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AGRICULTURAL WATER PRICING IN OECD COUNTRIES

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FOREWORD

In 1987, OECD published “Pricing of Water Services”. This publication reviewed pricing practices in several OECD countries for such water services as public supplied, sewage disposal, and direct abstractions. The study also addressed such topics as water subsidies and agricultural irrigation systems. The focus of the work was on reviewing how pricing systems for each of these components actually operate in practice (i.e. description), followed by a discussion of how the environmental and economic efficiency of those systems might be improved (i.e. prescription). Little distinction was drawn among the demands placed on water resources by individual economic sectors (e.g. households, industry and agriculture).

The OECD has recently decided to update the 1987 report, in a type of “10-year progress report”. This report provides information on the pricing of water services in one sector of economic activity — agriculture. It also seeks to explain why particular pricing policies exist in each OECD country, and the main factors currently influencing those countries in the process of reforming their water pricing policies. Other reports in this series deal with water subsidies and with pricing practices in the household and industrial sectors. A synthesis of all the reports is also being published under the title “*Water Pricing: Current Practices and Recent Trends*”.

This particular report was drafted by **Alberto Garrido**, of Universidad Politécnica de Madrid, Madrid, Spain. It was also discussed at an Ad Hoc Meeting of OECD Water Pricing Experts (Paris, September 22-23), and has since been revised based on comments received from delegates to that meeting.

The contribution of Almudena Gómez-Ramos is gratefully acknowledged for her assistance in collecting, analysing, and surveying most of the sources used to write this report. Eva Iglesias read preliminary versions of the document, and made suggestions that greatly improved the final product.

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EXECUTIVE SUMMARY

Adequate water pricing in the agricultural sector is a key factor in maintaining the operational capacity of water supply systems. Making irrigators pay for the costs they impose on public and private suppliers contributes to restraining short-term water demands, as well as providing a screening device for selecting those irrigation projects which generate the highest social and financial returns. If prices paid by farmers incorporate at least some long-run marginal cost components, water demands will more easily be kept at sustainable levels. Furthermore, adequate pricing implies that the charges paid by farmers approximate the social value of water (i.e. including its scarcity rent), allowing society as a whole to capture any gains that might be derived from allocating water more efficiently. On the other hand, and despite the importance given to them in previous OECD meetings — such as the 1997 Athens *Workshop on the Sustainable Management of Water in Agriculture* — pricing policies alone cannot deliver the benefits that more comprehensive water policies in the agricultural sector are meant to accomplish.

Unlike much of household and industrial water demands, agricultural demands are far from homogeneous, even within individual countries. This heterogeneity implies the need to conceive of irrigation water supply as a multi-attribute service in which “cost” alone (i.e. in the absence of other important characteristics) does not convey much information about water’s relative scarcity. Factors such as water quality, supply reliability, frequency of accessibility, whether (and to what extent) individual consumption is measurable, are just as important as the prices paid by farmers. Agricultural water’s relative price should ultimately depend on how productive water is to irrigators. Efforts to draw agricultural water pricing comparisons across different countries will therefore be hindered by any deficiencies in information about the other (non-cost) attributes attached to the service of supplying water to irrigation units. In spite of these difficulties, price information, combined with information about underlying policies and industrial structures, can provide a useful *beginning* for comparing water management strategies across countries.

This report attempts to provide some of this basic information for OECD countries. It illustrates that agricultural water pricing is *not* very widespread in OECD countries. Even acknowledging the unavoidable difficulties involved in comparing agricultural pricing policies among nations with diverse hydrologic conditions, the report makes clear that the objective of making farmers responsible for their water supply costs is burdened with many practical obstacles. A key obstacle is that strong public involvement in building water works and irrigation projects in those OECD nations which have significant irrigated acreages seems to be at odds with pricing policies that seek to make access to water more expensive than it presently is. The case of *Australia* demonstrates that political willingness and public persuasion can combine to open up new avenues for reversing the degree of public involvement in irrigation, and for facilitating the implementation of pricing mechanisms aimed at recovering the full costs of supply. An open and transparent public process, and a high level of public involvement have been important in enabling Australian water prices to increase towards full cost recovery. However, this case also shows that water pricing reforms must also be accompanied by other important mechanisms, in the absence of which “pure pricing” mechanisms might yield few benefits.

Although agricultural pricing is generally of secondary priority compared with agricultural and rural development policies in countries such as *Turkey, Mexico, Japan, Greece, Portugal* (and to a lesser extent in *Spain*), farmers in other countries, such as *New Zealand* and the *UK*, do not receive any special treatment in the charges they face for the water they use. In *The Netherlands*, agricultural holdings pay even more for water services than the costs of providing this water. In *Japan*, irrigated agriculture is perceived to be important not only for food production, but also as an environmentally-beneficial activity; even so, farmers still pay the O&M costs associated with irrigation. Still other countries, such as *Canada* and *France*, recognise the special characteristics of agricultural users, but have been able to implement policies that increase water charges, in order to better align farmers' contributions with the increasing costs of water supply. *Portugal* has also made significant progress towards charging farmers according to actual water supply and drainage costs. In the *US*, irrigators hold solidly-rooted rights to water use, which Federal and State agencies seem reluctant to encroach upon by increasing water charges. Although California is a partial exception, progress towards widespread implementation of agricultural water pricing is therefore proceeding very slowly in the US.

Although all countries surveyed in this report clearly understand the need to increase agricultural water charges in order to insure the financial stability of their water supply systems, only a few have yet taken decisive steps to do so. In view of this experience, it is possible to identify some of the factors which seem likely to facilitate the eventual implementation of such pricing reforms: (i) the suspension of policies that subsidise the construction of irrigation projects; (ii) the recognition that irrigation is no longer the only key to promoting rural development; (iii) a certain degree of inter-sectoral competition for scarce water resources; (iv) the realisation that water pollution and nature degradation can only be met by slowing down, or even reducing, total consumptive use; (v) the implementation of general economic reforms towards reduced public involvement in commercial activities.

Significant political determination and persuasion is required when designing and implementing water policy reforms (in which pricing is just one component). Some of the critical tasks that could enter into any generic process for water pricing reform might include: (i) a halt to further water diversions, unless these diversions are completely financed by the new users (with "users" being defined to include both public and private interests); (ii) a thorough and systematic estimation of the costs of water supply attributable to each user or group of users; (iii) a clear decision as to which percentage of total costs farmers will be made responsible for (or which environmental benefits they might be compensated for); (iv) specific provisions for drought situations, for farmers' inability-to-pay the higher prices, and for historical water-rights holders; (v) ensuring that irrigation assets are eventually handed over in good working order to users' associations, or to private water suppliers; (vi) taking into account the more explicit environmental costs of irrigated farming and, whenever possible, adding pollution abatement costs on to the water charges imposed on those users who pollute; (vii) abandoning public programmes to enlarge irrigated acreages (at least in those regions in which the water pricing reforms are being initiated); (viii) designing water charges that can be easily and cheaply collected; (ix) allowing water users' associations to become more deeply involved in managing both irrigation assets and water rights; and (x) persuading farmers that reforms will have positive returns, resulting from more secure water rights and a higher degree water supply reliability — made possible in part with their (larger) financial contributions.

AGRICULTURAL WATER PRICING IN OECD COUNTRIES

Scope and objectives

Context

This report was prepared in the context of on-going OECD work on the integration of economics and natural resource management strategies. While the focus of the report is on pricing practices in the agricultural sector, it therefore inevitably addresses broader subjects, such as general policies in the fields of agriculture and rural development, privatisation and/or government withdrawal from commercial activities, and natural resources management. The underlying premise of the paper is that water pricing policies derive from these other (more general) policies, and not the other way around. Put differently, agricultural water pricing policies in most countries result from external forces not necessarily linked to irrigation policies themselves. However, more refined and better tailored water pricing mechanisms would often benefit these more general objectives as well.

The report deals primarily with the pricing of irrigation services, rather than either water supplied to other agricultural purposes (e.g. livestock), or water used to dispose of agricultural wastes. Anecdotal information is provided for these latter two domains where it is available, but the primary focus of the paper is on irrigation.

Finally, the focus of the report is specifically on pricing policies. Broader issues relative to the achievement of *sustainable agriculture* are acknowledged to often lie behind these pricing policies, but these are not directly addressed here. In this context, it is clear that irrigation can be both of a contributor and an impediment to the achievement of sustainable agriculture, depending on specific local circumstances.¹

Objectives

One main objective of the report is to examine (and to provide plausible explanations of) why pricing policies follow different paths in different OECD countries. Since irrigation water pricing is typically a component of much more comprehensive policy objectives — for example, the development and promotion of irrigation itself — it is very unlikely that pressure to reform prices (usually upward) will ever originate within the very institutions that manage, finance, and promote irrigation projects. The implied conclusion is that agricultural pricing policies can only be successfully modified if changes are promoted from *outside* the agriculture sector.

1. For a more detailed exploration of the issues involved in the sustainable use of water in agriculture, the reader is referred to the proceedings of a recent OECD Workshop (Athens, November 1997) on this theme (OECD, 1998).

A related objective of the paper is to summarise the agricultural water pricing policies currently being used across OECD countries. It also seeks to review the reform processes presently occurring in each country with regard to the pricing of irrigation water services.

The report expands on previous OECD work in this field, by incorporating two elements not stressed in that earlier work. The first of these is an attempt to place agricultural water pricing policies in their “real” context, incorporating the various attributes that are typically added to the service of supplying water to irrigators. The second applies to the political arena — pricing policies must be judged not only in terms of how they are implemented, but also in terms of the degree of flexibility granted by the water institutions and/or laws introduced to modernise water pricing systems. It is a basic premise of this report that pricing policies in the agricultural sector can only be analysed by taking into account both of these dimensions, and that omitting either one may lead to erroneous conclusions. However, water agencies will often support price reform — even if they do not initiate it — if they believe that they can retain funds for high priority projects under their administration.

Sources

Among the many sources that have been used in preparing the report, two have been especially useful. One was a survey by Dinar and Subramanian (1997), whose objectives were similar, but which cover all water uses across both OECD and non-OECD countries. The other important source was the set of case studies and generic materials presented during the 1997 Athens Workshop on “*Sustainable Management of Water in Agriculture: Issues and Policies*” (OECD, 1998).

In addition to these two sources, many academic and non-academic references have been consulted, using various means. Several individuals, both academic and government-based, have also responded to requests for published and unpublished material. Unfortunately, although significant efforts were made to gather as much information as possible from all OECD countries, some of these are still presented rather briefly, due to the lack of sufficient information. Nonetheless, all OECD countries in which irrigated agriculture is a significant water user have been examined here. All references used are listed at the end of the report.

Structure

The paper’s objectives demanded that two parallel lines of analysis be developed. The first, and perhaps most important, was to survey the experiences of all OECD countries which use significant volumes of water in the agricultural sector. The second was to explore some of the “cross-cutting” issues that explain the present state of agricultural water pricing policies in OECD countries.

To accomplish these objectives, the paper begins by examining two potential problems. The first is addressed in the next section, which defines the main concepts used in the discussion, and formulates several *caveats* that will be useful later on when performing the comparative analysis. The second relates to the definition of the various pricing criteria that are often encountered in OECD irrigation projects.

The report then reviews existing water pricing mechanisms in OECD Member countries, the main factors influencing these prices, and recent trends. The most relevant elements of each country’s current agricultural water pricing policies are then discussed, focusing mainly on institutional issues. A generic agenda for water pricing reform is then provided, identifying those factors which would be most conducive to the successful implementation of such an agenda.

Definitions and caveats

The concept of “water price”

In order to be able to compare country experiences with “water prices”, it is essential to agree on a common definition of this term. The approach used in this report is that “water price” denotes any charge or levy that farmers have to pay in order to obtain access to water in their fields. This definition includes simple water charges, based on irrigated surface levies, but it also encompasses more intricate pricing systems. For instance, land taxes that discriminate between dry- and irrigated-land, and which constitute an essential element of access to water for irrigation, also fall within the scope of this definition.

Throughout the report, water prices originating from market (or voluntary) exchanges between farmers are given much less attention than those water prices established by public (or public-based) water suppliers. While governments can certainly promote, restrain, or even run private water markets, the emphasis here is given to the role of institutional and legal frameworks in pricing irrigation water. However, it is important to note that although administered prices and market systems are often presented as alternatives to each other, in practice they can be highly complementary and should be considered together. Thus, the implementation of any water trading (market) system should consider how the prices at which the original water allocations are sold at may affect the trading system. For example, inter-State water trading in *Australia* led to market distortions initially because public prices were set at different levels in different States. Similarly, any ambitious administered pricing system will lead to inefficiencies if users cannot sell or trade their rights. In particular, the least competitive users may not be able to profitably utilise their water allocation rights because they cannot afford the ambitious new prices, but if they cannot sell these ‘useless’ rights to a more competitive user who could utilise them, inefficiencies will be introduced in the system.

OECD countries experience a wide variety of situations regarding water availability, climate and aridity. While for consumptive purposes the concept of agricultural water pricing generally evokes a levy or payment made to gain access to water for consumptive use, many countries have large fresh water bodies available, such that rationing water is hardly necessary for this use. However, water pollution may still be a problem, and will need to be tackled. The fact that priorities differ so widely should not minimise the importance of agricultural taxation and other policies in countries where water abstractions do not need to be restrained.

Most agricultural water pricing analyses tend to distinguish between charges for water resources *per se*, and charges levied to cover part (or all) of the costs incurred in servicing water for irrigation. In theory, pricing mechanisms could be designed in such a manner that users could distinguish what part of their total cost corresponded to the consumption of “raw” water — i.e. to its opportunity cost or scarcity rent — and which part was meant to cover infrastructure supply costs. The first component would presumably aim to ration water use, whereas the second would guarantee that the supply system was financially self-sufficient. This report, however, argues that making such a distinction could be misleading and highly inappropriate in many important cases, even though in some situations it is a reasonable notion which might inspire sensible water pricing systems.

More specifically, such a distinction is only reasonable in those countries, regions, or basins where water resources are *abundant*, relative to the amount being abstracted for consumption purposes. In these cases, water charges might be based, for example, on environmental considerations, not necessarily to facilitate sharing of an abundant resource. The key feature here is that water be abundant, irrespective of the size of any structural facilities which may exist. But if water is abundant, why would it have to be

shared or rationed at all? Perhaps because water demand is growing at alarming rates, or because water pollution is expanding to worrying levels. The fact that water is not scarce at a given time does not imply that it will always be abundant. Hence, in anticipation of future (quality or quantity) shortages, a charge based on future water scarcities could be added to a charge based strictly on current supply costs.

In a completely different context — one driven by the *scarcity* of water resources — new physical or structural facilities actually contribute to expanding the water resource base. Without such works, the amount of water available for consumption would be much lower than it is. In these cases, water charges could not possibly be disentangled so as to allow the raw water charges to be separated from charges meant to recoup supply costs. This reasoning becomes clearer if one considers water charges raised by a company that supplies desalinated water. Without the desalination plant, fresh water *would not exist*, even though salted or brackish water might be abundant. Therefore, the scarcity value of fresh and desalinated water cannot be detached from the costs of producing it. Does this mean that scarcity rents or opportunity costs do not exist in the very contexts in which one would expect these rents to be high? Of course, they do exist in theory, but a public agency would never be able to set meaningful charges in practice that incorporated the inherent value of water in such a situation. World-wide experience therefore indicates that it is only in those places where water is made a tradable good that water prices tend to reflect their scarcity values, as distinct from supply costs.

