrigation technologies has ambiguous effects in general policy evaluations. Negative effects result from the fact that subsidies reduce the costs of irrigation applications increasing total water consumption. García Mollá (2001) shows that drip irrigation technologies have been subsidised in the region of Valencia in Spain, but contrary to general belief, irrigators have not reduced application rates.

New technologies are often associated with lesser environmental impacts. These arise from various sources, including the introduction of precise agriculture systems, which permits lower water application rates and more precise use of crop-protection products.

Positive results come by increasing water productivity, which in turn would reduce the windfall welfare losses resulting from water price increases. Rainelli and Vermesch (1998) showed that one reason that explains the significant growth in French irrigated acreage is the subsidisation of irrigation equipment, which reinforced the CAP incentives mentioned above.

The extent to which subsidisation of irrigation equipment should be taken into account in water subsidisation analysis is not clear. For one thing, a general belief is that these subsidies are redundant, because irrigators eventually invest in equipment with or without subsidies. Some of the reasons guiding their investment plans are labour cost reductions, lower input application costs through fertirrigation and upgrading produce quality. Simple calculations assuming a capital grant of 50% of the investment costs shown on Table 1 yield changes in the resulting water cost in the neighbourhood of 2%. But if they are redundant, they should be eliminated releasing taxpayers' money for other purposes.

### 2.7.2 *Adverse incentives in planning new irrigation development*

Some OECD countries still experience growth in their irrigated acreage. Turkey's plans to continue the Anatolia Project may still take decades to double present Turkish irrigated acreage. In Portugal, the Alqueva Project in the Guadiana Basin will add about new 110,000 hectares to the 787,236 presently irrigated in the country. Spain's growth will be moderate, but still 242,000 new hectares will be added by 2008 to the present acreage of 3,4 million hectares, which represents a 7 % growth rate (MAPA, 2001).

Portugal have obtained approval by the European Union's Cohesion Funds (FEOGA and FEDER), which shows that the project has successfully passed the EU Commission standard procedures for funding approval, ranging from environmental impact assessments to demonstrating the soundness of economic and social evaluations.

The Spanish case merits specific discussion, because its apparently mature water economy may be in conflict with a 7% growth in its irrigated acreage. A few facts are needed to learn about this plan. First, the new acreage will be located in basins where water resources are still available, but where irrigated agriculture's productivity is about five times lower than in the most productive regions. Secondly, all new acreage will result from the finalisation of projects that have been given significant impulse, but which still need substantial investments to become operational. Thirdly, on the average, a new hectare will cost about 10-15,000 \$, not including private irrigation equipment.

Some of the arguments proposed to defend the Spanish plan are: (1) irrigation contributes to rural development, fixing population in areas threatened by ageing population and abandonment; (2) important infrastructures have already been built; (3) new irrigation will promote more efficient and competitive food processing industries; (4) the beneficiary farmers have long demanded the investments and are willing to contribute with the 50% of the costs. Spain's plan includes also the notion of "social irrigation projects". Encompassing less than 4,000 hectares and located in remote or marginal areas with accessible water resources, these projects are believed to have special strategic value because of their relatively low cost, the potential to reverse downward economic trends and fix active population in areas suffering from emigration.

Work done by Sumpsi *et al.* (1998) shows that, even considering the income and price support presently delivered by agricultural policies to irrigation farmers, some of the districts under expansion will never be in the position to provide the 50% contribution foreseen in the plan.

The Alqueva irrigators in Portugal will not operate more benignly than the current CAP and WTO Agreement presently ensures, yet their water productivity will only allow them to contribute for the energy and districts O & M costs.

All these facts suggest that, in these new districts, irrigators will hardly be able to pay a small part of the investment costs, in addition to conservatively estimated O & M costs. What the history of irrigation in developed countries shows is that, under the present circumstances, it is very likely that irrigators' debt with the State will eventually be written off, and that their limited benefits will only allow them to cover their running costs.

### **3. Price responsiveness of irrigation water use**

#### **3.1 Literature review**

The number of studies showing that irrigators' water demand is highly price inelastic, at least at low water prices, is at odds with the fact that there are large differences in water consumption and application rates among irrigators and water districts. If demand is inelastic, how should this finding be interpreted in view of the significant consumption differences encountered among districts and irrigators operating under similar conditions? One would assume that, if a set of irrigators seem to operate with low consumption rates, then another operating under similar conditions could be flexible enough to reduce its consumption. Whether it is a change of water price or a reallocation of water rights, the conclusion would be that the latter irrigators can and should reduce their consumption, following a relatively elastic water demand curve. However, the literature suggests that irrigation water demand is quite inelastic.

Before delving into this paradox, Garcia Molla (2001) suggests to think of water as a productive input, whose demand elasticity depends on three factors:

- The elasticity of substitution of water for other inputs.
- The share of water costs as part of irrigators' total costs.
- The price elasticity of demand for the good being produced.

Standard economic theory suggests that, if: (a) water cannot be substituted by other inputs; (b) water costs represent at most 20% of the irrigators' total costs (Garcia Mollá, 2001, finds that in Valencia is in the neighbourhood of 10%); and (c) food and agricultural demand has been found to be inelastic, then water

demand should also be inelastic. The assumptions embedded in this reasoning turn out to provide clues that may solve the paradox. If technology is fixed, water rights are not tradable and water allotments are exogenous to the farm, then water demand is likely to be inelastic. Perhaps, looking at water use levels allowing for long-term adjustments, or looking at farms which do not rely on fixed water allotments, would exhibit greater elasticity.

However, relaxing these three assumptions clears the puzzle, but opens two more.

First, the adoption of water saving technologies is generally found in districts whose water allotments, granted by basin agencies, have experienced a gradual decline. Determining what is the cause and what is the effect is difficult to ascertain, because all that changes, namely, water consumption, allotments and technology adoption, evolve simultaneously (Garrido *et al.* 2000).

The second one stems from the fact that, in virtually all empirical attempts to measure water demand elasticity, the researched districts do not face any opportunity cost resulting from its water consumption. This means that most demand analyses posit hypothetical price increases and then infer what would be the likely response of farmers using modelling techniques. Does this imply that water tradability or variable cost charges would suffice in reality to allow irrigators to exploit the efficiency gains found from cross-sectional studies? In other words, is the absence of variable prices responsible for the relatively inelastic demand found by numerous analysts? If the answer is positive, reforming water charges would result in significant consumption changes.

Recent work by García Mollá (2001), in perhaps the most detailed analysis ever done in Spain to explain water use differences across all districts in the Region of Valencia, shows that water use variability is largely explained by three factors, namely, the type and institutional arrangement of districts, the origin of the used water, and the type of pricing scheme. Table 6 summarises her econometric results.