In short, water charges may be based on different philosophies, depending on whether or not the water resources involved are scarce. If they are abundant, charges based on both service costs and on raw water consumption *per se* can be developed and managed separately. If, on the contrary, water resources are very scarce, it is difficult to conceive of the value of raw water being differentiated from the costs involved in providing the infrastructure, at least up to the amount of water being provided by that infrastructure.

Heterogeneity of irrigation water

In the agricultural sector, the *supply* of water is far from homogeneous. Water supply to farmers must be conceived as a multi-attribute service, in which the essential components are: (i) water quality; (ii) level of uncertainty in fulfilling contracted allotments; (iii) frequency and certainty of availability for field applications; (iv) technological conditions of any metering devices; (v) discrepancies between *charged* volumes and *accessible* volumes at farm-gates; and (vi) water pressure.

When comparing agricultural water pricing levels, it is therefore desirable to accompany per-volume or per-surface price levels with a description of some of the attributes mentioned above. While this poses important (and sometimes insurmountable) obstacles to performing “pure” comparative analyses, not taking them into account can also make “price-based” comparisons rather meaningless.

Of course, some of these “supply” attributes are highly correlated with costs incurred in providing the water service in the first place. But this correlation becomes blurred when one looks in more detail at how water use for irrigation has historically evolved in a given basin or catchment area. For example, “first-comers” tend to enjoy cheaper and more convenient access to water than “late-comers” do. Occasionally, however, one finds the reverse situation — one where “junior irrigators” get the advantage of modern distribution systems, and can obtain low (but very reliable) water allotments at relatively high prices. “Senior” users, on the other hand, might have access to ample allotments at low rates, but the lack of proper maintenance of facilities, coupled with some degree of supply uncertainty, might make the water service enjoyed by these “older” irrigators relatively more expensive in real terms.

Looking only at water charges and the size of allotments, it might appear that “senior” irrigators had paid lower charges, even though the water supply for the “newcomers” is actually more cost-effective.

Agricultural water *demand* is also heterogeneous. For one thing, various agro-climatic characteristics will influence these demands. In arid climates, irrigation water cannot be substituted for, and is essential for growing crops. In wetter climates, irrigation water reduces the risk implied by unexpected climatic events, but crop production is still possible without irrigation.

In short, unlike the household sector, the irrigation sector is particularly prone to misleading interpretations if water pricing levels, criteria, and mechanisms are presented without an accompanying description of the precise conditions under which water is actually made accessible to farmers.

Water subsidies to the agricultural sector

The fact that water use in the agricultural sector has been heavily subsidised across most OECD countries, many of which have extensive irrigated acreages, is a major concern for national water policies. It is no exaggeration to assert that the subsidisation of water use invokes its heaviest criticisms from the non-agricultural sectors and stakeholders. However, the issue of irrigated water subsidisation is far more complex than it appears at first sight.

Two main factors contribute to this complexity. The first has to do with the very nature of water subsidies. Gardner (1997, pp. 9-10) offers a compelling way to think about these subsidies along the following lines: imagine that the separable costs of building irrigation projects are US\$ 0.5 per cubic meter (all figures are fictitious), and that farmers are required to pay only some fraction of this amount, perhaps 20 per cent (i.e. 10 cents/m³). A subsidy is thought to be a wealth transfer from the government to water users, so one part of the subsidy to farmers will be the difference between the value of water used in agriculture (say, 25 cents/m³), and the fee that farmers pay the government agency (10 cents/m³). Gardner argues that these 15 cents/m³ should by no means be conceived of as a continuing wealth transfer, however, since the land market quickly capitalises access to subsidised water into land prices. Hence, only the original beneficiaries of the project will capture the full amount of the subsidy, with those who buy land later on paying a purchase price which already incorporates in it the value of the subsidised access to water. The corollary to this is that if water prices are then increased at a later date to reduce water use subsidisation, the penalty will often fall on someone who never benefited from the subsidy in the first place — those who received the subsidies have already gained (twice) by first receiving the subsidies and then by selling the land at a price which includes the value of the subsidised water supply, and those who bought the land will end up suffering capital losses.

What then happens to the (generally huge) difference between irrigation project costs and the value of water to the farmers, as measured by their “willingness-to-pay” for water? Gardner contends that this amount should be viewed as a social dead-weight loss, because irrigation projects cannot be converted to alternative uses. Consequently, once the project is built, an increase in water prices would not alter the (presumably “inefficient”) original decision, since the capital has been already “sunk” into the irrigation project’s ditches and canals. Although this view could be challenged by bringing in other social dimensions (such as rural development and land colonisation issues), it remains a powerful argument in the farming community against water price increases aimed at reducing irrigation “subsidies”.

A review of the more radical OECD pricing reforms (in *Australia, New Zealand* and the *UK*) illustrates that an emphasis is usually placed on making farmers responsible for the costs incurred by their own water demands, rather than attempting to reverse situations which result from past policies aimed at expanding the supply of irrigation.

Legal and institutional dimensions

Most countries' water pricing policies are solidly integrated within their water codes or irrigation development acts. Commonly, these various pieces of legislation establish how water project costs should be evaluated, capitalised, assigned to different users, and recovered over time. However, there is ample evidence across OECD countries indicating that agricultural water prices have traditionally failed to raise enough revenues to meet even the modest recoveries which have been established by law.

Until quite recently, the fact that farmers were using water at subsidised rates remained largely unchallenged by other elements of society. Legislative bodies and governments often saw the development of irrigation as a means of promoting food production, colonising land, or making use of hydraulic works for other purposes, such as hydropower generation or flood control. As long as water resources remained reasonably available for competing users, the fact that farmers used large volumes themselves, occasionally to grow low-value crops, did not face significant social opposition.

As water resources become scarcer, irrigation pricing policies typically evolve in two stages. In the first, water agencies begin to charge farmers "reasonable" prices, usually meaning charges that are in line with some fraction of farmers' net returns or "ability-to-pay". At this point, charges start to deviate significantly from water supply costs.

After a few decades, irrigation water pricing policies then evolve towards the second stage, whose main characteristic is that different farmers operating in the same region end up paying widely divergent prices, even though they are (in principle) subject to the same "ability-to-pay" considerations. Wahl (1989) showed that across 17 *US* Federal Water Projects, for example, one could encounter farmers for which the ratio of "willingness-to-pay" to "ability-to-pay" for irrigation water ranged from 51.0 to 1.9. Examples from *Spain* and other countries illustrate similar developments. It is clear that such a system is not only inefficient, following Gardner's argument, but highly inequitable.

The political process of reforming water pricing policies

Once a country reaches a certain level of maturity in its water sector, pressures to reform water prices in order to correct these operating inefficiencies build up significantly. While analysing the political processes of reforming specific water pricing policies is well beyond the scope of this report, it is useful to make a few *generic* comments about these processes.

Reforms of agricultural water pricing policies are most likely to occur when several forces converge. These forces include: (i) competing claims for irrigation water from other users, including environmental needs; (ii) the failure to obtain continuing budget appropriations from state or national budgets to cover the costs that farmers do not cover through water charges; (iii) the realisation that farming often uses large amounts of scarce water to grow not very valuable crops; (iv) the accumulation of scientific evidence linking irrigation farming with harmful environmental results, including the deterioration of water sources for drinking water purposes; and (v) sufficient reduction in farmers' power within the political system so that Legislatures can bear the additional costs of initiating pricing reforms (on the assumption that these reforms will be generally contested by farmers' groups).

It is widely acknowledged that farmers in OECD countries hold more political power than their economic importance might otherwise suggest. Political reforms that would prevent farmers from using water at subsidised rates can therefore be sometimes "ransomed" by opposition groups in society. While *Spain* provides an example of this problem (Pérez-Díaz *et al.*, 1996), *Australia* shows how the joint

willingness of all major political parties cleared the way for deep policy reforms in the irrigation water sector.

As discussed later, the European Commission has recently launched a process with the ultimate objective of approving a Framework Water Directive (COM(97)49, latest version July 1997) that would apply to all *EU* Member States. Although still under discussion, one of the major objectives of this Directive would be full cost recovery, applied to all water users. If it is eventually adopted, this Directive would also exert some external pressure on those governments reluctant to undertake reforms on their own.

The elusive definition of “full-cost recovery” prices

Any water pricing reform must be based on some definition of the costs that will be recouped through water charges. Ironically, while “full-cost recovery” appears to convey a clear-cut criterion for designing water charges, when one looks at how this concept is actually put into practice across OECD countries, significant differences can be found. “Full cost recovery” implies the recovery of only O&M costs in some countries, the recovery of (O&M + capital costs) in others, while still others seem to want to go even further. For example, the *EU* is currently considering the incorporation in their definition of both scarcity values and environmental externalities caused by water users (see later discussion).

Debate has also arisen over even such seemingly simple and straightforward issues as defining what capital costs should be recovered through pricing systems. Thus, some argue that farmers should be liable for the actual costs of replacing equipment, while others suggest they should be responsible instead for the historic costs of the existing equipment.

Irrigation water demand elasticity

Estimating agricultural water demand elasticities has attracted much attention, as arid and semi-arid industrial countries have experienced increasing periods of water scarcity. In general, most available estimates seem to indicate some degree of demand elasticity. In other words, farmers *do* seem to react moderately to water price levels, water application costs, and water shortages. However, there is also substantial evidence that water rates and irrigation technologies can be more intensively influenced by other factors (such as climate variations, agricultural policies, product prices, or structural factors), than they are by prices.

Among the many studies characterising water demand functions in the agricultural sector, several conclusions stand out as being of particular empirical interest:

- Water demand is usually inelastic only up to a given price level. This “price threshold” depends on: (i) the economic productivity of the water; (ii) the set of alternative production strategies that farmers actually adopt in order to substitute for water consumption; (iii) the proportion of land devoted to permanently-irrigated crops; (iv) the irrigation technologies in place; and (v) the size of the water allotment. Table 1 provides selected research results concerning irrigation demand elasticities as evaluated in different contexts):

Table 1. Cross-sectional Price Elasticity Estimates for Irrigation Demands

Source	Method/context	Region/country	Water demand elasticity
Moore <i>et al.</i> (1994)	Groundwater price variations	US Northwest	-11.72
	Econometric model	US Central plains	3.99
	Cross-sectional data	US Southwest	-16.88
		US Southern plains	-2.16
Garrido <i>et al.</i> (1998)	Institutional price simulations	Spain (Andalusia)	LP: -0.06; MP: -1.00
	Dynamic math programming model	Spain (Andalusia)	LP: -0.12; MP: -0.48
		Spain (Castile)	LP: -0.09; MP: -0.26
	Long-term results	Spain (Castile)	LP: -0.00; MP: -0.03
Montginoul and Rieu (1996)	Math programming models	France (La Charente)	LP: -0.04; MP: -0.27
	Over 170 irrigated farms		

Key: LP: Low water price ranges ; MP: Medium water price ranges.

- The “price threshold” indicates possibilities for increasing water charges without significantly perturbing farming activities. Although net farm returns would be reduced by price increases, these (operating) losses would eventually be captured by reductions in the (capital) values of land.
- Farmer responses to price increases could include: (i) changes in cropping patterns; (ii) reductions in the amount of irrigated land; (iii) improvements in on-farm water management practices; (iv) changes in irrigation technologies; and (v) abandonment of irrigation altogether.
- Price increases, combined with more efficient distribution systems, might actually end up *increasing* total water consumption. This could result from the net reduction of on-farm water costs caused by the reduction of leakages in the water distribution system. The volume of water returns generated in the irrigation district as a whole might then be reduced more than the reduction in the amount of water demanded on the farm. As a result, the basin’s water balance might actually be worsened by price increases.
- The adoption of more efficient irrigation technologies is accelerated by higher water charges, or higher water application costs. But other factors, such as land quality, well depths, and agricultural prices are just as important, if not more so, than the price effect of water itself.
- Subsidies to the rehabilitation of irrigation districts, and to new irrigation technologies might end up increasing on-farm water consumption. Although water productivity, measured as revenues per cubic meter used, would increase, total water consumption at the level of the basin might also increase, unless allotments were simultaneously revised downwards.
- Cross-section studies of irrigation districts, both at the national and international levels, have found conflicting evidence of the influence of water price levels on water management efficiencies.

Pricing mechanisms in the agricultural sector

Although interest in water metering increased significantly in the *UK* following the large-scale privatisation of water services in that country, metering is still an exceptional procedure in most irrigation districts in OECD countries. For one thing, the metering of water use in agriculture is costly, and occasionally inefficient. For example, Tsur and Dinar (1997) have estimated that, under quite generic

conditions, if the cost of applying volumetric pricing techniques exceeds 10 per cent of the revenues collected through these charges, simple-area pricing would usually be more efficient.

The fact that water is often rationed among users without metering should by no means be interpreted as a situation in which property rights are poorly defined. Likewise, the fact that water is metered does not mean that it is either expensive or scarce. There are many examples illustrating that achieving water distribution and/or management goals need not involve metering approaches. In fact, appropriate signals about water scarcities can even be provided to users without water pricing at all. Admittedly, these cases stand out as exceptions, and they cannot be easily achieved unless the accompanying institutional arrangements are well-established and accepted by all participants.

Another important element of the water pricing decision is whether or not prices are to be based on marginal (long- or short-term) costs, or on average costs. Marginal cost charging is rarely encountered in irrigation water prices. More commonly, irrigation prices are intended only to make farmers responsible for all *variable* costs of supplying water, whereas part or all the *fixed* costs are covered by public agencies, at tax-payers' cost.

Clearly, if individual water consumption is not metered, the range of available pricing mechanisms is more limited. The following types of water pricing mechanisms can be found in at least some OECD countries (adapted from Tsur and Dinar, 1997):

- *Volumetric pricing*: based on actual records of consumed volumes, or on measurement of time use of a known flow.
- *Area-pricing*: charges for water used per unit of irrigated area. Sometimes area-pricing discriminates based on the crops that are irrigated, on irrigation technologies, or on the season of the year.
- *Tiered-pricing* (sometimes called block-rate pricing): different prices for the volumes of water expected to be used in different ways.
- *Two-part tariff pricing*: makes farmers pay a volumetric charge for each unit of water used, as well as a fixed annual charge (usually based on the fixed cost component to be recouped through the charge).
- *Betterment levy-pricing*: charges irrigated land based on the increased value of land, due to the provision of irrigation water.
- *Water markets* (including auctions): public agencies can elicit farmers' "willingness-to-pay" for marginal *units* of water, and set prices accordingly.
- *Passive trading* (as suggested by Brill *et al.* (1997): the district offers a *price* — presumably the one which equates aggregate water supply and demand — and farmers make use of whatever amount of water they want. Farmers' consolidated rights to water are then charged at the average price, but those whose consumption is higher would have to pay the offered *price*, and those consuming below their rights would receive a payment for their thrift.

- *Volumetric pricing (of any kind), with a bonus:* farmers are required to pay for any water that exceeds a certain volume, and are financially rewarded if their consumption is below another threshold.

OECD country experiences

This section reviews existing agricultural water pricing policies and on-going reforms in most OECD countries, as well as providing some background concerning the water pricing provisions of the draft *EU* Water Framework Directive.

Although some countries are treated in greater detail than others, an effort has been made to avoid important omissions pertaining to those countries in which irrigated agriculture is a significant water consumer. In this section, selected data are presented on water prices and other variables pertaining to each country. (Table 2 also provides additional basic data for some of these countries.) The following section is devoted to comparative analysis, and includes more detailed tables concerning water prices in most OECD countries.

Australia

Among the arid or semi-arid OECD countries, Australia is the one that has gone furthest in reforming its water industry. Each of the six States and two Territories has considerable authority to pursue independent policies in water resources management. Until the late 1980s, Australia's water sector was exhibiting many of the classic problems of mature water economies: (i) an inability to raise enough revenues to cover service costs and to replace depreciated capital; (ii) severe environmental degradation; (iii) strong dependence on government budgets to refurbish waterworks; (iv) wide differences (both intra- and inter-sectoral) in water productivity; (v) strong involvement of government financing in projects, without much attention being paid to economic feasibility; (vi) a significant lack of transparency in service costs and charge collection systems among different users; and (vii) an excessive degree of water over-allocation in critical basins.

This situation led the Federal Government to promote substantial water reforms under the powers of the Council of Australian Governments (COAG). The initial momentum for this reform, begun in 1992, resulted from pressure for general *economic* policy reforms, that set forth a general re-engineering of the Australian economy to make it more market-oriented and to reduce the economy's reliance on subsidies (Grieg, 1997).

By February 1994, the COAG had developed a strategic framework for the reform of Australia's water industry, and had made some progress in agreeing guidelines that could be used by the States to implement such principles as "full-cost recovery" water pricing. The framework had several other key objectives as well, such as promoting opportunities for water trading; increased transparency; improved institutional arrangements; identifying new evaluation criteria for project approvals; the separation of land and water use rights, in order to promote agricultural water use efficiency; deeper involvement of local management in water use decisions; and sounder environmental management of water ecosystems.

Interestingly, one of the key consequences of moving toward full-cost recovery pricing was that water reallocation via the trading of entitlements was given a central role as a means to generate efficiency gains. Since each State had somewhat different pricing policies before the reforms were launched, the movement towards market pricing also required that some way was found to reallocate water to more efficient users — and trading offered the obvious solution.

Table 2. Basic Country Data

	Irrigation acreage (1 000 ha)			Arable area in use (1 000 ha) 1993	Irrigation acreage (%)	Total abstractions (million m ³) 1995	Agricultural consumption (%) 1995
	1961	1985	1993				
AUSTRALIA	1 001	1 700	2 107	48 900	4	15 055	-
CANADA	350	748	710	41 400	2	43 900	-
DENMARK	40	410	435	2 600	17	887	16
FRANCE	360	1 050	1 485	19 200	8	40 641	12
GERMANY	321	470	475	12 400	4	46 300	-
GREECE*	522	1 099	1 330	3 900	34	7 030	81
ITALY	2 400	2 424	2 710	12 000	30-35	20-25 000	50-60
JAPAN	2 940	2 952	2 782	4 600	60	90 497	64
KOREA	1 150	1 325	1 335	-	-	23 700	63
MEXICO	3 000	5 285	6 100	24 400	25	73 674	83
NETHERLANDS*	290	530	560	1 952	29	1 128	13
NEW ZEALAND	77	256	285	13 600	2	2 000	55
PORTUGAL	620	630	630	3 200	20	6 880	60
SPAIN	1 950	3 217	3 453	20 500	17	33 288	72
SWEDEN	20	99	115	2 800	4	2 725	4
TURKEY	1 310	3 200	3 674	27 115	15	35 100	69
UK	108	152	108	6 700	2	11 752	1
US	14 000	19 831	20 700	189 900	11	470 000	64

Note: * The statistics for the Netherlands and some for Greece refer to the amount of area "sprinkled", rather than to the standard irrigated area.

Sources: Redaud (1997); Raskin *et al.* (1997); Massarutto (1998).

The specific guidelines that the COAG framework established for the pricing of water resources (to be fully implemented by 2001) included the following points (Aeuckens, 1997):

- The full costs of providing water services to identifiable beneficiaries should be recovered through charges. New water projects will be authorised only after thorough financial and economic analyses recommend their construction.
- Costs not directly attributable to specific beneficiaries should be treated as “community service obligations”.
- If costs are to be subsidised by a local government, any such subsidy should be made explicit and transparent.
- The costs of water services should be paid by those who are responsible for generating the need for those services. Those who cause more services to be required should pay more.

“Full economic costs”, as defined by the COAG framework, include the following components: (i) operating and maintenance expenses; (ii) administrative expenses; (iii) environmental externalities (e.g. for salinity control); (iv) depreciation on a “replacement cost” basis; and (v) the opportunity costs of capital.

Special provisions were given to irrigators in order to relax the requirement to charge for water on the basis of fully covering the “replacement costs” needed to guarantee service capacity. The task of defining the actual costs and charges turned out to be very complex, particularly in the political context of a federal country. By 1992, however, the Industry Commission had estimated that water charges in the agricultural sector would need to be raised by 250 per cent in order to make farmers responsible for their full costs, including capital replacement costs. Other estimates have challenged this view, arguing that the needed price increase for a minimum level of cost-recovery for operations, maintenance and renewal costs would need to be only about 50 per cent (Cox, 1998). In any event, the implementation of the new pricing systems in the agricultural sector actually has so far resulted in water charge increases of only 35-50 per cent.

The gains for the agricultural sector resulted from four basic sources: (i) the expansion of high-value crops, using water made available for sale by growers of lower-value crops; (ii) farmers were persuaded that higher prices could be translated into better management of their water rights, and that better maintenance would result in better water supply security; (iii) better water management made better ecological performance possible; and (iv) the separation of water management responsibilities from regulatory tasks made each water supplier more accountable to their customers and other stakeholders.

The main lessons to be learned from Australia’s reforms are: (i) that extreme care is required, even to agree on generic guidelines for identifying and measuring water service costs; (ii) that pricing policies can be reformed even in arid and semi-arid countries with a strong tradition of governmental intervention in the water sector (although it is questionable whether such reforms would have been possible if they had been pursued as an independent policy (i.e. in opposition to mainstream government involvement in other sectors such as international trade, energy, or telecommunication services); and (iii) that water pricing reforms need to be implemented in conjunction with other water policy strategies, such as water trading, environmental policy reforms, abstraction caps, and institutional reforms (e.g. separation of roles among different agencies or official bodies, etc.).

Austria

Irrigation water in Austria is rarely needed to complement natural precipitation. Rech (1998) cites occasional water applications on sugar beets or horticultural crops. Irrigation water is typically pumped from aquifers by farmers who are required to obtain a permit from the water authority. This permit is usually granted free of charge. Water used for livestock activities is obtained from municipal systems, and is priced at household rates, ranging from US\$ 0.23 to US\$ 1.738 per m³ (Breindl, 1998).

Belgium

Water management and pricing policies in Belgium fall under the responsibility of the regional governments (Wallonia, Flanders, and the City of Brussels). Prices themselves are the responsibility of the distribution companies and the municipalities. Price controls are carried out by the Minister of Economic Affairs. Of the total 216 million cubic meters of water consumed annually by the agriculture industry in Flanders, 6.5 per cent goes to agro-industry, 12.4 per cent to livestock, 8.9 per cent to greenhouses, and 72 per cent to irrigation (Nys, 1998). The prices charged for agricultural water depend on the water source: users linked to waterpipes pay the same charges as households; users abstracting directly from groundwater sources pay (as from 1998) a levy on declared volumes; and users relying on surface water also pay a levy based on declared quantities.

An estimated 14 million m³ of water is used annually by the agro-food industry in the Region of Wallonia, less than one-third of which is drawn from the public system. Water drawn from the public system for agricultural purposes is charged at about 4 BF per m³, generally corresponding to the 3F per m³ abstraction charge levied on potable water producers. Preferential pricing tariffs are given depending on consumption levels. Thus, agriculture or industrial users directly abstracting groundwater for their own use pay a charge of between 0-3 BF per m³, depending on the annual volume of water authorised. Volumes under 3 000 m³ are exempted.

Wastewater taxes ("polluter pays" taxes) are also levied on domestic and industrial water users in Wallonia. Water used in livestock production is either assimilated into domestic wastewater (and taxed at 16 BF per m³) or is spread over the agricultural land and subject to a special industrial tax (as a function of the amount of land it is spread over or pollution for agro-food industry). Most livestock producers pay the domestic wastewater tax, though exemptions are given for about half the water consumed.

Canada

Traditionally, Canada's water policy has resulted in agricultural water being supplied at heavily subsidised rates (some estimates indicate that the subsidisation amounts to 90 per cent of supply costs). Volumetric charges are rare, and flat rates have usually generated insufficient revenue to match either the increasing costs of O&M, or of replacing capital. Tighter federal budgets, together with an inability to raise enough revenue, have prompted many agencies to implement new agricultural water pricing policies. In 1987, the Federal Government set forth an agenda to reform Canadian water policy, including a set of guidelines to the provinces' governments. Although Canada's provinces are in charge of setting agricultural water prices, only the driest ones (interior British Columbia, Alberta and Saskatchewan) were actually charging water rates to farmers by 1988.

In four provinces (British Columbia, Saskatchewan, Ontario and Nova Scotia), the water industry sets different charges for wholesale and retail surface water supplies. Access to groundwater by

farmers is free throughout Canada. Although volumetric charges do exist, prices are not used as a rationing mechanism to allocate scarce water. Excess demand, when it occurs, is dealt with by licences, water rights, and other sharing rules (Horbulyk, 1997).

Significant changes are now being implemented in various provinces. Despite the fact that water prices are being raised by retail (as well as by wholesale) water suppliers, the resulting percentage of O&M costs actually paid by farmers is still very low. Fairley (1997) reports that even a 300 per cent price increase in various publicly-run Saskatchewan irrigation districts would end up recovering only 60 per cent of total O&M costs by the year 2000. Sonntag (1996) reports that, across the Prairie Farm Rehabilitation Administration's irrigation districts, farmers were contributing only about 25 per cent of O&M costs, even though the PFRA had initiated price reforms entailing charge increases of 13-45 per cent. As a result, the irrigation districts of Southern Alberta had raised water prices from US\$ 15/hectare to about US\$ 22.50/hectare during the last 10 years.

Although irrigated agriculture in Canada occupies less than 3 per cent of its arable and pasture acreage, and water resources are generally abundant, initial steps have been taken to implement water markets in Alberta, the province which accounts for 70 per cent of Canadian irrigated acreage. Alberta's 1996 Water Act is unique in Canada, in that the trading of water rights has been given a key role in efforts to obtain efficiency gains, whereas the other provinces are relying completely on public pricing approaches (Horbulyk and Lo, 1998).

Overall, Canada's water economy is far from suffering the stressful conditions that are common in other countries reviewed in this report. Most water policies in Canada tend to focus on water *quality* issues, rather than on water *allocation* ones (Harker, 1997). On balance, Canadian agricultural water pricing reforms have been aimed mainly at replacing subsidies traditionally provided by the Federal and Provincial governments with a situation where costs are covered by the farming community itself.

Czech Republic

The Czech Republic has only 154 000 ha of irrigated land — which occupies 3.6 per cent of its cultivated land and uses only 6 per cent of its available water resources (Raskin *et al.*, 1996). Although the country is currently undergoing a profound privatisation process, the service of providing water to farmers is still carried out by state-run organisations, which are financed in turn by the Lands Fund of the Czech Republic (OECD, 1997). The government will apparently continue to cover the O&M costs of the irrigation districts until the existing irrigation systems are completely privatised. However, other on-going policy changes have involved a complete halt to the construction of new irrigation projects, and the approval of a set of specific incentives to farmers aimed at reducing polluting activities. It is expected that the use of irrigation water will gradually decline once water subsidies are removed (OECD, 1997).

Denmark

Irrigated farming in Denmark represents about 35 per cent of all consumptive use of water. OECD (1997) reports that tax-payers contribute to the financing of a programme to restore waterways and borings that have been contaminated by, among other things, nitrates and pesticides. However, because this programme aims to reverse a situation that has been generated by irrigated as well as non-irrigated farming, it should technically not be considered a subsidy or welfare transfer from general tax-payers to water consumers.

France

Although France is generally considered to be a country with abundant water resources, recent droughts in some basins, together with a significant increase in irrigated acreage over the last twenty years, have given rise to profound institutional changes in the way water resources are managed and priced in this country. The new Water Code (1992) has reinforced public interest in water resources and basin management, and has contributed to substantial progress in pursuing environmentally-oriented policies.

Water charges in France have two components: a *catchment* component — based on the volume abstracted — and a *consumption* component — levied on the difference between abstractions and return flows. River Basin Agencies can exercise considerable scope in designing water management plans and in setting water charges. Most users and stakeholders are represented in (and hold decision-making authority for) French water management authorities. Water is then provided to cities, industries, and farmer associations by supply companies (both privately- and publicly-owned). The criteria used by these companies in setting water charges vary substantially across basins, and mostly depend on such characteristics as the probability of drought, the type of user, capital costs, and ownership composition. Another key factor which influences agricultural water prices in France is whether the water supplied originates in replenished rivers, in non-replenished watercourses, in aquifers, or in hill impoundment lakes (Duchain, 1997).

Irrigation farming represents 42 per cent and 12 per cent of net French water consumption and withdrawals, respectively (Montginoul, 1997). Between 1973 and 1988, agricultural water use grew by 43 per cent, largely due to generous public programmes which provided subsidies to farmers installing irrigation equipment, as well as guaranteeing generally low water prices for agriculture. This trend was reinforced after the 1992 reform of the Common Agricultural Policy, as a result of the higher remunerative compensatory payments given to irrigated acreage than to non-irrigated acreage (Rainelli and Vermersch, 1998; Dubois de la Sablonière, 1997).

Until the late 1980s, most irrigation projects were financed by the State. Now, irrigation projects are completely financed by ASAs (*Associations Syndicales Autorisées*), which recover investment costs and capital losses through water charges paid by farmers. These ASAs contract wholesale water supplies with Regional Development Companies (SAR, *Sociétés d'Aménagement Régional*), which have access to public funds, but which are also private companies and are required to balance their budgets.

SARs are perhaps the most distinctive participants of the French water economy. Developed under the sponsorship of the Ministry of Agriculture between 1955 and 1960 to promote agricultural development, they have responsibility for supplying water to retailers, such as city companies or farmers' associations, as well as for setting water use charges. In very rare cases, SARs also supply water directly to individual farmers on a retail basis. Each SAR has the authority to perform key tasks, such as designing charge structures, setting charge levels, and implementing discriminatory schemes across different water use sectors. Both *demand* pricing schemes, based on elasticities and sectoral differences, and *supply* pricing schemes, based on marginal or average costs, can be found in different SARs operating in different regions.