**Table 6. Water consumption differences among Valencian irrigation districts**

(type org, type rates) +, means more consumption -, means less consumption S: surface water; G: groundwater		Type of district rates			
		Two-part based on # Hours	Two-part based on # applications	Flat rates	Variable based on # Hours
Type of organisation	Traditional districts supported by State projects (S)	(-, -)	(-, +)	(-, +)	(-, -)
	Traditional districts (S&G)	(+, -)	(+, +)	(+, +)	(+, -)
	State projects (S&G)	(+, -)	(+, +)	(+, +)	(+, -)
	Private Associations (G)	(+, -)	(+, +)	(+, +)	(+, -)

Source: García Mollá (2001).

García Mollá's results suggests that "Traditional districts supported by State projects" combined with "Two-part tariff systems" exhibit lowest consumption levels. It also suggests that all districts using groundwater exclusively or in combination with surface waters tend to consume more than those that rely exclusively on surface resources. Lastly, flat rates are directly associated with larger consumption.

García Mollá's work provides evidence that seriously disputes the results of Llamas *et al.* (2001), although this one did not consider Valencian districts. Perhaps the conflicting results can be reconciled by the fact that in Valencia surface water is very scarce and much less reliable than groundwater sources, whereas in Aragon or Andalusia surface water is generally more abundant.

Recent work by Dono and Severini (2001) in Southern Italy adds further evidence to the inelasticity hypothesis. They also suggest that water demand turns increasingly less elastic as water charges increase, and as the economic environment in which agriculture evolves deteriorates, in the form of lower subsidies and prices.

Xiloyannis and Dichio (2001) show that large water consumption differences for the same crops are found between a district in Puglia and another in Basilicata. Among the differences found in their areas of study is that the Basilicata district charges flat rates, whereas the Puglian one has the following block-rate system:

- Flat rate of US\$ 13 per ha.
- Variable rate \$0.076 per cm (for less than 1300 cm/ha); \$0.08 per cm (for 1300-2000 cm/ha); \$0.13 per cm (for 2000-3000 cm/ha) and \$0.18 per cm (for any unit exceeding 4000 cm/ha).

### 3.2 *The need to refine demand analyses, conclusions and suggestions*

Hydrologists and ecologists warn that very little is known about the way current resource patterns affect the state of hydrologic systems. Irrigated agriculture being the main water user in most of the OECD countries and regions where water scarcity is perceived more sharply, more research is needed to learn about the effects of alternative policies on the environment. Some of the issues that require further attention are listed below:

- The presence of return flows and water conservation restrictions to integrate them in policy evaluations.

In highly appropriated river basins<sup>3</sup>, upstream return flows are critical to ensure that downstream users can exert their water rights (See Box 1). Huffaker and Whittlesey (2000) analysed various definitions of water conserving technologies and contrasted them with the way various US State programmes and Water Codes make them operational. The debate is placed on the criteria to determine how water savings should be measured. According to Huffaker and Whittlesey (2000), California's statute definition of water conservation is "the reduction of the amount of water consumed or irretrievably lost in the process of satisfying beneficial uses which can be achieved either by improving the technology of the method for diverting, transporting, applying, reusing, salvaging, or recovering water, or by implementing other conservation methods" (p.58).

By contrast, Oregon's statute provides a much less restricted definition of reductions of water consumed or irretrievably lost, focusing only on whether diversions from water bodies would be reduced as a result of any water conserving initiative.

Return flows add complexity to any effort to carry out agricultural demand analysis. This is because irrigators' consumption must be quantified as the difference between abstracted or diverted flows and the return flows. Thus, to model price responsiveness, and evaluate demand elasticity, it is important to incorporate hydrologic models that permit obtaining approximate values of water flows and movement at various stages along the path from the abstraction point to the return location.

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<sup>3</sup> A degree of basin "appropriation" is the ratio of the sum of all water granted by means of operative or outstanding water rights over the basin's available resources in an average year.

**Box 1. The return flows externalities**

Irrigation return flows constitute a significant portion of stream flows in the US West, Spain, Australia and Mexico. Irrigators can improve their use efficiency rates by developing water-conserving strategies. Any action to conserve water aims to reduce the rate of application losses, ensuring that a larger proportion of the diverted volume reaches the root zones of crop. Private benefits accrue as a result of greater crop yields or produce quality because of less moisture stress. Higher efficiency rates imply lower return flows, which may or may not reduce stream flows in downstream locations. Work done by Huffaker and Whittlesey (2000) and Garrido *et al.* (1997) show that, under plausible conditions, ensuring water conserving strategies to result in lower consumption or lower irretrievable water loss requires reductions in water diversions. Otherwise, water-conserving technologies would result in larger consumption rates at the river basin level. The US Department of Interior's blueprint plan "Water in the West: The Challenge for the Next Century" (1998) states that "Estimating potential benefits from water conservation is difficult. The National research Council explains that, while increasing irrigation efficiency can reduce the amount diverted, the return flows will be decreased because "conserved" water is often used elsewhere on the farm or by other water users" (p.6-24).

- Salinity problems and how to evaluate correcting policies.

Salinity and related water quality problems are known to cause serious damage to economic activities and ecosystems. Although recognised as major threats to numerous river basins across the world, perhaps the Colorado and Murray Darling Basins are two of the most intensively analysed cases across OECD countries. An indication of the relevance in Australia is the US\$ 0.75-billion, 7-year "National Action Plan for Salinity and Water Quality in Australia" (Commonwealth of Australia, 2000), and the projection that about 1 million hectares may become affected by the rise of water tables. In evaluating the Australian salinity mitigation policy, Mues and Kemp (2001) point out various challenges that will require further work to increase the chance of success. First is the setting of a baseline for future economic impact of the water quality degradation from salinity, which means evaluating the additional costs society will bear if the problem is not tackled. Secondly, forward looking policies must be evaluated and compared against the baseline calculations. Third is the recognition that all management changes will not come without secondary damages, which must also be evaluated. For instance, re-vegetation may reduce groundwater recharge, but it may also reduce surface run-offs, reducing water availability for downstream users and for salt dilution.

Bell and Beare (2000) take on to examine the way the Australian salinity plan has set salinity targets to provide measures of accountability and performance against a range of quantitative objectives. Among two possible targets, salt concentration and salt loads, the authors discuss pros and cons and draw a few key conclusions. One is, that depending on the characteristics of the sub-basin or location, one target may be more appropriate than the other to track progress and evaluate performance. Second is the assumption that if salinity targets are enforced, some individuals and groups will be subject to processes outside their control, but they will be liable for the outcomes. This suggests that solving salinity problems must face the challenge that those bearing the costs may not be the direct beneficiaries. While Bell and Beare suggest that policy incentives, where possible, should use market incentives, major obstacles still persist in designing legitimate, enforceable and efficient instruments that take into account both primary and secondary effects.

In sum, the Murray Darling case illustrates that water resources must be measured and managed according to quantitative and qualitative measures. While it is widely recognised that agriculture is responsible for most salinity problems across world river basins, reverting the strong inertia of soil salt concentration caused by decades of salt loads will require multi-billion dollars and years of programmes and actions. None of these can be carried out without the support of irrigators, who will bear the lion's share of the costs.

- The fact that groundwater is not constrained and surface water generally is.

Apart from the Netherlands where farmers are subject to a tax of US\$ 0.03/cm<sup>4</sup>, in majority of countries groundwater resources are regulated by barriers to entry and zoning provisions that restrain potential users to drill new wells. This means that, unless serious problems of over-exploitation exist, irrigators will be free to pump as much as they want. Table 1 showed that groundwater may be very expensive, but at the same time it provides much more flexibility than other irrigation systems organised in turns or subject to network failures. Surface water is less reliable in drought-prone areas and its supply services are largely constrained by the state of infrastructure. Transportation efficiency rates of about 50% are quite normal in large irrigation areas.

To solve the water demand elasticity paradox mentioned above, it is useful to distinguish between districts that are subject to allotment constraints from those that are not. In general, groundwater users fall on the latter case, but a case by case analysis is needed for surface water.

A conclusion emerging from a Seminar recently held in Italy<sup>5</sup> to discuss the role of water pricing in demand management systems is that higher prices promote more efficient land allocation patterns, but not much should be expected from water price increases in terms of reduced consumption. This implies that higher prices will help farmers become more efficient, and this may help increase their contributions through water charges or at least make them more acceptable.

### 3.3 *Water rights allocation mechanisms and charges design*

All countries require irrigators to be given a permission, licence or entitlement to divert water and assign it to a "bona fide" or beneficial use. A "bona fide" activity is generally associated with any productive use carried out by the right-holder. Until very recently, in Australia, Spain and the US, irrigators were given rights to make beneficial use of the water. This meant that if irrigators did not exhaust the yearly allotments for a number of seasons, they would risk losing their rights. Presently, transferring the rights temporarily to another user is seen as a beneficial use. In general, irrigators are granted river diversion rights which entitle them to exhaust the diverted volumes, although more recent water conserving policies distinguish between diverted volumes and water effectively used or irretrievably lost.

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<sup>4</sup> Hellegers and Ierland (2001) report that only 2% of Dutch farmers pay the tax, as the Groundwater Act (1985) foresees that it should be applicable for any unit exceeding 40,000 cubic meters per annum. This is another example of the combined use of quotas and prices that effectively keeps farmers' water use levels under control.

<sup>5</sup> Trans-national Workshop on Managing Water Demand in Agriculture through Pricing: Research Issues and Lessons Learned (CNR-ISPAIM, Irrigation Institute, Ercolano, Italy), Telesse Terme, 24-26 May 2001.

Water rights can be defined under diverse forms and criteria. The procedure to obtain a water right has evolved through history and varies across countries and regions. A typical irrigation district in Spain or Western US States has rights to a proportion of the water flowing to a reservoir, which farmers can make use of, respecting a number of provisions and rules. These rules are usually based on Water Codes, but the details were set forth by the time the infrastructure came into operation, and may be amended through statute procedures with agreements among all parties involved including government agencies. In Spain, old irrigation districts claim water rights that date back centuries. In the Western US, the doctrine of prior appropriation, under which access to water is ordered by the relative seniority of the water claimants, coexists with proportional rights that ensures equal access to water among all right holders. In Spain, water access is ordered by means of a mixed system, which includes priority users and proportional distribution among use classes. Basin plans envision many exceptions to the general rule, based on historical rights, infrastructural constraints and other reasons.

### 3.4 *Distinctive approaches*

Among the obligations of new right holders resulting from new infrastructures, is paying the charges resulting from the sum of a number of items, which include the repayment of part of the investment costs, the debt servicing costs, and part of the O&M costs of the infrastructure.

Singular infrastructures seem to follow more strict criteria to set irrigators' charges, yet significant deviations from strict full cost recovery are identified. For instance, transfers such as the Colorado Big-Thompson Project (CBT) in Colorado (US) and the Tagus-Segura Transfer (TST) in Spain show that moderate cost recovery rates can be effectively established and raised from the projects' customers, including irrigators. These two major infrastructures were developed by public agencies with the help of public financial support, but currently operate with the entire support of projects' beneficiaries.

An interesting difference is that in the CBT right-holders are allowed to sell or lease-out their rights with the special restriction that the buyer must be located within the boundaries of the district, whereas TST right holders are not allowed to trade the water rights. During drought periods, TST has serviced water to the Las Tablas de Daimiel wetlands to ensure wildlife habitat conservation.

Due to intense urban growth in the Eastern slope of the Colorado Rocky Mountains, the market price of permanent water rights has grown from US\$ 0.81 per m<sup>3</sup> (equivalent to an annualised rate of US\$ 0.04 per m<sup>3</sup>) in 1988 to \$US12.9 per m<sup>3</sup>, (or US\$0.645 per m<sup>3</sup> in annual terms) in 2000. This illustrates that full-cost recovery prices do not reflect the resource value in the CBT project; instead it is by means of the exchange prices that one can learn about water's opportunity cost and users can adjust their water use by observing the market value of water. Curiously, the charges paid in the CBT depend on whether or not right-holders have changed hands since 1959. While initial beneficiaries must pay an annual fee of US \$1.50 per unit, which on average entitles its holder to 964 cm, irrigators who acquired units from initial right holders must pay US\$ 7.38 annually per unit. At this charge level, market price for water is roughly a hundred times higher than the annual charge paid to cover the US\$16 million operating budget of the CBT.

Hoppe (2000) assumes that a realistic repayment rate in a newly irrigated area in Alberta (Canada) would be about 25% of the investment costs, and about 17% in Manitoba. While these subsidisation levels may be equivalent to those for the direct beneficiaries of CBT and TST, their rate structure currently in place would not tell us anything about water allocation efficiency. In other words, efficient water allocation is one thing and adequate cost recovery rates another. While the latter will certainly help the efficiency objective, the former does not require any cost recovery level to occur, once the project starts operating.

The approaches to full cost recovery charges in Spain, the US and Australia differ quite remarkably. While Australia has made progress with existing irrigators, their counterparts in Spain and the US have not been exposed to charge increases, although a few signs of change are visible in both countries.

Two major approaches are identified from these two countries' recent progress.

a) The US Bureau of Reclamation

In the US, federal policy establishes that irrigators that are beneficiaries of Bureau of Reclamation's projects should renew their contracts with new financial obligations, resulting from the objective to reduce the costs currently borne by taxpayers. The 1999 Reclamation Reform Act requires that any new contract or contract amendment between the irrigation districts and the Bureau of Reclamation must include full cost recovery charges. The 1999 Californian Central Valley Improvement Act obliges all water districts to implement Best Management Practice plans and adopt a water pricing structure for Contractor water users based at least in part on quantity delivered.