In regions with strong seasonal variations, water is allotted to users on a rotating basis, and depends on the total flows available during summer periods. In other regions, SARs (such as the Compagnie des Coteaux de Gascogne) have implemented quotas together with tiered prices, which discourage high consumption rates by farmers. The Bas-Rhône-Languedoc SAR, which primarily

services farmers and farmers associations, sets charges based on three objectives. The first is to ensure that all farmers pay exactly the same price, except where energy costs make up a significant portion of the total price of irrigation services. The second is to allow farmers to opt for one of two alternative pricing schemes, depending on the type of crops grown and the frequency of water applications. The third objective is to insure that the lowest charges are higher than marginal costs, so that total collected revenue at least covers O&M costs (Montginoul and Rieu, 1996).

In general, water charges across all irrigation units in France have been increasing over time, for three basic reasons. The first is the result of the 1992 Water Code, which sought to broaden the revenue base for water supply companies in order to insure their financial stability. Second, there has been a large increase in newly-converted irrigated acreage across France, adding more pressure on several basins during summer periods and/or drought conditions. Several water companies have pricing schemes that discourage usage beyond certain thresholds, in order to keep total water abstractions within reasonable levels. Third, pollution is now considered to be another “use” of public waterways and bodies, so that water authorities can sometimes justify charging “resource-based” prices which can be added to other accounting and/or capital cost components.

Germany

Water management is the responsibility of the *Länder*. Generally, irrigated agriculture is not very extensive, and general water policies tend to override more specific policies that pertain exclusively to the agricultural sector.

Traditionally, water prices have been based on the costs of extracting water from the natural cycle, and of water treatment and transportation. Until the Baden-Württemberg *Länder* established a “water tax” in 1988, water remained significantly undervalued. Since then, other *Länders* have followed suit, and water taxation has become more common. (Hesse, Lower Saxony, Bremen and Mecklenburg-Western Pomerania implemented water taxes in 1992; Saxony and Schleswig-Holstein did so in 1993 – see IISD, 1998).

However, these water taxes deviate from the commonly-accepted definition of water charges for two reasons. One is that water taxes are generally levied only in cases where a permit or licence is required. Since water metering in the agricultural sector is not common in Germany, some estimates show that the allotted volumes (as stated in licences) deviate substantially from the actual abstractions carried out by licensees. The second reason is that the revenues collected through water taxes have often been used to compensate farmers for restrictions on fertiliser use in vulnerable areas.

There are also tax rebates (which can reach 90 per cent) for those farmers who can provide evidence of being financially impaired by the tax. However, these rebates are conditional on farmers implementing water-saving strategies, and on using surface water sources, instead of ground water ones.

Greece

The contribution of the agricultural sector to Greek GNP is one of the highest in all OECD countries. Greece has about 1.33 million hectares of irrigated land, which represents 38 per cent of its total arable area and almost 10 per cent of the country’s total land surface. Irrigated farming accounts for more than 80 per cent of the nation’s total water consumption. The Greek agricultural sector is possibly the most structurally handicapped of all OECD countries in terms of: landholding structure (only 4.1 hectares per farm); ageing farmers (58 years old on average); and the slope of intensively-farmed fields (61 per cent of land a slope greater than 5 per cent) (Selianitis, 1997). The fact that about 20 per

cent of the active population makes its living from agriculture clearly indicates how important the rural economy is in Greece.

The recent expansion of irrigated acreage — by about 65 per cent in the last 20 years — is the outcome of a strong political commitment to increase both agricultural production and farm incomes in rural areas. It is also the result of private initiatives, which currently represent about 60 per cent of total Greek irrigated acreage. In most cases, sprinkler or drip irrigation technologies are used. The remaining 40 per cent of the total irrigated acreage is composed of co-operative irrigation projects, resulting from the joining of the Local Land Improvement Boards (TOEV) and the National Land Improvement General Boards (GOEV). TOEVs are run by elected councils, who represent project beneficiaries. Their responsibilities include managing water allocations, collecting farmers' fees, and managing collective facilities. GOEVs are semi-governmental organisations, established to finance works affecting more than one TOEV. Public projects are also primarily equipped with modern irrigation technologies, with 52 per cent and 7 per cent of the 532 000 hectares using sprinklers and drip technologies, respectively, while 41 per cent involve the less efficient gravity irrigation systems. The construction of irrigation projects comes under the responsibility of rural regional authorities. Therefore, all government assistance given for irrigation facilities is aimed not only at economic objectives, but also at environmental consumption and social objectives as well.

An ongoing challenge facing Greek water authorities is to find ways of exploiting the country's tourist potential without worsening the environmental conditions of its rivers and aquifers, and still protecting the economic interests of the agricultural sector.

According to Lekakis (1998), access to water resources has not yet been fully regulated, and the organisation of the water management agencies and water suppliers is essentially governed by the civil code. This institutional framework, together with the remarkable hydrologic complexity which exists in Greece, explains why it is not possible to identify any common trends in Greek agricultural water pricing systems. Another factor which contributes to this heterogeneity is the fact that more than 40 per cent of agricultural water demand is supplied by groundwater resources, so that water fees are totally dependant on extraction costs. TOEVs set fees to cover the administration as well as maintenance and operation expenses of the collective facilities. On average, the revenues collected with these charges represented about 60 per cent of TOEVs' total expenses in 1994. Lekakis (1998) also provides an estimated range of pumping costs of US\$ 54 to US\$ 250 per hectare.

Recently, a government-controlled experiment has begun to operate in Western Crete (known as the Organisation for the Development of Western Crete (OADYK)). This Agency provides water for drinking and irrigation purposes. It is a non-profit, but self-financed, organisation.

Greece is presently approaching "maturity" with respect to new opportunities for expanding irrigation supplies. Public investment in reclamation projects have decreased about 32 per cent since the 1970s. Although there are some on-going initiatives which combine environmental objectives with better water and irrigation management, no significant effort has yet been made to make farmers pay for the important rehabilitation and maintenance costs which will be needed in the future. Both the challenging natural conditions of Greece and the relative economic importance of its agricultural sector are factors which explain the delay in implementing water pricing reforms in this sector. Of equal importance is the widely held perception in Greece that water supply projects are multi-purpose facilities which contribute towards social progress, and environmental conservation and protection.

Italy

Italy has abundant, but unequally distributed, water resources. Despite large recent investments in water works and infrastructure, it is estimated that a large proportion of water users (primarily in the southern part of the country) do not yet receive sufficient quantities of drinking water (Destro, 1997).

Irrigated land is mostly located in the northern Po Valley and in the southern Capitanata Region. Farming in Italy represents about 61 per cent of the country's consumptive use of water. In strict quantity terms, water is amply available in the Po Valley, but quite scarce, and much more vulnerable to droughts, in the South.

The large-scale development of irrigated land in the Po Valley was partly the outcome of a long-standing public objective to reclaim large marsh areas prone to disease. The Land Reclamation Act (1933) gave momentum to a policy which included the conversion of all water bodies to the public domain, and set forth the principles which would guide the management of all water resources in Italy for decades to come. Consortia for Integrated Land Reclamation were created as a consequence of this Act, and were given self-financing capacity to foster rural development, as well as to build irrigation projects. The government provided funds to cover all project capital costs, while the Consortia took responsibility for managing and maintaining these systems, and for collecting charges from farmers.

Farmers pay much less than other users, and their charges do not yet include depreciation costs. Capital replacement is therefore still dependant on the general government budget. Some estimates indicate that farmers' charges cover only about 60 per cent of total fixed and variable costs (Vacca *et al.*, 1994). An indication of water prices for agriculture relative to other sectors in Italy can be seen by noting that abstraction fees for a water "module" (100 litres per second) could be obtained in 1994 by irrigation Consortia (who then resell the water with a mark-up to farmers) at a price of only US\$ 42, whereas "module" fees for households and industrial users were set at US\$ 1 820 and US\$ 13 330, respectively (Malaman and Prosperitti, 1995). In their study on irrigation water charges in Serdegna, Aiello *et al.* (1997) show that rates vary within each Consortia based on the type of water conveyance system (canal or pipes), pressure, crops, and irrigation technology. A range of prices are indicated, from a flat rate of US\$ 65 in Nurra Consortia (1993) for drip irrigators to US\$ 500 for rice growers in Campidano di Oristano Consortia (1994).

An ambitious new programme with three main components is now being implemented in the southern Capitanata Region (Mastrorili, 1997). The first component of the programme seeks to improve the management of collective irrigation systems and extension services. The underlying objective here is to provide compensation to farmers for having their allotments standardised at the (relatively low) level of 2 050 m³/hectare, by giving them broad advice on technical matters. The second component is the implementation of a two-part charging system that discourages water use levels which exceed crops' critical water needs. Besides penalising excessive consumption, those farmers who consistently exceed indicated water use levels also risk having their allotments completely cancelled. The third component of the programme seeks to increase waste water recovery, as well as the re-use of "unconventional" waters.

Water pricing policies will experience fundamental changes that will affect all users of the Italian public water system when the recently-passed Framework Law on Waters 36 comes fully into force. Water prices will then have to be determined by local governments, in accordance with a set of guidelines proposed by the Ministry of Public Works. The most important guidelines will be that: (i) prices must generate enough revenue to match investment and operating costs; and (ii) these prices should reflect the quality of water supplied (Destro, 1997). However, the majority of irrigation users draw

water from the Consortia, which are not under obligation to reach full cost recovery. In fact, the public budget continues to pay 100 per cent of capital cost and a significant share of operational costs.

Japan

Among OECD countries, Japan is perhaps the one whose agricultural economy has the strongest ties to tradition and history. The Japanese agricultural sector is also one of the most highly structured — a fact which has often been used to justify the leading role of government intervention in promoting and subsidising irrigation projects.

Not much has changed in the way water is used by rice growers during this century. Although Japan is a country blessed with abundant rain and snowfall, precipitation occurs only during the rainy season in June and during the September typhoons. Traditional rice growing occupies 80 per cent of the 2.8 million hectares of irrigated land, and about 55 per cent of the country's total cultivated acreage (Redaud, 1997). Japanese irrigated acreage declined by almost 20 per cent in the period 1970-93. At present, irrigated farming makes use of 64 per cent of the nation's water abstractions, most of it being surface water.

Irrigation is organised through Land Improvement Districts (LIDs), which take responsibility for managing common facilities and organising water rotations among farmers. Their decisions follow the one-farmer-one-vote co-operative system. LIDs can file applications for new irrigation projects, or for the enlargement of existing ones, and ultimately enjoy capital subsidies of about 50-65 per cent from central and local governments. Any proposed project must provide evidence of being consistent with the objectives of national agricultural policy in order to obtain these subsidies .

Farmers pay flat rates to their LIDs in relation to both O&M costs and investment projects. Water is allocated between farmers, following strict equity criteria. Since water is so critical, water rights are assigned to provide minimum access to water, even when severe drought conditions exist (normally once every ten years). O&M fees are in the range of US\$ 246/hectare, and represent about 2.5 per cent of total farming costs. Farmers' fees more than match LIDs' O&M and repair costs, and also cover part of the capital and financing costs (Nakashima, 1997).

Although flat rates generally provide disincentives to use water efficiently, three factors help to alleviate these presumed efficiency losses in Japan (Nakashima, 1997). First, most farmers grow the same crop (rice) and have very similar land-holdings. Second, anecdotal evidence seems to indicate that farmers use water at marginal productivities greater than zero, due to self-restraint in water abstractions, and in order to avoid both regional disputes and the environmental deterioration of rivers. Third, although water prices themselves are flat, farmers do incur additional marginal costs in using that water, which might induce them to increase marginal productivities. In fact, under stressful drought conditions, water application costs usually increase sharply, because water has to be managed very closely, thereby rationing its use at LID and farm levels.

There are three main agricultural water policy strategies anticipated for the future in Japan: (i) to preserve the consistency of water policies with agricultural structural reforms, and to make irrigation systems sufficiently flexible to accommodate changes in water use patterns expected to result from these new agricultural policies; (ii) to promote within- and out-of-agriculture water transfers, seeking efficiency gains and occasionally reducing the need for new physical water provision infrastructure; and (iii) to work toward improved environmental performance.

Mexico

Mexico's irrigated acreage is second only to the US among OECD countries, totalling about 6.1 million hectares, and extending over more than 25 per cent of the nation's cultivated land. Mexico's 1982 economic crisis put a virtual end to decades of investment in irrigation projects and water harnessing facilities. Thus, investment in irrigation infrastructure declined from US\$ 3.6 billion in 1981 to US\$ 230 million in 1990 (Johnson, 1997). Whereas farmers paid about 95 per cent of their total O&M costs in the early 1950s, forty years later farmers' contributions had fallen to 37 per cent (Johnson, 1997). Mexican irrigated agriculture accounts for 50 per cent of its agricultural production, and for 70 per cent of its agricultural exports.

The main force leading to reform has been the steady decline in the quality of irrigation facilities, which resulted from the failure to raise enough revenue to match O&M costs. By the end of the 1980s, about 800 000 hectares of irrigated land had been taken out of production, or were being used with lower intensities, due to severe deterioration in irrigation facilities.

When the government instituted a programme to transfer management responsibility from the National Water Commission (CNA) to water users in 1990, a new approach to water irrigation management began to bear fruit. The National Program for the Decentralisation of Irrigation Districts aimed at decentralising retail water management and gave birth to "irrigation modules" of 5-50,000 hectares, operated by user associations. In addition to this initial decentralisation initiative, the reforms also had the objective of insuring some degree of financial sustainability, thereby allowing the "modules" to maintain their production capacity. The second stage of the reforms involved the creation of Limited Responsibility Societies (LRSs), again made up of irrigation modules, to take on the responsibility of wholesale water supplies.

As a result of these changes, the "modules" presently cover 80 per cent of operation and maintenance costs. Proof of the significant improvements achieved recently in Mexico in terms of increasing financial self-sufficiency of the irrigation modules is the fact that the 1995 economic crisis did not disturb their functioning, despite the fact that the crisis caused the federal government to put an end to financial transfers to agencies such as the National Water Commission.

By 1998, more than 91 per cent of the 3.3 million hectares of publicly-irrigated land had already been transferred to joint management, and seven LRSs had already been created, comprising about 705 000 hectares (Johnson, 1997). Although the reforms are proceeding as planned, a number of "second generation problems" have also emerged. Among these, Johnson (1997) highlights: (i) financial stress in drought conditions; and (ii) the salary costs of CNA employees involved in operational activities are still being paid by the government.

The Netherlands

There are 66 Water Control Boards in the Netherlands, and they are the agency units in charge of water management. Boards' costs are fully covered by water users, and work in close co-operation with the inhabitants in their areas. The agriculture sector contributes 27 per cent of the US\$ 556 million of total levies raised for quantitative water management. Unlike in many other OECD countries, the Dutch agricultural sector contributes more revenue to water management than actually spent in its direct benefit, with a discrepancy of about 5 per cent.