The US Bureau of Reclamation, as mandated by the 1999 Reclamation Reform Act, will be renewing contracts with districts conditional on the redefinition of water charges, to be calculated following full cost recovery prices. It will also review the implementation of best management practices, which include, among others, water metering, application of incentive pricing within the irrigation district, and environmental assessments for rehabilitation or modernisation projects (see Box 2).

**Box 2. The Central Valley Improvement Act (California)**

**METERING OF WATER USE REQUIRED.** - All Central Valley Project water service or repayment contracts for agricultural, municipal, or industrial purposes that are entered into, renewed, or amended under any provision of Federal Reclamation law after the date of enactment of this title, shall provide that the contracting district or agency shall ensure that all surface water delivery systems within its boundaries are equipped with water measuring devices or water measuring methods.

**WATER PRICING REFORM.** - All Central Valley Project water service or repayment contracts for a term longer than three years for agricultural, municipal, or industrial purposes that are entered into, renewed, or amended under any provision of Federal Reclamation law after the date of enactment of this title shall provide that all project water subject to contract shall be made available to districts, agencies, and other contracting entities pursuant to a system of tiered water pricing. Such a system shall specify rates for each district, agency or entity based on an inverted block rate structure with the following provisions:

- (1) the first rate tier shall apply to a quantity of water up to 80 percent of the contract total and shall not be less than the applicable contract rate;
- (2) the second rate tier shall apply to that quantity of water over 80 percent and under 90 percent of the contract total and shall be at a level halfway between the rates established under paragraphs (1) and (3) of this subsection;
- (3) the third rate tier shall apply to that quantity of water over 90 percent of the contract total and shall not be less than the full cost rate; and
- (4) the Secretary shall charge contractors only for water actually delivered. The Secretary shall waive application of this subsection as it relates to any project water delivered to produce a crop which the Secretary determines will provide significant and quantifiable habitat values for waterfowl in fields where the water is used and the crops are produced; provided that such waiver shall apply only if such habitat values can be assured consistent with the goals and objectives of this title through binding agreements executed with or approved by the Secretary.

Source: U.S. Code.

b) The Spanish approach

Spain follows various distinctive approaches. According to the 1999 Water Law reform, three slightly different avenues are open to change irrigators' water charges. First, all irrigators with prevailing water rights will be obliged to meter their water consumption, and their charges may be augmented by a factor 2 and reduced by a factor 0.5 if the recorded consumption exceeds or falls below a standard consumption based on the area's crops and technical and natural conditions. These standards can be assimilated into "best management practices", though it remains to be seen how they will finally be fixed.

The second possibility results from the creation of new "water companies" to which the State provides 50% of the capital and the future companies' customers the other half. This means that future irrigators and customers will have contributed 50% of the capital costs of the new infrastructure and will be contributing all O&M costs to ensure its financial stability.

The third possibility will be applied to the future customers of the large water transfer envisioned in the recent National Hydrological Plan, which plans to provide water to about 90,000 hectares of land currently under irrigation. The transfer's agricultural customers, representing about 55% of all transferred water, have been screened with two criteria: one is exposure to insecure or insufficient water supply, and the other is reliance on over-exploited aquifers. In the latter case, irrigators will have to relinquish all rights to tap the aquifers, in return for the water serviced by the transfer. The Plan's background studies foresee that farmers will pay about US\$ 0.28 per m<sup>3</sup>, which presumably includes all transfer O&M costs, a significant part of the investment costs and an environmental compensation component equivalent to US \$ 0.027 per m<sup>3</sup>. The proceeds of this environmental charge will be assigned to environmental projects in the Ebro basin, which provides the waters to be transferred to four other basins.

In short, the trends in Spain continue to consolidate a three-pronged model, in which old users will likely maintain their status unless the implementation of the Water Framework Directive of the EU (discussed below) brings about significant changes in the costs' evaluation criteria at the basin level.

Thus Spain's case will evolve quite differently from the US one, or at least in the command area of Bureau of Reclamation. In the US, process will take place case by case, using the contract renewal negotiations to reformulate a whole array of issues, including pricing, best management practices, water rights redefinition, harmonisation with environmental needs and restoration of water rights to Indian tribes and nations.

Plausibly, Spain's recovery rate may improve faster than in the US because of two factors. One is that only Federal agencies' beneficiaries will be renewing their contracts, which means that about 50% of the US irrigated acreage will be left outside of this policy. Thus, unlike the Australian and European cases, which force all jurisdictions and member states to move at similar pace, US irrigators not serviced by federal agencies will be subject to State or local policies, which may or may not identify full cost recovery prices as a substantial policy change. The second one is that in Spain, as in all EU member States, any water user will become in 2010 liable for all water service costs, irrespectively of how water supply is performed, the origin of the water and type of users. The fact that any unjustified exception will make the violating country subject to financial sanctions ensures that the policy is potentially applicable to all irrigators.

### 3.5 *Market incentives and pricing policies*

While water trading has been a common practice in Western US since the first signs of scarcity were felt decades ago, Australia and Spain have resorted to regulate water right exchanges more recently.

In Australia, the Council of Australian Governments (CoAG) made explicit in 1994 the need to facilitate water entitlement exchanges to increase water use efficiency and to provide an acceptable solution to those users who could not pay the full-cost recovery prices. The CoAG assumed that the best way to offset the impact of rising water prices was to allow inefficient farmers to sell their entitlements to restructure their farms or abandon irrigated agriculture. Water tradability across and within Australian States required that progress towards full cost recovery was consistent among Jurisdictions to prevent market distortions caused by different charge criteria (Pigram *et al.*, 1992). In the Murray-Darling basin, a moratorium was introduced in 1994 to prevent further growth in use, although the four riparian States interpreted and implemented it under slightly different forms, giving rise to some friction among the States once inter-state trading was initiated.

In addition, water exchanges have been associated with increases in extraction rates and in salinity levels (Bjornlund and McKay, 1998). Looking at actual exchanges in South Australia during 1987-1993, these authors conclude that "...market analysis gives some indications that inefficient water buyers and buyers with environmental problems are capable of purchasing water at reduced prices. This is against the intentions of tradable water entitlements and can have a negative impact. The analysis also lent some support to the theory that sellers under pressure to sell in thin markets have to accept lower prices from opportunistic buyers in stronger financial positions..." (p.1569). New attempts have been made to regulate inter-state trading in the form of a Pilot project, promoted by the Murray-Darling Basin Ministerial Council (see Box 3).