Water use records in The Netherlands are regularly updated. The total annual tap water used by Dutch agriculture (through 106 068 connections) amounts to 149 million cubic meters. This is made up of

25 mcm used by glasshouse culture, 38 mcm devoted to arable land and horticulture, and 86 mcm used in cattle farming. On average, water supply costs to agriculture total US\$ 1.33 per cubic meter. Farmers are required to pay the full supply costs and, where appropriate, the full drainage costs as well.

Farmers in the Netherlands are generally subject to the groundwater extraction tax, especially when they draw on tap water resources for cattle production. If they find the price (including the tax) too high, they can decide to extract groundwater directly themselves. In that case, the following rules apply: (i) a permit from the Central Government is required if the capacity of the pumping facility exceeds 10 m³/s; (ii) any farmer using more than 1000 000 m³ per year has to pay the abstraction tax; (iii) a smaller provincial tax also has to be paid for facilities exceeding 10 m³/s, the proceeds of which are used to research groundwater depletion; and (iv) provinces also sometimes require permits for abstractions with capacities lower than 10 m³/s. Generally, farmers insure that they do not install pumping facilities that exceed 10 m³/s, so they usually do not pay the abstraction taxes.

New Zealand

The fact that New Zealand has abundant water resources explains why, even after the complete privatisation of water supply services, the prices users pay for these services are quite low by world standards. New Zealand's agriculture sector contributes about 10 per cent of the nation's economic output, on irrigation acreage of only 234 000 hectares, of which about 105 000 hectares were publicly-developed (Farley and Simon, 1996). While private irrigation districts generally use groundwater resources, the (formerly) public ones are mostly serviced by surface water sources.

Before the major economic reforms in New Zealand in the late 1980s, the government was heavily involved in building irrigation projects, in providing water services, and in covering the losses that resulted from insufficient water charges. Since 1910, when the Public Works Act originally came into effect, the government has made several attempts to amend the criteria on which water charges were set. Despite these efforts, projects incurring large O&M deficits continued to be systematically covered by the government. The (1990) Irrigation Scheme Act, among other radical changes of the time, allowed the government to sell all its irrigation projects and to put an end to public involvement in irrigated agriculture. In 1991, New Zealand adopted the Resource Management Act, providing a new framework for managing their natural resources, including water.

The privatisation process was finalised in 1996, when irrigators became the legal owners of the irrigation projects in which they operate. The government's policy of conceding its irrigation assets was generally favourable to irrigators in that: (i) many projects were handed over at negative prices, partly because some projects were downsized or unfinished and water rights were relinquished from beneficiaries, or because water works were in poor condition, requiring significant rehabilitation costs to upgrade them; (ii) instead of using competitive tendering procedures, the sale prices resulted from direct negotiations between the government and a team of irrigator representatives; and (iii) the government's objective was to quickly abandon its involvement in commercial irrigation, rather than to maximise the financial returns from the sale of assets. The result was that few projects realised very high selling prices (Farley and Simon, 1996).

Water prices in New Zealand have both wholesale and retail components. Whereas wholesale prices are based on the costs incurred in abstracting water from rivers or water bodies, retail prices are levied by Irrigation Companies which provide water services to farmers. Often these companies are owned by their own (farming) customers, and prices are set in line with supply costs (with typically 66 per cent relating to "running costs" and 33 per cent relating to emergency expenditures).

New Zealand's water economy is expected to experience some difficulties in the future for three basic reasons (Scrimgeour, 1997). First, not all claims over access to water rights have been resolved. Second, most river flows have already been allocated to different users, and any further change in the pattern of users will only be able to occur through water trading. Third, both irrigated land and urban consumption are growing, adding further pressure on urban utilities, especially when unexpected water shortages occur. As a result of these and other factors, volumetric pricing is already being implemented for urban consumers, and is likely to be applied soon to agricultural water users as well.

Portugal

The Portuguese Water Law combines public and private ownership of water resources. Considering the country's small population and the extensive amount of land which is currently irrigated, Portugal is relatively well-endowed with water resources. Nevertheless, wide differences exist between the North and the South. Traditionally, water abstractions have been allowed free of charge, provided that users do not generate significant levels of pollution. Irrigated land constitutes about 60 per cent of the nation's total water supply.

Unlike most OECD countries, the State's role in promoting irrigation projects in Portugal has traditionally been quite limited. Purely public irrigation projects make up only 19-25 per cent of the 630 000 hectares of irrigated land, most of which are located in the southern part of the country. The rather small proportion of publicly-developed irrigated land also makes the role of public water pricing policies less important for national-level water management strategy. However, major institutional and legal reforms have been made in recent years in terms of implementing water charges for public projects.

Agricultural water prices are levied by users' associations, but in accordance with very complex mechanisms and formulae. The complexity arises because WUAs sometimes supply municipal water as well; because property sizes affect the water charges; and because charges are combined with drainage fees in projects that require drainage. Between the passage of Decree 269/82 (in 1982) and new legislation in 1995, farmers were charged a two-pronged levy. The first was meant to recover the O&M costs of irrigation schemes and was based on individual farm acreages. The second component was meant to reimburse the State over a fifty year period for the capital costs invested in projects. Project beneficiaries were required to pay a yearly set charge called TEC ("Taxa de Exploração e Conservação"), which includes a selection of no more than three of the following components: (i) fixed charge per reclaimed or ameliorated hectare (ranging from US\$ 18 to 270); (ii) fixed charge per irrigated hectare (ranging from 31 to 146 US\$); (iii) volumetric charge per cubic meter, if metering is possible (ranging from US\$ 0.01 to 0.028 per cm); (iv) a drainage fee, when drainage of excessive water is required (ranging from US\$ 19 to 67); and (v) a crop-based fee applicable for specific crops and projects (ranging from US\$ 16.9 to 87.3) (Bragança, 1998).

Although the capital cost charge element has never achieved its intended objective of full cost recovery (as in many other countries), the Portuguese system has the peculiarity that it computes fees payable using different interest rates, with the rates varying according to each area's soil quality and the crops grown. For instance, Bragança (1998) reports significant water price differences paid by farmers in Sorraia: US cents 1/m³ for rice (involving 17 200 m³/hectare) and US cents 1.5/m³ for corn (involving 7 200 m³/ha); and US cents 2.5/m³ for tomatoes (involving 5 400 m³/hectare).² It is clear that the "ability-

2. Equivalent to Portuguese Escudos (ESC) 1.90 per m³ for rice, ESC 2.76 per m³ for corn, and ESC 4.77 per m³ for tomatoes.

to-pay” principle, combined with other agricultural policy objectives, underlies these price differentials. Nonetheless, charges in Sorraia were gradually raised over the period 1991-97, such that they are now set at levels that exceed total O&M costs (with the extra revenues being used to cover fixed management costs in dry years). On the other hand, this project in Sorraia does not typify the majority of Portuguese irrigation projects.

As of 1995, all licensed use of water has been subject to a water levy, whose amount depends on: (i) the amount of water used; (ii) the net returns generated by each type of user; and (iii) each region’s relative scarcity of water. The implementation of this levy is being phased in, and will be completely in force by 1999, although farmers will be exempted from paying the tax for the first five years (OECD, 1997).

The Alqueva project in the Guadiana Basin — currently under construction, and to be completed in 2024 — is expected to expand Portugal’s total irrigation area, by 110 000 - 200 000 hectares (the final increase will depend on final design features). A large part of the US\$ 2.35 billion costs of the project will be financed by European Union Structural Funds. Currently, there is intense debate within Portugal about how O&M and capital costs should be distributed among the various user sectors (not only in agriculture) which will benefit from the project. New legislation will be needed to establish how, and to what extent, these costs are finally shared among these water users.

Spain

Spain has one of the largest irrigated acreages in OECD countries. Most of this acreage is subject to arid or semi-arid conditions, as well as to a remarkable degree of climatic variability. In response to these natural constraints, the development of irrigation has been at the top of public, collective, and private management priorities since the beginning of the VIIIth century. The combination of mild temperatures and a large number of sunshine hours in Mediterranean regions has provided generous returns to those who have invested in controlling and transporting water resources for the irrigation of land. Although Spain has relatively abundant natural water supplies on average, the distribution of these resources is such that the Northern basins receive about nine times more water than the South-eastern basins do.

The 3.3 million hectares of irrigated land use (in average years) 75-80 per cent of all the water consumed in Spain. More than two-thirds of this land has been publicly developed, as part of a widely-accepted objective of investing in irrigation projects as a means to promote economic development and agricultural production. About 50 per cent of total employment in rural Spain is directly or indirectly related to irrigated agriculture.

The new (1985) Water Law implemented significant changes in the way water management was performed under the old (1879) Water Law. Essentially, the 1985 Law was meant to deepen public involvement in the most important aspects of water management. Among the most significant changes were the conversion of all water resources into the public domain; the provision of a mandate to the government to approve a national water management plan; and the reinforcement of the role of the river basin authorities to take responsibility for flood control, water-works construction, the granting of water concessions (or licences), and the setting and collecting of water charges. Water use rights are solidly connected to land use rights. Although the Water Law establishes legal procedures that permit changes in the characteristics of the water use rights, water markets are not permitted, and the process of transferring water rights continues to be quite cumbersome.

Farmers using surface water sources for irrigation are required to pay two types of charge. One, the regulation levy, is intended to reimburse the State for capital investments made in principal water works (without which, available water for abstraction would be much more limited than it is). The other charge is a tariff designed to cover the O&M costs of water storage and transportation systems. Both charges are computed according to criteria strictly laid down in specific decrees, in accordance with the Water Law.

However, close scrutiny of how these charges are actually collected, and the amount of revenue actually raised, provides substantial evidence of problems in their administration. First, basin authorities often fail to collect the revenue the statute dictates they should raise. Second, not all users that are legally obligated to pay for using the water are actually required to do so.

Besides these institutionally-fixed charges, farmers belonging to irrigation districts (of which there are about 7 000) are required to contribute to the costs of running and maintaining these collection and allocation systems. Overall, these co-operatively-run institutions, some of which are several centuries old, have demonstrated an ability to efficiently and equitably run their systems.

When it comes to assessing the actual charges paid by Spanish irrigators (both institutional and collective), one finds extremely wide differences, even across farmers operating in nearby irrigation districts. Although charges might differ according to the relative water scarcity of the basin, or to the costs incurred in making the water available, other factors, such as farmers' water rights seniority or the degree of public involvement in cofinancing the project, are often much more important (Sumpsi *et al.*, 1996).

Despite these difficulties, the Spanish irrigation sector has shown remarkable resilience and innovative capacity. Putting aside its overall dependency on government budgets, there are plenty of examples of efficient uses of water, as well as of collective and private efforts in Spain which demonstrate that water is truly being treated as a scarce economic commodity.

The Government of Spain made clear in 1996 that a three-pronged public policy in regard to irrigation — a new water law, a new national water management plan, and a new irrigation national plan — would be a high priority. Among the major obstacles to getting each of these elements in place was the fact that each required fundamental changes in the principles that govern the financial side of the Spanish water economy. Since any water pricing policy is likely to impose irrigation water price increases, irrigators' associations are typically the most vocal opponents of these changes.

Sweden

Because water shortages are seldom a problem in Sweden, farmers that need water for irrigation can freely abstract it from nearby sources. To do so, they are required to file a petition, which is usually granted free of charge (Hagström, 1998). Irrigated acreage in Sweden occupies approximately 60 000 - 100 000 hectares of the 2.8 million hectares of arable land. Access to ground and surface water in Sweden is by law part of the land ownership rights, so it is only when there is a shortage of water in a given regions that farmers there are required hold permits for water abstraction. About 10 per cent of irrigation farmers have this kind of permit.

As with many other humid Northern countries, Swedish water and agricultural policies place the highest emphasis on water quality issues. Since 1984 special taxes have been placed on the use of pesticides and fertilisers; and cash crops, protection zones and ecological farming have been given

considerable support through the Swedish application of the EU Agri-environmental Regulation (2078/92).

Switzerland

Water supply to the Swiss irrigation sector is provided by regional agencies which charge a wide range of prices. Overall, however, irrigation uses only 4 per cent of all Swiss water abstractions, and its acreage is very small. What makes Swiss pricing policies different from those of other countries is the fact that farmers are required to pay for wastewater treatment, as well as for water supplies. Hence, the system recognises the potential polluting effects of farming activities on water bodies, and makes polluters pay the treatment costs. Siegrist (1998) reports total prices ranging from US\$ 0.33 to US\$ 1.96 per m³.

Turkey

Turkey generally has adequate water supplies to meet its needs, but this water is not always in the right place, or at the right time. Overall, only about one-third of surface water capacity, and about half of groundwater capacity, are currently being utilised.

Approximately 28 million hectares is classified as cultivable land, of which 8.5 million is considered to be economically-irrigable using available technology. At present, about 2.98 million hectares (net area) of irrigation infrastructure has been developed by the public sector, and a further 1.07 million hectares are provided with supplementary water by small-scale privately-owned irrigation schemes. Thus, the total area under irrigation is about 4.05 million hectares.

Within the public sector, two agencies are responsible for the development of water resources:

- the General Directorate of State Hydraulic Works (DSI) — the main agency responsible for planning, developing, and managing large-scale irrigation infrastructure. DSI is also responsible for other water works, including dams for water and power utilisation, flood control, river diversions, water supply schemes, and groundwater development.
- the General Directorate of Rural Services (GDRS) is responsible for on-farm development and small-scale irrigation works (those with a discharge capacity of less than 500 l/s). GDRS has already developed about 16 000 such schemes. One of its major new challenges is dealing with the ever-increasing on-farm development requirements associated with the large-scale irrigation schemes financed by DSI.

As of 1997, DSI had been responsible for the development of 1.74 million hectares; GDRS for 0.92 million hectares; and the two agencies had jointly developed 0.32 million hectares from groundwater sources.

In the early 1950s, DSI started a programme to transfer some irrigation systems to local users, through Water User Groups (WUGs) and Irrigation Groups (IGs). Until 1993, these transfers had been taking place at a fairly slow pace, and only the smaller-scale schemes were being transferred (an average annual area of about 2 000 hectares were so transferred). However, these transfers have been significantly accelerated in recent years, and some larger-scale facilities have also been included in the transfers. In 1998 alone, 140 000 hectares were shifted. The total area transferred by the end of June 1998 amounted to 1.42 million hectares (almost 82 per cent of the area developed by DSI).

Prior to 1993, DSI had been reluctant to transfer larger schemes into private management., but three developments in particular convinced them to consider a policy change. First, the fiscal burden on the public sector was becoming unsustainable. Second, experience with earlier transfers had demonstrated that the private managers would adequately maintain the irrigation infrastructure for which they were responsible. Third, other countries were also moving in this direction at the time, and were having positive experiences with their policy (e.g. Mexico).

By law, both capital costs and O&M expenditures incurred by DSI in the provision of irrigation systems are subject to repayment. In principle, these charges should be based on the actual expenditures of the previous year, plus the amortised value of capital costs (with the amortisation period not to exceed 50 years). In practice, no interest charges are imposed on the capital portion of the charge. In addition, once amortisation charges have been established, they are generally not subject to change. It is only when these charges become very low that the amortisation annuities are adjusted, and approval of the Prime Minister is required to do so. (This was last done in 1985.) Special rates are also given for the repayment of capital costs. These rates are based on the repayment capacity of farmers, on the geographical location, and on the original amount of the investment.

In the past, farmer payments had covered only about 40 per cent of the previous years' total O&M costs, partly because inflation was ignored in setting rates for the new year, and partly because the actual collection of water charges tended to be quite low. The accelerated transfer of management responsibility to local users has resulted in a sharp increase in O&M cost recovery rates (for example, collection rates have increased from less than 54 per cent under the previous arrangements, to an average of 90 per cent under the new ones).

Local organisations to which the responsibility for managing irrigation schemes has been transferred determine their water charges on the basis of *estimated* O&M and investment costs for the following season (i.e. not on the basis of previous years' *actual* expenditures). This has the effect of incorporating price inflation into the calculation. Water charges per unit area are determined by dividing the projected O&M and investment costs by the projected irrigation area for the following irrigation season. These charges can be applied on the basis of total crops, crop types, irrigation times, or water volumes.

Major future challenges to the Turkish agricultural water economy include: (i) the increasing importance of environmental issues, such as erosion processes and salinity build-up; and (ii) the threat to agricultural land from significant population growth in urban areas.

United Kingdom

There are slightly more than 100 000 hectares of irrigated land in the UK. In Scotland and Northern Ireland, water resources are abundant, and farmers can take water from adjacent rivers simply by filing for permission, which is granted at no cost. In those regions, water use is regulated by the traditional Common Law. Water resources are becoming increasingly scarce in England and Wales, but irrigation represents only 3 per cent of all abstractions.

The obligation to obtain a licence for water abstraction was introduced in these regions in 1963, and since 1968 an abstraction charge has been levied on abstractors, set generally on the basis of the amount licensed to be abstracted, rather than the actual volume taken. The present charging scheme came into effect in 1993. As well as licensed volume, charges are calculated from factors reflecting the nature of the water source, the season in which abstraction is allowed, and the extent to which the abstracted water

will be returned directly to water sources. Different basic charges are set for each of 10 regions, roughly corresponding to the major river basins in England and Wales.

Only direct abstractions for spray irrigation require an abstraction licence, and thus attract an abstraction charge. Other forms of direct abstraction for irrigation are currently exempt from the licensing requirement, although the UK Government has indicated its intention to bring this exemption to an end in the near future.

Spray irrigation charges are, unusually, based partly on actual volume taken as well as the other factors in the general charging scheme. Abstraction licences are conditional on approval of the individual metering procedure by the Environment Agency. The schedule is designed so that 25-50 per cent of the annual charge is based on the volume specified in the licence, with the other 50-75 per cent based on actual recorded consumption. Prices vary from US\$ 0.0109/m³ in Yorkshire, to US\$ 0.028/m³ in Northumbria.

Direct abstractions for agricultural purposes other than irrigation require licences and attract abstraction charges based solely on the licensed amount. New abstraction licences, for any purpose, are granted by the Environment Agency only if there are sufficient water resources in the area to sustain the abstraction. In some areas, water resources are already fully committed.

Where mains water is used for agricultural purposes, the user is charged by the supplying water company according to tariffs scrutinised by the financial regulator, Ofwat. Metered charges for these purposes are common, but unmetered use is charged on a flat rate basis with no reference to actual water use.

United States

The US comprises a wide range of climatic and geophysical types. Although it has abundant water resources on average, more than 50 per cent of its territory is vulnerable to droughts to some extent. Disputes related to water resources spring up quite frequently, sometimes because of the effects of droughts, but more recently, it is often because influential social groups advocate not only that no further water works should be constructed in already-controlled rivers, but also that some existing waterworks should be decommissioned in order to return rivers' to their natural states.

Although average total irrigated acreage has stabilised at about 20 million hectares since 1982 (USDA, 1993), irrigated land in the Pacific and Mountain States has declined by about 7 per cent during the 1982-92 period, while in the Great Lakes Area, the Corn Belt, and the Appalachian and Southeast States it increased more than 25 per cent. This reflects the significant differences which exist across states and individual river basins. Since agricultural water pricing problems in the Western regions are generally more challenging, this section focuses primarily on that part of the country.

Before the Reclamation Act of 1902, land settlers obtained access to water resources through their individual investments. Water rights were chronologically assigned to farmers or miners who could show evidence of putting water resources to "beneficial use". Hence, the seniority of water access was established by the dates at which farmers were able to convert their informal water use into legal water rights.

The Reclamation Act also established the Bureau of Reclamation (BoR), which subsequently became very active in building irrigation projects. Although its role as a developer of irrigation acreage came to an end in the early 1980s, the BoR still serves as the water wholesaler for about 25 per cent of the

West's irrigated acreage. Presently, the West's water sector is facing an array of problems, among which the most important are: (i) the need to comply with increasingly stringent environmental and natural habitat restoration regulations; (ii) the need to increase urban water supply to meet urban growth needs; (iii) the need to improve the economic efficiency of water used in the agricultural sector; and (iv) the need to raise more revenue from users in order to recover a larger proportion of water supply costs from irrigators (Wahl, 1989).

Although many OECD countries have intricate water sectors, water institutions in the US West are particularly complex as a result of several factors. First, historical priority rights for water access, which are considered private property, exist for water users who operate in irrigation districts supplied by Federal or State water agencies. Second, water trading (both through spot or permanent rights transactions), is common and is publicly-promoted in many Western States. It is well documented that, besides promoting efficiency gains, water markets also pose serious administrative difficulties for State agencies, mainly due to environmental restrictions and to the increasing complexity of disputes over water access. Third, while it is clear that irrigation water subsidisation is the source of water use conflicts in many western States, any effort to reduce these subsidies is challenged by the fact that the subsidised rates have already been capitalised into land prices, so that newcomers would effectively be required to pay again for something they already bought when they bought the land. Fourth, water rights are solidly established in law, with the result that any effort to alter these rights in any way will face considerable difficulties (Cummings and Nercessiantz, 1992).

The pricing of irrigation water in Federal projects have been based on two main principles. One is that Federal water charges to farmers would not be set in an attempt to generate full cost recovery. Congress therefore made it possible for farmers to pay these costs over a very long time period (at little or no interest), and at rates not exceeding their "ability-to-pay". The other principle is that delivery contracts between the BoR and the irrigation districts would establish firm conditions regarding quantities and prices over long periods (25-50 years). As a result of these and other restrictions, significant changes in the criteria used by the BoR to set prices have been very slow to emerge.

California's Central Valley Project Improvement Act (CVPIA, 1992) is one exception to this. In addition to enhancing the protection of fisheries and recreational resources, this Act established mandatory increases in water charges, via the introduction of tiered rates and a flat surcharge of US\$ 0.0049/m³. The most expensive tier, which affects water consumed above the 90th percentile of the volume specified in the contract, is charged at full-cost recovery. This includes interest costs, which were traditionally excluded in the computation of water charges (Gardner and Warner, 1994). It also denies automatic renewal of the existing (40-year) supply contracts at subsidised prices. A previous experience (1988) with tiered pricing in the Broadview Water District (California) was successful, although the main objective here was the reduction of drainage volumes (Wilchens, 1991). The CVPIA was also intended to facilitate water trading, to promote more efficient use of water and to enhance instream benefits. In addition, some other initiatives designed to set higher charges on groundwater sources have recently been implemented in Arizona and other Central Plains States.

European Union

The EU Water Framework Directive (European Commission, latest version July 1997) represents an ambitious plan by the European Commission to integrate several disperse pieces of Community legislation with direct or indirect relationships to water issues, as well as adding a few new objectives which were neglected in the past. Although still under discussion, this proposal has generated considerable debate in EU Member States, and some elements of this debate deserve special mention here.

One of the most controversial components of the draft Directive is the role assigned to water prices for achieving the conservation of sufficient water supplies. Essentially, the Directive's underlying philosophy is that the failure to make water users responsible for the complete costs generated by their use is a source of water misallocation — and one which seriously jeopardises future generations' access to water. It follows, then, that the implementation of “full-cost recovery” prices to all water users — including all accounting costs — would represent a significant step towards a more sustainable exploitation of water resources. While the European Commission has set up modest objectives with regard to costs recovery, it has not ruled out the incorporation of scarcity values and environmental externalities in full cost recovery (Kopke, 1998). Nevertheless, placing precise values on environmental damage and resource scarcity components is widely recognised as an extremely difficult task.

Although the draft Directive states clearly that cross-subsidisation between sectors should be avoided, it does allow Member States to guarantee access to basic volumes of household water at “social” charge rates. Likewise, Member States are permitted to grant exemptions based on programmes that encompass the subsidisation of capital costs for infrastructure projects with environmental objectives, as well as for projects developed in regions entitled to Structural Funds. Despite these provisions, the Directive states clearly that all deviations from “full-cost recovery prices” should be explicit and transparent.

Of course, irrigation water would not fall into these categories of exceptions. Therefore, should the Directive be approved in its current form, EU farmers would be required to pay “full cost recovery” prices for the water they use from the year 2010 onwards.

A comparison of OECD agricultural water prices

In view of the very diverse situations outlined in the previous section, drawing comparisons of agricultural water pricing systems across OECD countries is a complex task. In addition to the conceptual vagueness created by the use of common words to denote different things (“full-cost recovery” being perhaps the best example), any cross-country comparisons will ultimately be based on general trends which mask important deviations within individual countries. Nevertheless, and despite the lack of comprehensive data, some generic factors do seem to contribute to explaining at least part of the observed differences in pricing practices among OECD countries. It is important to take into account the social/economic and hydrological factors of each country (as discussed in the previous section) when drawing comparisons across countries. Prices serve precise objectives; inasmuch as these may vary across countries according to the social/economic and hydrological factors, pricing mechanisms and criteria will likewise differ.

In a temporal context, the problem of inflation will also seriously compromise the precision of any cross-country price comparisons that are made. Although inflation has been relatively low in recent years in most OECD countries, it has been quite high in others (e.g. *Turkey*, *Hungary*, and the *Czech Republic*). Clearly, special care will be required when generating any impressions of price trends for these latter countries.

In the following section, the various institutional frameworks prevailing in OECD countries are first summarised. Next, comparative quantitative information on actual water pricing levels is presented.

Differing institutional approaches to agricultural water pricing

Roughly speaking, OECD countries can be divided into three main groups according to the role and potential productivity of irrigated farming. One group comprises those countries or regions which

have climates that make irrigated agriculture much more productive than dry-land agriculture. This group includes *Australia, Greece, Spain, Western US, Mexico, Portugal, Turkey, Japan, and Southern Italy*. The second group includes those countries or regions in which irrigation is carried out mainly as a complement to climate conditions which are otherwise favourable to dry-land agriculture. This group includes *Northern France, Northern Italy, New Zealand, Canada, and the UK (England and Wales)*. These are countries or regions in which irrigated agriculture is still increasing, and where farmers are still investing in irrigation equipment primarily in order to reduce risk. The third group is made up of countries in which irrigated agriculture is negligible, or is generally limited to horticultural productions in the summer time. The countries in this group are *Norway, Austria, Sweden, Finland, Denmark, Netherlands, Belgium, Poland, Czech Republic, Germany, and Switzerland*.

Each of these groups is examined in the following paragraphs. A selected list of key variables affecting each OECD country in which irrigation is relatively important (i.e. Groups 1 and 2) is given in Table 3.

Group 1 is certainly the most complex and heterogeneous. Some of the common features here include: strong inter-sectoral competition for water resources; wide differences in net agricultural returns, depending on whether or not irrigation exists; long and deep involvement of public agencies in building water works and/or irrigation projects; increasing difficulties in preserving the environmental quality of waterways, without reducing the quantity available to users; and increasing costs of generating new sources of water supply. Despite these similarities, countries do tend to differ in the relative “maturity” of their water economies. The most mature ones are perhaps *Australia, Spain, the US, and Japan*. These countries experienced 10-20 years ago the same types of expansion that *Portugal, Mexico, or Turkey* are undergoing at the moment.

The cases of *Portugal* and *Turkey* differ slightly from those of other countries in Group 1, in that large-scale expansion of irrigated land in those countries is still possible, and is in fact a general public policy objective. Considering the size of projects currently under construction in these countries, it is very unlikely that the final beneficiaries would ever be able to make positive economic returns, should they be forced to pay for all of the capital costs directly attributable to them. Thus, it can be concluded that, in many cases, periods of expansion of irrigation infrastructure are *not* very compatible with the goal of implementing full-cost recovery prices.³

3. It is also noted that three OECD countries (*France, UK, New Zealand*) have moved some way toward “efficiency-based” water pricing, and yet are each expected to significantly increase their total irrigated acreage in the future.

Table 3. Institutional Framework for Agricultural Water Pricing Policies in Selected OECD Countries

Country	Types of water rights		Pricing criteria/ Agency	Recovered costs	Differential charges based on:				Other factors		Performance	Other economic instruments	Inter-sector water competition	On-going reforms
	Surface	Ground water			EQ	LQ	HR	IT	ATP	AP				
Australia	Entitlements	Licensed	Federal Guidelines and State (or other jurisdiction) criteria	O&M + salinity control and capital replacement	X	X	✓	X	Initially	X	Good	Tradable permits; caps on diversions	Strong	Full-cost recovery expected to be completed by 2001
Belgium (Flanders)	Use rights	Geographically- and historically-defined	Prices set by individual distribution companies, within provincial jurisdiction. Federal government controls prices	100% of costs for piped water; levy on declared quantities of surface and groundwater abstractions	X	X	✓	X	X	X	Good	Pollution charges	Light	n.a.
Canada	Use permits	Free (provincial variations)	Provincial level, and water agencies	O&M	X	X	X	X	✓	X	Poor	Tradable permits (Alberta); env't'l regulations	Light	Budgetary constraints; stringent environmental regulations
France	Use rights	n.a.	Regional Development Companies	O&M + capital replacement	✓	X	X	✓	✓	X	Fair	Quotas (depending on water availability)	Climate-dependent	General trend towards use of pricing, but subsidies to irrigation equipment also induce expansion of irrig'n
Germany	Use rights	n.a.	Länder	Extraction costs	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Poor	Tax-exemptions for farmers	Light	Stringent environmental regulations
Greece	Use rights	Licence	Regional Dev't Agreements and private suppliers	O&M + administration costs	✓	✓	X	✓	✓	✓	Poor	Agricultural policies; rural development policies	Strong	National Land Registry; creation of self-financed Water Management Agencies
Italy	License	License	Irrigation boards	O&M (+ % of capital replacement)	X	X	X	✓	X	X	Poor	Quotas; progressive pricing in the South	Strong in the South	Devolution of public systems to local governments; integrated water management plans
Japan	Historical and use rights to WUAs	Not used	Districts	O&M (+ % of capital replacement)	✓	✓	✓	X	✓	✓	Fair	Agric. struct. reforms; transferability (in-kind)	Strong (during droughts)	Districts' rehabilitation programmes; modest lib'n; consistency with agr. policies
Mexico	Use rights (50 years)	n.a.	Federal level and Irrigation "modules"	O&M	✓	✓	X	X	✓	✓	Fair	Agric. policies: water planning	Strong	Decentralisation; devolution toward irrigation "modules"; rehabilitation projects
Netherlands	Use rights	Licence	Water Control Boards, cost-based, including treatment	O&M	X	X	n.a.	X	X	X	Good	Pollution levies and Flood control levies	Low	Moving towards a different view of flood security policies.