### **Box 3. The Australian interstate water trading pilot project**

With the objective of facilitating interstate water trading and water price consistency, the project aimed at eliminating the fears of upstream rural communities resulting from large volume of water sales, leaving these communities with significantly lower tax base and insufficient water to justify and pay for the maintenance of existing irrigation infrastructure. In general, the project resorted to pose limits on water sales, excluding irrigators within irrigation areas operating with gravity systems or limiting total sales to 2% on water export each year.

In addition, two different exchange rates were introduced to prevent environmental and third party damage. For instance, due to the reduction of dilution flow, trade from South Australia to New South Wales is subject to a exchange rate of 0.9, which means that one unit sold entitles its buyer to 0.9 units. A primary objective of the project is to prevent increases in salinity levels, reduction of river flows and degradation of the environment. To fulfil this aim, each State established clearance procedures to ensure that trading also benefits the environment. In Victoria and NSW the state governments are financially responsible for any increase in river salinity (Salinity and Drainage Strategy).

Recorded trade under the project seems to follow a consistent pattern, characterised by:

- Price ranges for permanent entitlements of US\$ 0.59 and 0.65 per cubic meter, which in annualised terms may be equivalent to about US\$ 0.03 per cubic meter. This clearly indicates that most trading has had irrigators as buyers and sellers.
- Most exchanged units were acquired by grape growers in South Australia
- About 21% of the water sold was in the hands of rights-holder who, prior to the option to trade their rights, did not used them (sleeper of dozer water in the Australian jargon), and 47% was previously used for pasture or broad acre cropping.

Source: Bjornlund and McKay (2001).

Spain's new 1999 Water Law will allow right holders to lease-out water rights. To become effective, a Regulating Decree will have to be passed to lay down specific details regarding the definition of water rights, the legal procedures to submit exchange proposals to the Basin Agencies and, most importantly, how to define and measure the amount of water that each right holder can effectively lease out. The Law article 61bis, that lays down the basic conditions of the water transfers, does not establish any connection with the amendments proposed in article 106 to modify water charging schemes, except for the fact that water buyers will be responsible for the financial obligations assumed earlier by the seller.

Linked to the issue of return flows and the debate arising from conflicting views on water savings across US States, the Spanish market proposal states that Basin Agencies should define, accordingly with technical studies, the volume each right holder can effectively lease-out. Surely, this provision will reduce the volumes available for sale, but the Law opts for the safe side to avoid third-party effects and seems to follow the more restrictive view held by the California Statue regarding the definition of irretrievable losses. The European Commission (2000b) praised the Spanish move to liberalise the allocation of water resources, but failed to recognise the potential role of water trading as a means to send signals to market participants and non participants about its opportunity cost. However, the EU WFD explicitly excludes water trading in their mandates to Member states for reasons of competition.

The US has a long experience with water trading. However, since each State follows quite different approaches, it is difficult to establish general conclusions. The Bureau of Reclamation being the leading federal agency, it is instructive to learn its view on water trading in the "Final Report - Water in the West: The Challenge for the Next Century" released by the US Department of Interior in 1998. The report considers water transfers to be an essential mechanism to meet new urban demands and to restore environmental flows, in a fair and efficient manner. It mentions that governing institutions with intensive irrigation water use face "a difficult balancing act – to facilitate transfers on the one hand, recognising the benefits they may produce, and to scrutinise transfers, on the other hand, understanding their potential costs to society" (Department of Interior, 1998, p.6-27). To reduce social costs, the Federal agencies have a key role to co-ordinate approval procedures administered by State and tribal governments, ensuring that third party effects and environmental impacts are anticipated and reduced to the largest extent possible. The doctrine under which transfers' proponents or beneficiaries should bear the mitigation costs is fully endorsed, including the need to develop mechanisms to compensate communities for the losses of tax base resulting from transfers.

In addressing the debate on the potential use of transfer taxes to mitigate water project's environmental impacts, the report concludes that the "federal government should not try to recapitulate the subsidies involved in federal water projects beyond the repayment of all contractual obligations by the project beneficiaries" (p.6-28, Op.cit).

It appears then that the view of water markets in the US is now more prudent than previous widely held beliefs would assume. While most analysts and official reports admit that voluntary transfers are irreplaceable means of ensuring equitable apportionment among states, tribes, and for restoring environmental flows, finding ways to reduce the external costs and identify overall benefits of transfers is essential in order to maintain social acceptability (Easter *et al.* 1998).

#### **4. Review of on-going reforms across OECD countries or regions**

In this section, the report updates previous OECD work on water pricing, focusing on various aspects such as definition of costs, design and phasing-in of water tariffs and charges. Following one of the major conclusions emerging from "The Price of Water" (OECD, 1999), the experiences that will be examined in

this report will be framed within other overarching reforms. This will allow identification of political factors and major motivations for progress in, or initiating new pricing policy reforms.

#### **4.1      *Legal initiatives***

Various OECD countries have recently passed new water codes, altering, to a larger or lesser extent, the role given to water tariffs or other economic instruments. This section reviews new legal initiatives passed before or by the time the previous OECD work on water pricing was published.

##### **4.1.1    *The European Union Water Framework Directive***

After a long debate, lasting several years, in year 2000 the European Parliament and the European Council agreed on a final text which will change significantly the water policies of all Member States of the European Union and of the new accession countries. The EU Water Framework Directive (WFD, hereafter) has the overarching objective to improve the ecological state of the European freshwaters and the quality of the water services. The instruments set forth to achieve both objectives are (a) water pricing; (b) river basin management plans; and (c) programmes of measures to improve water quality in highly modified water bodies.

The WFD has inspired a significant amount of work from all fields ranging from ecology to social sciences. Even in the narrower area of water pricing, entire monographs such as “Pricing water: Economics, Environment and Society” (European Commission, 2001) have been devoted to the issue of tariffs.

In article 9, the WFD states:

“Member States shall take account of the principle of recovery of the costs of water services, including environmental and resource costs, having regard to the economic analysis conducted according to Annex III, and in accordance in particular with the polluter pays principle... [ensuring]:

- that water pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive,
- an adequate contribution of the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services, based on the economic analysis conducted according to Annex III and taking account of the polluter pays principle.”

Right after the passing of the WFD, the European Commission (2000b) issued a “Communication” with the objectives to clarify a few notions about water pricing, outline the major reasons behind a strict application of full cost recovery charges and propose guiding principles that may help the understanding of the water pricing articles.

A balanced interpretation of the WFD and the European Commission’s opinion regarding water pricing in the agricultural sector may include the following:

- The recognition that improper resource pricing may have contributed to the undesirable present state of freshwaters in the European Union.

- The expectation that water charges inspired by financial, environmental and resource costs is, and should be, applicable in its full extent in the irrigation sector and that it will deliver significant benefits to society in the form of lower consumption and lesser environmental impacts.
- The conviction that pricing is the best and most appropriate economic instrument to achieve both environmental and quality-of-service objectives.

Despite the clarification delivered by the EU Commission with the above Communication, the WFD foresees that Member States will be allowed to take into account the social, environmental and economic impacts of implementing full cost recovery charges. This implies that the external benefits associated with irrigated agriculture mentioned above will be invoked by interested Member states to justify partial application of article 9.

#### 4.1.2 *The 1999 Amendment of the Water Law in Spain*

In December 1999 the Legislative in Spain passed a Law that significantly amended the Water Law entered into force in 1986. The chief economic innovations affecting agricultural water pricing are:

- The authorisation to farmers holding water rights to lease them out or to buy from other right holders temporal utilisation of part or all their rights.
- The possibility of creating water banks at the basin level, to facilitate water rights trade among right holders under severe water scarcity circumstances.
- The obligation to meter water consumption by individual irrigators, or under cost effectiveness grounds, record consumption by irrigation associations.
- The definition of consumption modules based on the technical, agronomic and natural conditions of each irrigation district.
- The proposal to increase (reduce) farmers' charges if their metered consumption is above (below) the consumption module set for their specific conditions.

Apart from the exceptional cases of the recently created water companies and the special financial conditions legally imposed on proposed and existing inter-basin water transfers, the rest of Spanish irrigators will not experience significant changes until the WFD comes fully into force by year 2010. With regards to the full application of the WFD to the Spanish irrigation sector, it is still too early to anticipate what, if any, water charge increases will eventually be implemented. It is instructive to recall that Spanish irrigators are already subject to Basin Agencies' tariffs and levies, however loosely they may be defined or collected, so it remains to be seen whether the European Commission will simply accept the charge definition and a better collection rate, or require Spain to change its costs calculation criteria entirely. A fair view of the Spanish irrigation sector is that all private and district costs and variable part the O&M costs of the basin agencies are borne by the irrigators.

## 4.2 *The role of pricing in national plans or strategic documents*

This section summarises a number of official reports that are believed to provide the views, diagnostics and alternative actions to tackle water problems in some of the OECD countries in which irrigation is the major water consumer.

### 4.2.1 *U.S.A. "Water in the West: The Challenge for the Next Century"*

The U.S. Department of Interior commissioned the report "Water in the West: The Challenge for the Next Century" to summarise the major water trends in the Western States, identify key scientific facts and processes and make suggestions to address water problems effectively and sustainably.

At the outset of the Findings and Recommendations Chapter (#6), the report states that "West's waters are over-appropriated in many places....Substantial amounts of water are needed to address obligations to Indian nations, restore endangered species and meet society's growing needs... National, state and local objectives for the use of water may differ.... Therefore, there will be fewer truly win-win solutions in the future. [There is a need] to seek solutions that equitably share the burden and minimise social disruption" (p. 6-1).

A summary of the relevant issues covered in the report is the following:

- Non-point source agricultural pollution seems to stand out as a major source of water quality deterioration. Policies should continue to address this problem with consistent programmes and by establishing national benchmarks for water quality and for best management practices.
- Congress should prohibit the Bureau of Reclamation from granting new contracts, contract renewals or extensions, and other financial benefits for any project that has not taken steps to address impacts of agricultural drainage water.
- Federal agencies providing water-related services must re-examine their customers' subsidies to determine whether they serve current and future needs. Hence, new and renewed contracts should bring service prices closer to the tax-payers' cost of service provision.
- Water markets and exchanges will be promoted but closely checked to reduce third-party impacts and externalities.
- There is a need to ensure proper maintenance of water infrastructure. This includes appreciating the importance of sufficient O & M funding, recognising the fiscal desirability of preventive management, promote initiatives to privatise federal assets ensuring the compliance with environmental laws, the public involvement and the protection of taxpayers' interests.
- Protection of productive agricultural communities, and recognition that irrigators are simultaneously polluters and stewards of isolated communities and supporters of important undeveloped land that benefits habitats and wildlife. However, the report recommends that federal water policy should not subsidise growth and development in productive agricultural areas.

#### 4.2.2 *Spanish Ministry of the Environment “White Paper for Water”*

Issued in November 1998, the White Paper for Water (MIMAM, 1998) is the most complete and self-contained report about the current situation of Spanish water resources and governance. The report provides a detailed account of the pending water problems and the failures of programmes, laws and plans to address them or even revert the negative trends experienced in areas such as water quality, cost recovery rates or the control of groundwater uses.

In addition to stirring up the debate in Spain about the present and future situation of its water resources, the report's conclusions paved the way for three subsequent government proposals: the 1999 reform of the Water Law, briefly commented above, the National Hydrological Plan approved in the Lower Legislative Camera in April 2001 and the National Irrigation Plan made public in June 2001.

While the three proposals, due to enter into force or be implemented simultaneously with the European Union WFD, will significantly affect the rights and duties of the Spanish irrigators during the next ten years, only WFD proposes significant changes in the criteria with which water charges will evolve until the WFD is fully applied by year 2010. Nonetheless, the White Paper address institutional and legal issues and gives numerous details of the inconsistencies, gaps and needs that the Spanish water sector must address to better serve the interests of the general society and of water users.

#### 4.2.3 *The Canadian report “The Health of our Water. Toward Sustainable agriculture in Canada”*

Edited by Coote and Gregorich (2000), the 180-page report does use the term water “price” on three occasions, all of them in Chapter 9 titled *Maintaining Reliable Water Supplies*. Canada's main preoccupations in the field of irrigation are water pollution and insuring irrigators and other rural areas reliable sources. As has already been mentioned, Canada may experience a significant irrigated acreage growth in the next decade. Calculations made by Hoppe (2000) show that irrigated agriculture is about twice more profitable than dry-land production. However, despite the extremely low cost of developing new irrigated land in Canada, federal and provincial budgets must provide capital grants to cover about 75% of total developing costs. This author reports that 1998 water rates in Alberta, which is the province more prone to water scarcity, ranged from US\$ 5.33 to 11 per hectare.

#### 4.2.4 *The Australian National Competition Council*

On February 5 2001, the report “Framework for the Third Tranche Assessment of Governments' Progress with Implementing National Competition Policy and Reform” was released. Progress made in the water sector since 1994 is reviewed and hot spots identified and discussed to propose ways to overcome major obstacles to reform. The assessment represents the third implementation stage put in place by the Council of Australian Governments in 1994, materialised in its CoAG strategic water reform framework. While the Council's second tranche assessment focused on the establishment of the legislative systems and structures to deliver the CoAg reforms, the third tranche provides more detailed explanation and interpretation of the water reform obligations.