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	Surface	Ground water			EQ	LQ	HR	IT	ATP	AP				
New Zealand	Use rights (resource consents)	Use rights (resource consents)	Local authorities and Irrigation schemes	100% of costs	X	X	X	X	X	X	Good	No	Increasing	Increased water metering; price differentials, depending on farmers' costs
Portugal	Public and private rights	n.a.	Government and private water company criteria	O&M	✓	✓	✓	✓	✓	✓	Poor	Agric. policies; rural development	Low	Alqueva project will set the new water pricing policy (still largely undefined)
Spain	Use rights	Licenses (but almost private)	River Basin Agencies (by law) and Irrigation Districts	O&M (+ % of capital replacement)	✓	✓	✓	✓	X	✓	Poor	Quotas (allotments); occasional markets	Strong	Items under discussion include: an amendment to the Water Law; a national water management plan; and a national irrigation plan
Turkey	Use rights	Licenses	National Government and WUAs	O&M	✓	✓	X	✓	✓	✓	Poor	Agric. Policy	Low	Transfer of O&M cost collection responsibility to WUAs
UK	Licenses	Licences	National River Agencies and Water Companies	100%	X	X	X	✓	X	X	Fair	Quotas	Increasing in some areas	Wider metering of water consumption; possible implementation of incentive charges and permit trading
US	Private and public rights	Private	Federal and State Agencies	O&M (+ % of capital in California)	X	X	✓	X	✓	X	Fair	Tradability: water banks (in-kind exchanges)	Strong	Stringent environmental requirements; block-rate prices; devolution to WUAs

Key to Table 3:

- ✓ = Yes; X = No; n.a. = not available.
- EQ: equity considerations (are prices adjusted in order to avoid wide differences among irrigators?)
- LQ: Do land quality considerations justify different price levels?
- HR: Do historical rights explain any price variations (holding other factors constant)?
- IT: Is irrigation technology taken into account when setting charges?
- ATP: "Ability-to-pay" (see text).
- AP: Is general agricultural policy taken into account when setting charges.
- Performance is rated by comparing the objectives of each country's charging systems with their accomplishments.

What about the objective of raising enough revenue to cover at least the O&M costs? Even here, it must be recognised that there are other equally important objectives of agricultural policy besides cost recovery. Irrigated farming is usually perceived as a means of promoting economic development, so water prices are often set in accordance with the relative profitability of each irrigated crop (or of the productivity of the land itself). Privately-managed irrigation works are often more successful at setting prices which better reflect the full costs of water supply. Thus, the relative importance of private irrigation districts in *Portugal* has led to charges which are now much more linked to actual water supply and drainage costs. The recent transfer of a large portion of publicly-developed irrigation works to water users in *Turkey* has also significantly increased O&M cost recovery rates in that country.

Japan's case is not matched by any of the other countries surveyed in this report. Several factors contribute to the particular situation in place in that country. One is tradition: paddy growers have been using publicly-supplied irrigation water for centuries. Another reason is based on the structural difficulties associated with metering water uses. One might also argue that as long as all stakeholders agree on the criteria used to share available resources, there is no need to meter it (this reasoning is also applied in the more traditional irrigated areas of *Spain*, where the institutional framework has shown remarkable adaptability for centuries).

Japanese irrigation districts have demonstrated considerable ability to ration water under stressful conditions, without the intervention of external forces. As a result, there has not been much emphasis placed on the pricing option. Interestingly, the Japanese government seems to be inclined to modestly liberalise the allocation of water rights, thus drawing some advantages from the increasing willingness of urban suppliers to pay for water, and contributing new revenues for rehabilitating the old, inefficient, and very "atomised" water districts in Japan. Clearly, this approach is not aimed at reversing a situation which has existed for centuries, but at attracting non-rural capital in order to persuade water rights holders to accept "in-kind" water trading, without encroaching on their traditional rights or vested positions.

The Capitanata region of Southern *Italy* provides another unusual example. Water is a scarce, but agriculturally-productive, resource in this region. Irrigation districts are given considerable power to allot water quotas, to charge prices that generate enough revenue to cover O&M expenses, and to discourage excessive water application rates. These two factors help to explain much of the successful experience with water pricing which has been observed in Southern Italy.

Among the countries belonging to Group 1, *Australia* is the one which has gone the furthest in reforming its water pricing mechanisms. The reform of Australian water policy has resulted from a deep change in the government's basic approach to economic intervention. In this sense, the economic reforms have been promoted by external political forces. On the other hand, the fact that water-based environmental problems had grown to worrying levels was another important factor contributing to these changes. The basic principle underlying the water pricing reforms is that users should not make use of water resources if they are unable to pay the costs incurred in providing those services. Behind this seemingly innocuous principle, however, lie many problematic issues which have demanded prolonged discussion, negotiations, and compromises. Some of the most important institutional changes linked to the pricing reforms have been:

- Further abstractions in over-appropriated basins are capped. Water can no longer be made available to any applicant who wants access to the resource. In general, environmental quality enhancement has become one of the government's top priorities.

- The new pricing criteria can not discriminate between farmers, or by land quality or any other factor. Prices would henceforth be set in line with estimated water supply costs. The estimation procedure was designed at Federal level, following lengthy negotiations, and has been set in such a way that each water user or sector should cover the costs it generated on its own.
- The procedures used to estimate water service costs should be commensurate between individual States, so that price distortions across borders do not exist. These Federal guidelines are being progressively implemented by the States, with some price differences continuing to exist across borders.
- Water entitlements were converted into tradable property rights. Those farmers who do not generate enough net returns to pay the new water prices are allowed to sell their entitlements. This too is being progressively implemented, and there are many difficulties (including environmental issues) still to be resolved.
- Irrigation districts (i.e. distribution systems) were successfully privatised.

Mexico's situation differs from *Australia's*, in that its general economic reforms have lagged behind reforms in the water sector. *Mexico's* reform of water pricing policies seeks to improve the management of water at the irrigation district level, and to make wholesale and retail water allocation systems less vulnerable to cyclical shortfalls in federal budgets. One driving force here was the general recognition that the lack of revenues available to cover O&M costs had rendered huge areas of irrigated land virtually useless. Large irrigation units, which had proven to be too big to be adequately managed, were therefore broken up into smaller districts, and given more administrative independence to collect charges, to maintain collective assets, and to manage their water resources. These reforms have managed to partially equip many irrigation districts with the ability to recuperate through farmers' charges enough to sustainably maintain the operational capacity of their assets.

The *Greek* water economy is also quite heterogeneous, and is also subject to some pressure from general agricultural and rural development policies. At the moment, the top priorities of the Government are: (i) the completion of a National Land Registry that will permit the authorities to have more effective control over water and land uses; (ii) improvements in the process of granting water rights, so that all users will eventually hold water rights (as envisaged under current legislation); (iii) the construction of ambitious water facilities to ameliorate the effects of droughts and guarantee access to water resources in tourist areas. In these contexts, pricing policies are seen to be important only where they contribute to infrastructure rehabilitation projects in industrial districts, or in cities. As far as the agricultural sector is concerned, the Greek approach to water pricing can be understood as the combination of the objective of promoting sustainable agriculture and pure economic principles.

The *Spanish* case is both complex and extremely diverse in terms of performance and pricing criteria. Although water is structurally and/or cyclically scarce in large parts of the country, public pricing policies are not used to ration access to these resources. The Water Law sets clear guidelines as to what charges can be imposed on farmers using surface waters. In spite of these guidelines, however, agricultural water charges have not matched the O&M expenses of basin agencies, nor has that portion of capital costs which should be legally assigned to irrigators been recovered.

Overall, the Spanish water economy seems to follow two paths. At the wholesale level, both public policies and the institutional framework exhibit a tendency to continue to expand, even though it

seems clear that Spain reached “infrastructure maturity” some time ago. Indicators of this further expansion include: (i) irrigation districts are still being built with the assistance of subsidies, and total abstractions are still increasing in basins which are prone to drought conditions; (ii) irrigation water is far from being considered a valuable economic commodity; (iii) the collection of charges is not universal; and (iv) most water “bottlenecks” are being tackled by building new structural facilities, rather than by increasing prices to reduce demand.

However, at the district or retail level, farmers’ associations have shown a remarkable ability to raise enough revenues to cover the costs of allocating water under stressful conditions, to maintain and improve their assets, to solve internal conflicts, and to manage to enlarge their water resource base, mostly through private investments. Attempts to implement more ambitious water pricing systems are presently being hindered by several factors:

- new irrigation districts are still being built at subsidised costs;
- agricultural water demand at zero or very low prices is still being provided through subsidised structural facilities — although this is becoming less common;
- the Water Law currently in force severely restricts the ability of basin agencies to increase water charges.

The *Western US* water economy is even more complex than the Spanish one. Although the Federal Bureau of Reclamation has played a leading role in expanding irrigated land in this region, states have considerable authority to pursue quite different approaches to water pricing, to promote (or to refrain from) further irrigation projects, and to set their own individual water-related priorities. Broadly speaking, two priorities drive public water policy development here. One is to find ways of meeting the increasing demands found in most Western cities, and to improve the reliability of this supply. The other is to enhance the environmental conditions of rivers and lakes, to protect wildlife, and to preserve natural habitats. Irrigators therefore find themselves in the middle of most water disputes, and restrictions on their water rights is often viewed as a viable solution for alleviating any water scarcities which may be identified.

Most US sources seem to concur that the option of increasing water prices is overrated. Several arguments have been put forward against making wider use of public pricing mechanisms. As in other OECD countries, one argument is that increasing prices would penalise farmers who bought land at prices in which access to subsidised water had already been capitalised. Another reason is that farmers’ water rights are solidly entrenched in the legal system, so any attempt to charge farmers a higher price could be easily challenged on legal grounds. The final reason is that water pricing would be inefficient, in view of the general lack of information facing water management agencies.

California’s 1991 Central Valley Project provides a different example. Although tiered water-pricing *has* been implemented for farm use water from this project, contract renewals are taking place at a very slow pace, because most farmers still have long-term contracts with the BoR.

In sum, the implementation of irrigation water pricing seems to be out of the question in most US States. Instead, regions such as the Western US are attempting to exploit other types of market or incentive mechanisms, such as water banks or “in-kind” water trading arrangements, in order to provide appropriate signals about water scarcities.

The second group of countries consists of those in which irrigation is still expanding. However, each country's institutional framework again follows somewhat different paths. At one extreme, *New Zealand's* irrigated land expansion has resulted from private entrepreneurs seeking profits by servicing irrigation water to farmers, or by groups of farmers who associate in order to build collective private facilities. New Zealand's public policy has been limited to granting "resource consents" to applicants, and to charging permit holders adequate prices to cover all administrative costs. Other water service costs, at both wholesale and retail levels, are paid by final users. The pricing institutions in the *UK* are similar to those which exist in New Zealand.

Water pricing policies in *France, Northern Italy, and Canada* are also evolving towards "full-cost recovery", although each country is following a somewhat different path in implementing these reforms.

In France, pricing policies are being combined with other instruments (such as quotas), and are designed by the regional agencies responsible for managing water resources at the wholesale level. In this sense, the French system grants each of the five river basin agencies broad independence to design and implement local water policies, which generally seem quite well-suited to the hydrologic conditions prevailing in each area. On the other hand, the fact that farmers are heavily subsidised for investments in irrigation equipment offsets (at least to some extent) the effects of increased water prices as a deterrent to further agricultural water abstractions. In addition to these subsidies, national incentives for irrigation use are reinforced by the EU's Common Agricultural Policy, which rewards those farmers with installed irrigation equipment more generously than those without it (Rainelli and Vermesch, 1998).

In Northern Italy and Canada, water institutions do not suffer the periodically-stressful conditions that exist in some parts of France. Perhaps a key motivation for both countries to charge higher water prices to farmers is simply that new sources of revenue are needed to pay for water supply. Modest progress towards water pricing liberalisation in the Canadian Province of Alberta is an exception, and has been driven by the water scarcity problems that are occasionally experienced there.

The third group of countries is characterised by farmers having easy access to water resources, and by the fact that, in aggregate, agricultural water consumption is not very significant relative to total abstractions. Water pricing policies in all of these countries are much less important than other environmental policies which affect irrigation and non-irrigation farming, including general natural resource management policies. In these countries, water pricing policies are therefore virtually non-existent. Irrigation districts (at least as they are conceived of for those countries belonging to Group 1) simply do not exist.

Differing levels of agricultural prices

As noted earlier, comparing agricultural price levels across different countries and regions can be quite deceptive, unless they are put into an appropriate context. Table 4 summarises some price data on irrigation water pertaining to several OECD countries. Among the countries included here, *Canada, New Zealand, and Portugal* have the lowest agricultural water prices, although the reasons for this vary.