As in other overarching reforms, the 1994 Australian reform included many other aspects in addition to full cost recovery prices, including:

- a) New methodologies to assess the economic viability and sustainability of new investments.
- b) Water industry regulation
- c) Setting environmental requirements
- d) Implementing the National Water Quality Management Strategy

- e) Defining property rights to promote efficient and sustainable investments and trade
- f) Water reform and legislation review

The pricing requirements for rural water supply are:

- a) Water charges should be reviewed to ensure that, by no later than 2001, they comply with full cost recovery prices, with any subsidies made transparent.
- b) Achieve positive real rates of return on the replacement costs of assets.
- c) In the case of water trading across State borders, pricing and asset valuation arrangements must be consistent.
- d) Set aside funds for future asset refurbishment and/or upgrading of government-supplied water infrastructure.
- e) In the case of Murray-Darling Basin Commission, put in place arrangements so that, out of charges for water, funds for the future maintenance, refurbishment and/or upgrading of the headworks and other structures are provided.

## **5. Potential policy lessons**

### **5.1 Policy reform processes**

Water pricing reforms affect the value of critical capital assets. Access to cheap water ends up capitalised either in irrigators' land value or in the value of water rights if they are tradable. This means that water pricing reforms stir strong opposition from irrigators, who claim being unprepared to face significantly higher water charges and complain that more expensive water would erode their rents.

None of the pricing reforms reviewed in this report has been proposed in isolation. This indicates that irrigators must be assisted in different ways to make them responsible for taxpayers' burden and help them reduce their polluting activities. Also, rural water pricing policies must be dovetailed with other sectors' prices and put in perspective with the relative water scarcity suffered in each region.

Apparently water pricing reforms may follow lexicographic objectives, which are ordered from more to less levels of social acceptability:

- i. Reduce dependency on taxpayers' proceeds.
- ii. Improve recovery of O&M costs, increasing the standardisation of definition, calculation and application of costs.
- iii. Increase farmers' contribution to governmental agencies' costs, especially those directly and indirectly attributable to irrigators' water services.
- iv. Make farmers responsible of their environmental impacts, which include those resulting from non-point pollution sources and those resulting from the use of socially valuable water resources.

The order of such list coincides with generally approved definitions of farmers' property rights. For instance, while it is clearly indisputable that irrigators are not permanently entitled to proceeds from taxpayers to run their irrigation systems, it is not widely accepted that farmers' use of scarce water resources should inspire resource-based charges. If this is the case, farmers are entitled to financial compensations if they are forced to reduce water consumption. This is where voluntary exchanges come into action, but the expectations built around them vary across countries. While the US seems to judge that win-win solutions will be increasingly rarer, higher expectations about water trading characterise the policy reforms in Spain and Australia. In this sense, it is noticeable that in Australia public support for water trading and for programmes to make markets more efficient is behind that of the US, whose history of water trading goes back to the 19<sup>th</sup> century.

The EU and Australian reforms deviate from the US in that in America irrigation water reform will progress at the same pace at which districts formalise new contracts with the federal agencies that supply irrigation water. In the EU and Australia, pricing reforms must progress towards common targets and deadline, and any exception must be made transparent and justified. The different approaches perhaps result from the fact that EU and Australia must deal with different States or jurisdictions, whereas in the US the main water supplier to the irrigation sector is the Bureau of Reclamation, which is a federal agency.

As the Australian and EU cases show, State and national governments have incentives to make progress with Federal or Community policies because they are under threat of financial penalties if they fail to fulfil their obligations. Hence, decentralisation, subsidiarity or devolution should not be major impediments to implementation of water policies, provided that adequate enforcement, monitoring and sanctions are in place.

Policies across countries recognise that sound charges based on the fulfilment of the above criteria i) and ii) help mitigate the problems that would be addressed by objectives iii) and iv). Thus, the fact that all effects of irrigation water miss-pricing are interrelated justifies to address them simultaneously. There are a number of reasons for preferring overarching reforms instead of lexicographic reforms, which targets one stage only if the previous one has been achieved.

First, there are technical constraints that must be considered. Best management practices and incentive pricing need water metering at the lowest possible scale. But water metering is rarely encountered in poorly maintained irrigation districts, which in addition are characterised by low efficiency rates in water transportation and application and abundant access to water resources. This implies that districts may need assistance to rehabilitate their infrastructures, so as to allow for water metering and facilitate technology adoption all the way from districts' door to the plants' root zone.

Secondly, policies generally seek coherence and a balanced set of objectives. This means that irrigators' effort may be accompanied by programmes funded by taxpayers that not only assist irrigators to achieve higher technical efficiency, but also have proven benefits for the environment. Alternatively, voluntary agreements among irrigators and other sectors' representatives, indirectly affected by irrigated agriculture, constitute a means to deliver the desired benefits at a reasonable cost.

In arid and semi-arid countries and regions, this unfolds to two interrelated aspects, namely, the reduction in irrigators' water consumption and in polluting activities. This report has shown that the benefits associated with moderate water consumption by irrigators are not negligible. Thus, it may be in the social interest to provide farmers with capital grants to help them become more efficient and completely self-financed when new charges based on full costs recovery enter into force.

Thirdly, policy consistency is also a powerful and persuasive element to challenge farmers' complaints and opposition. If price increases came first, earlier than the carrots in the form of capital grants to refurbish their infrastructure or the proceeds resulting from water sales, then irrigators suffering net worth losses will be less prepared to invest in technical improvements and face rise in water costs. Alternatively, if full cost recovery prices are implemented in combination with other technical and institutional reforms, which may or may not demand taxpayers' contributions, then irrigators cannot argue that all the burden is put on their shoulders.

In short, while overarching reforms are more costly, more complex, and require long implementation timetables, the long-term benefits clearly offset the costs. However, in other countries in less mature stages, lexicographic approaches may be more convenient, or at least more easily applicable, as the Mexican case seems to indicate.

## 5.2 *Prerequisites for making progress*

Any effort to reform irrigation pricing policies must be based on a number of conducive conditions and prerequisites, which are listed below:

With regards to policies affecting new water projects:

- To enhance policy consistency, new commercial water uses must be primarily funded by the contributions of the direct users and other beneficiaries. This does not prevent public policy action in helping potential irrigators to develop a new scheme, it suggests instead that irrigators' commitment to fund the entire costs of the project should be used as the main test to confirm the financial viability of the project. Proper evaluations of the environmental impacts and resource sustainability are also needed.
- New projects must ensure that the future beneficiaries will be able to cover all O&M costs. New irrigators can be asked to operate following strict 'best management practices'.
- In any case, subsidisation of new projects should be made transparent and based on clear evaluations of the presumed social benefits they are meant to deliver. In no case should these projects result in water demand increases in already over-appropriated basins or in water quality deterioration.
- New projects must implement from the outset pricing mechanisms that fulfil simultaneously two basic objectives: strict cost recovery definitions and proper signalling of the opportunity cost of water. This requires block-rate pricing and revenue collection stability. A combination of quotas, water trading and two-tier rate scheme may provide an optimum instrument to address all possible situations.

With regards to existing irrigators and irrigation districts:

- Ruling out any objective to amend past pricing mistakes will help target present objectives, and focus on the present and future cost recovery.
- Metering is essential. However, as the experiences in Japan (Sarker and Itoh, 2001) and Valencia (Spain) show, water metering can be complemented with alternative indicators such as application rates, use time records and so on.
- Metering in the most backward districts is almost impossible. Under these circumstances, indirect measures may be a valid method to implement variable rates. In many instances, by looking at the combination of crop, technology and soil that each farmer uses, the district can obtain an approximate figure of the actual amount of water consumed.
- Reforming countries must stress the fact that self-financed irrigation districts are much more efficient, reliable and less polluting than those suffering from institutional and infrastructural decline. This means that the objective to ensure that districts are well financed has external benefits in the form of lower water applications, lesser pollution and the possibility to implement sophisticated demand management systems.
- Institutional failures may provide districts' managers with incentives to disregard proposals to increase or modify rate structures, even under conditions where it would be in all farmers' interests to do so. A conducive factor to move out of this situation is to provide one-time

capital grants to rehabilitate the infrastructures, conditional on the implementation of advanced demand management strategies, including block-rate rates and ‘best management practices’.

- No pricing policy will ever make progress if irrigators’ benefits are severely compromised as a result of its full implementation. In the short and medium term, irrigation farms’ economic survival is essential to ensure that pricing policies do not end up degraded by numerous exceptions, generous grand-fathering provisions or extremely long application timetables.
- While agricultural policies may give farmers incentives to increase water demand, this may be a reason in the political debate to make farmers’ more responsible for their water service costs.
- Benchmarks are needed to:
  - Track progress
  - Increase accountability
  - Promote transparency
- However, in defining benchmarks it is essential to ensure that those farmers or irrigation districts whose progress will be measured against them are easily understood and directly connected to their actions.
- Transaction costs of shifting from traditional organisational mechanisms, in which price is non-existent, to irrigation economies based on price incentives and stringent cost-recovery practices may be significant. Not only because they will impose costly changes in the way water and individual farmers are controlled, but also because societies based on communal values may be in conflict with pricing options based on individual consumption and different cost-sharing procedures.

### **5.3 *What can be expected from reforms in irrigation pricing policies?***

Irrigation pricing reforms should not expect significant reductions in farmers’ water consumption. This assertion is backed by anecdotal evidence and by numerous economic analyses carried out using differing methodologies on many regions and countries. To reduce farmers’ water consumption, water markets or rights tradability may or may not be a valid instrument, depending on the perceived risk of causing damage to other non-consumptive users or environmental externalities. Water quotas or allotments are also adequate instruments to restrain or reduce irrigators’ water use. This is especially relevant for groundwater resources, as usage or abstraction charges are unlikely to restrain farmers’ extraction rates.

However, better water pricing in the irrigation sector may deliver significant social benefits that will surely offset the costs. Some of the identified benefits of progressive water pricing are:

- An effective means to put an end to new projects that need large subsidies to be developed.
- Self-financing of irrigation districts and the reduction of taxpayers’ contributions to cover their running costs and capital replacement costs.
- Reinforcement of the role of water users associations, making them responsible of their infrastructure and water allocation systems.

- Less water pollution as a result of better application efficiency rates, more control of water flows in and out of the districts, and easier application of demand management strategies, including water exchanges.

## **6. Areas of interest to OECD countries in the field of irrigation water pricing**

Recent OECD work has helped expand our knowledge of water use and policy trends across OECD countries. In the last five years, significant progress has been made in related fields such as developing environmental and water use indicators, evaluation of policy reforms and development of legal and planning initiatives. All countries have benefited from the exchange of information and experiences.

However, despite these promising trends, there are a number of gaps and challenges that demand further work in the field of rural water pricing policies:

- Develop methodologies and applications to evaluate the irrigation costs at several administrative and responsibility levels. With a better understanding of the roles of districts, the public agencies and the irrigators themselves, it will be possible to judge different tiers' performance and develop policy action targeting areas where progress is found unsatisfactory.
- A lot more work on how costs are measured and used to define charges is needed to reach realistic measurements of the subsidisation levels benefiting the irrigation sector and evaluate the economic effects. A similar comment applies to the evaluation of external and social benefits of irrigation.
- In order to ensure both resource efficient allocation and sound cost recovery rates, it is essential to focus on synergistic instruments and how to combine them in a balanced and acceptable formula. This report has provided some evidence that charging cost recovery rates may not be the best way to ensure that farmers respond the social value of water or do not internalise the environmental costs. It also shows that consistent cost recovery rates are needed to establish market schemes and open the way to implement 'best management practices'. Hence, full cost recovery charges may be perceived as a necessary condition to achieve other objectives, such as allocation efficiency and less environmental pollution. This necessary condition must be accompanied by other sufficient conditions, such as evaluations of external benefits, adequate methods and application of cost evaluations, and the inclusion of transaction costs associated with the shift from traditional institutions to more new ones driven by resource-pricing and allocation efficiency considerations.
- However, in many arid and semi-arid regions, moving towards more efficient water allocation may provide society more dividends than ensuring that taxpayers contribution covering part of water projects' investments costs is completely eliminated.
- Related to the previous point is the need to learn more about the social costs and benefits of farmers' water utilisation levels. This report has shown that where trading is active and frequent water tends to move from low to more efficient users, sometimes to the benefit of the farming sector itself. Market prices are sometimes one order of magnitude greater than the charges or levies that right holders must pay. In the age of information and almost costless data transfer, it is now possible to control for potential third-party effects or externalities allowing, at the same time, for water transfers that make farmers responsive to the social value attached to the resources they use. Looking at these advanced mechanisms,

analysing their effects and sharing these experiences will help governments to promote technological adoption and design policies, that build on earlier experiences.

- Another area which deserves more attention is the evaluation of the costs and benefits of new irrigation projects. Countries in all continents still subsidise new irrigation projects, realising negative financial returns, although claiming to generate other economic or social benefits. Perhaps, integrated assessment approaches and multi-criteria analysis are more suitable than cost-benefit analysis to reach judgements about the social desirability of new irrigation projects.
- Benchmarks are needed to ensure that comparisons are meaningful, realistic and usable to increase accountability. Similarly to the environmental indicators for agriculture, benchmarks on cost recovery rates and costs' definition will become essential elements to track progress and have a better idea of subsidisation levels. OECD can help the exchange of experiences in areas such as costs' evaluation.
- And as a final caveat, it should be stressed that any comparison of water cost and charges across OECD countries should be based on sound and complete data. This implies that any cost comparison of countries in which several layers of government action focuses on irrigation may be biased or incomplete unless all these layers' costs and charges are reported.

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