Table 4. Agricultural Water Price Ranges and Characteristics in Selected OECD Countries

Country	Region (year)	Supply characteristics	Type of charge	Price (in \$)		Cost-recovery	Comments	Sources
				Surf. (per ha)	Vol. (m ³)			
Australia	N.S.Wales (95)	Wholesale+min.charge	Volume (low security)	-	0.0024	100% O&M+CD	Includes resource management	Musgrave (1997)
	N.S.Wales (95)	Wholesale+min.charge	Volume (high security)	-	0.0028	100% O&M+CD	Includes resource management	Musgrave (1997)
	Queensland (95)	Wholesale	Volume	-	0.00739	100% O&M		Musgrave (1997)
	Murray-Darling (92)	Wholesale	Volume	-	0.010	60% O&M	Since 1992, prices rose by 11%	Musgrave (1997)
	National average (96)	n.a.	Two-part		0.75-2.27	0.0195	Variable	Most representative figure
Austria	National average (98)	Retail (from municipalities - waterpipes)	Volume	-	0.23-1.78	100% O&M	Livestock consumption	Rech (1998); Breindl (1998)
Canada	Saskatchewan (98)	Retail	Surface	10.5-14.9	-	100% O&M	In federally-owned districts	PFRA (1998)
	British Columbia (88)	Wholesale	Surface	90	-	< 100% O&M	In publicly-developed districts	Horbulyk (1998)
	British Columbia (88)	Wholesale	Volume	-	0.00016-0.0002	< 100% O&M	In publicly-developed districts	Horbulyk (1998)
	Alberta (98)	Retail	Surface	12.2-26.7	-	100% O&M	In farmer-controlled districts	PFRA (1998)
	National average (96)	n.a.	Two-part	6.62-36.65	0.0017-0.002	100% O&M	Most representative figure	Dinar & Subramanian (1997)
France	Adour-Garon W.A (97)	Wholesale (replenished watercourse)	Volume	-	0.00527	100% O&M	Water abstracted for irrigation	Duchein (1997)
	Adour-Garon W.A (97)	Wholesale (groundwater)	Fixed	-	0.0046	100% O&M	Water abstracted for irrigation	Duchein (1997)
	C.d.Côteaux de Gascogne(93)	Wholesale	Fixed (equiv. prices)	-	0.158	100% O&M	Water abstracted for irrigation	Montginoul & Rieu (1996)
	Rhône-Med.Cor.W.A.(94)	Wholesale (surface)	Fixed (equiv. prices)	-	0.0031	100%O&M	In Provence to irrigate 50 ha	Montginoul (1997)
	Rhône-Med.Cor.W.A.(94)	Wholesale (ground)	Fixed (equiv. prices)	-	0.0065	100%O&M	In Provence to irrigate 50 ha	Montginoul (1997)
	Canal de Provence (93)	Wholesale	Fixed (equiv. prices)	-	0.11	100%O&M+cap	Varies, depending on factors	Montginoul (1997)
Greece	Crete (OADYK), (97)	Retail	Surface	-	0.021	100%O&M	Self-financed public company	Lekakis (1998)
	Crete (OADYK), (97)	Retail (pumping)	Surface	-	0.082	100%O&M	Self-financed public company	Lekakis (1998)
	National aver. (97)	Retail	Surface	92-210	-	60-75% O&M	In publicly-developed districts	Selianitis (1997)
Italy	Northwest (94)	Retail	Surface	32.67	-	93% O&M	Average Consortia Data	Destro (1997)
	Northwest (94)	Retail	Surface	53.11	-	64% O&M	Average Consortia Data	Destro (1997)
	Nurra-Serdeгна (94)	Retail	Two-part (citrus)	250	-	n.a.	Consortia Data	Aiello <i>et al.</i> (1995)
	Nurra-Serdeгна (94)	Retail	Two-part (drip sys)	62.4	-	n.a.	Consortia Data	Aiello <i>et al.</i> (1995)
	Nurra-Serdeгна (94)	Retail	Two-part (melon)	125	-	n.a.	Consortia Data	Aiello <i>et al.</i> (1995)
Japan	National average (97)	Retail	Surface (rice grnr's)	246	-	100% O&M+ part of cap	Most representative figure	Nakashima (1997)
Mexico	National average (97)	Retail	Surface	60	-	68-80% O&M	Most representative figure	Johnson (1997)
	Cortazar (97)	Retail	Surface	33	-	73% O&M	Transferred irrigation module	Johnson (1997)
Netherlands	National average (98)	Wholesale and Retail	Surface and Groundwater		1.44	>100% O&M	Most representative figure	National Reference Centre for Agriculture (1998)
New Zeal.	Lower Waitaki	Retail	Surface	11-27.5	-	100%O&M+cap	Irrigation companies	Scrimgeour (1997)
Portugal	Sorria (97)	Wholesale	Fixed or two-part (rice)	173-208 (a)	0.010	100% O&M	In publicly-developed districts	Bragança (1998)
	Sorria (97)	Wholesale	Two-part (maize)	105 (b)	0.014 (c)	100% O&M	In publicly-developed districts	Bragança (1998)
	Sorria (97)	Wholesale	Two-part (tomatoes)	136 (b)	0.025 (c)	100% O&M	In publicly-developed districts	Bragança (1998)
	Vigia (97)	Wholesale	Fixed (maize) (sprinkler irrigation)	-	0.042 (d)	<100% O&M	In publicly-developed districts	Bragança (1998)

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Country	Region (year)	Supply characteristics	Type of charge	Price (in \$)		Cost-recovery	Comments	Sources
				Surf. (per ha)	Vol. (m ³)			
Spain	Andalucia.Gen-Cab (95)	Wholesale + Retail (pump)	2-part (sprinklers)	90	0.027-	100% O&M	A modern public district	Sumpsi <i>et al.</i> (1996)
	Andalucia. Viar (95)	Wholesale + Retail	Surface	113	-	100% O&M	An old private district	Sumpsi <i>et al.</i> (1996)
	Valencia Ac.Real (95)	Wholesale + Retail	Surface	142.92	-	100% O&M	Historical irrigation district	Sumpsi <i>et al.</i> (1996)
	Valencia Novelda (95)	Retail (groundwater)	Two-part	90	0.133	100% O&M+cap	Privately built for speciality crops	Sumpsi <i>et al.</i> (1996)
	Castille. Retencion (95)	Wholesale + Retail	Surface	90	-	100% O&M	A publicly developed district	Sumpsi <i>et al.</i> (1996)
	Castille. Villalar (95)	Retail (groundwater)	Vol. (+ energy)	-	0.07	100% O&M	A publicly developed district	Sumpsi <i>et al.</i> (1996)
Turkey	Mediterranean (98)	Wholesale+Retail	(Cotton) surface	49.50	-	70% O&M	WUA transferred from DSI	DSI & WUAs (1998)
	Mediterranean (98)	Wholesale+Retail	(Cotton) pumping	96.50	-	70% O&M	WUA transferred from DSI	DSI & WUAs (1998)
	Central Anatolia (98)	Wholesale+Retail	(Wheat) surface	19.80	-	70% O&M	WUA transferred from DSI	DSI & WUAs (1998)
	South-east Anatolia (98)	Wholesale+Retail	(Wheat) pumping	44.00	-	70% O&M	WUA transferred from DSI	DSI & WUAs (1998)
UK	Northumbria (97)	Abstraction charges	Vol.	-	0.028	100% Costs	Minimum annual charge \$42	Environmental Agency (1997)
	Northumbria (97)	Abstraction charges	Vol. (+equip used in summer)	-	0.136	100% Costs	+	
	Wales (97)	Abstraction charges	Vol.	-	0.013	100% Costs	Application charge \$167	
US	N.Sacramento River (CA) (97)	Wholesale+min.charge	Vol. up to 80%	-	0.0049+0.011	100% O&M	Central Valley Improvement Act	Wahl (1997)
	N.Sacramento River (CA) (97)	Wholesale+min.charge	Vol. up to 80-90%	-	0.0049+0.014	100% O&M	Central Valley Improvement Act	Wahl (1997)
	N.Sacramento River (CA) (97)	Wholesale+min.charge	Vol. up to 90-100%	-	0.0049+0.016	100%O&M+cap	Central Valley Improvement Act	Wahl (1997)
	Tehama.Col. Cl (CA) (97)	Wholesale+min.charge	Vol. up to 80%	-	0.0049+0.025	100% O&M	Central Valley Improvement Act	Wahl (1997)
	Tehama.Col. Cl (CA) (97)	Wholesale+min.charge	Vol. up to 80-90%	-	0.0049+0.048	100%O&M	Central Valley Improvement Act	Wahl (1997)
	Tehama.Col. Cl (CA) (97)	Wholesale+min.charge	Vol. up to 90-100%	-	0.0049+0.071	100%O&M+cap	Central Valley Improvement Act	Wahl (1997)
	Pacific North West (90)	Wholesale	Average	13.4	-	17%of total costs	B of R average for 1.1 mill ha.	Schaible (1997)

- Notes:
- All currencies have been converted to dollars, using exchange rates shown in *The Economist* (first issue of March 1998), unless the source provides the figure directly in dollar terms, in which case the figure has been transposed to this Table as it appears in the source.
 - Some figures which appear as Vol.(m³) might have originated from surface pricing, but were then converted into volumetric ones, using the estimated consumed volumes.
 - Portugal: (a) the maximum value was derived by adding the drainage tax (US\$ 35/ha) wherever it is applied to the consumption estimated volumetric cost (for 17 200 m³ at US\$ 0.01/m³); (b) these values were derived by adding the extra crop taxes (maize: US\$ 33/ha, tomatoes: US\$ 82/ha) to the volumetric costs; (c) these values were derived based on the estimated water volumes, the value per m³, and the extra crop taxes for maize and tomatoes; and (d) in this project, the tax is paid in accordance with water volumes and the value of m³ is fixed yearly for the majority of irrigated crops.

Except in Alberta (which comprises about 70 per cent of *Canada's* total irrigated land), water resources are so abundant in Canada that irrigation districts can easily tap into nearby water bodies to supply their farmers. Because of this abundance, competition for water is low, and supply costs are also typically very low. Canadian prices are therefore quite low, and are usually based on flat-rates. Furthermore, there is not much need to meter farmers' consumption, and the application of marginal cost pricing would be highly inefficient, given the application costs likely to be associated with such an approach.

In *New Zealand*, water resources are also abundant, but here, the irrigation companies have been fully privatised. The result is somewhat higher prices. These retail companies, some of which are owned by the irrigators themselves, are required to charge full-cost recovery prices. However, those companies whose assets were created before privatisation took place only need to charge capital replacement costs on top of O&M costs. This is because, as mentioned earlier, the handing over of irrigation assets to farmers and users' associations was not performed with the aim of maximising the government's returns, but rather of ensuring that the privatised districts remain operational. The net result, therefore, is that "cost recovery" in this case includes only the capital costs of investments made after the irrigation district was handed over to its final private owners.

Portuguese water pricing policies are severely constrained by the fact that most of that country's irrigated acreage has been privately developed. In publicly-developed irrigation districts, water prices have therefore been tailored to specific crops and irrigated techniques, conforming with the "ability-to-pay" principle, but still managing to raise some revenues with which to ease the government's financial burden. The water pricing criteria which will ultimately be applied in the Alqueva project are still undefined. Since the *European Union* is financing a part of these costs, it will be interesting to see how the EU Water Framework's Directive's principles are eventually applied to the beneficiaries of that project. Currently, public water charges in Portugal seem insufficient to match even O&M costs. Overall, irrigation policy in Portugal is driven mostly by agricultural and rural development policies, rather than by natural resource management objectives.

Irrigation water prices in *Japan* are well above those existing in most other OECD countries. Access to irrigation water is vital for paddy growers, who generally operate in a highly structured landholding system. Although water rates are typically flat, water is scrupulously distributed among district farmers, and under fairly stressful natural conditions. Also, since marginal application costs are high, farmers generally refrain from using excessive volumes of water. The deterioration of many old irrigation districts' collective assets is a result of the inability to raise enough revenues to match (generally increasing) maintenance costs. Nakashima (1997) singles out co-ordination failures among a large number of dispersed farmers as the major explanatory factor behind inadequate capital replacement and maintenance activities. The government is currently studying options for allowing water transfers to urban suppliers, in return for capital investments in the districts' infrastructures; some projects of this type already exist.

In *Turkey*, water rates discriminate according to the irrigation techniques used, and appear to differ by crop.⁴ Turkey is now roughly at the stage of water development that the *US*, *Spain*, or *Australia* underwent 30-40 years ago. Generating market returns, or even avoiding capital losses, on irrigation projects has historically been a much lower priority than either settling farmers on less-favourable lands, or improving Turkey's position as a major agricultural exporter. However, the O&M financial burden on

4. All crops were charged at the same base price, but an additional charge was levied for crops with particularly high water consumption rates (maize and tomatoes).

the government has acted as a catalyst in recent years for an accelerated transfer of public irrigation systems to water user associations, which are generally more successful in recovering full costs.

In *England* and *Wales*, farmers are on an equal footing with other water users. Only those farmers who install acceptable metering devices and procedures are charged rates in accordance with actual consumed volumes. However, metering of water in the UK is still rare, even for cities and industries. Abstraction charges are set by the water companies, which make each user responsible for its own costs. In the Thames region, water charges are estimated to be well below long-run marginal costs (Rees, 1997). However, imposing incentive charges greater than current costs is not legally permitted at the moment. Hence, if the *EU* Water Framework Directive is passed in its current form, and then transposed into UK Law, these price ceilings may need to be removed.

Italy exhibits two basic approaches to water pricing policy. The Po Valley is completely different from the dry Mezzogiorno. In the North, water prices do not even cover O&M costs. In the South, of which the Capitanata region is a representative example, water is distributed on the basis of strict quotas –to the extent that quotas are taken away from those irrigators who consistently exceed their targets. At the national level, a recently-passed Framework Law on Waters seems to provide a means for implementing pricing policies that bring the collected revenues nearer to O&M and investment costs. In principle, this Law does not seem substantially different from the proposed *EU* Water Framework Directive.

Although water charges paid by farmers in *Mexico* are currently increasing, they are still relatively low by OECD standards. Prices lagged behind inflation rates during the thirty years prior to the 1990s, and the coverage of actual irrigation costs was very low. Charges will probably increase under the recent ambitious programme of devolving irrigation district management to the recently-created “irrigation modules”. One problem encountered with volumetric charging in Mexico is that when drought conditions result in a decrease in the water volumes to which water right-holders are entitled, the amount of revenue collected also declines. Hence, regions which are vulnerable to natural water shortages will also experience difficulties in matching “modules” costs for some time to come. On balance, irrigation water prices in Mexico will probably be limited to levels which cover total O&M costs, at least over the medium-term.

France seems to follow a slightly inconsistent policy with regard to irrigation water prices. Water companies have quite a long experience of supplying water services to irrigators, and of charging differential prices based on the costs these companies incur in servicing their customers. Inasmuch as French basins are quite heterogeneous, it is not surprising that water companies would use completely different pricing criteria, and therefore end up charging quite different price levels. Some companies operating in basins with large natural supply variations tend to combine prices with quotas, with the size of the quota depending on each season’s water availability for irrigation.

Although the recovery of 100 per cent of O&M costs is already being widely achieved by French water companies, the 1992 Water Law empowers companies and basin agencies to levy environmental taxes as well as volume-based charges. This Law aims to treat all water users, whether consumptive or non-consumptive, as resource users who should be made responsible for the full costs they impose on water systems. The slight inconsistency mentioned above results from the fact that, despite significant recent efforts to raise water use charges, irrigation farming is increasing, in part because of programmes which offer subsidies to farmers who invest in new irrigation equipment.

Overall, *Greece* takes a similar approach to that of *Portugal* and *Turkey*, in that it actively encourages agricultural and rural development with its water pricing strategies. However, the Greek case is somewhat more complex, mainly because its hydrologic characteristics are much more challenging. Also, while water charges are much higher in Greece than in Portugal or Turkey, Greek farmers operating in publicly-developed irrigation units still do not fully cover O&M or capital replacement costs. A noteworthy example is that of a public (albeit financially autonomous) company operating in Crete which supplies water to farmers and drinking water. This company charges rates that are set in line with the particular O&M costs incurred in servicing each type of client.

As has been argued earlier, *Australia's* water pricing policy is unique among the semi-arid OECD countries. Curiously, the water charges that result in Australia from the application of the "full-cost recovery" principle turn out to be much lower than in countries which do not yet apply this criterion. This seeming contradiction can be explained by two factors. One is that the "grandfathering" provisions included in the Australian reforms were quite generous to already-established irrigators, so that the definition of "full-cost recovery" is rather narrow, especially regarding capital costs. The other factor might be that water supply costs are themselves lower than in other semi-arid countries, such as *Spain* or the *US*. This is particularly true for basins which deliver particularly large quantities of water (e.g. the Murray and Murrumbidgee rivers) and for which the fixed capital costs can be spread over a large charging base.

Of course, the fact that water prices turn out to be only moderately high does not negate the importance of the Australian example. On the contrary, the next section of this report borrows substantially from Australia's experience in defining a tentative agenda for future water pricing reform in OECD countries as a whole. An interesting feature of how water rights have been defined in some Australian States is that irrigators can hold low- as well as high-security water rights. This is useful, because it allows irrigators to adapt their individual farm situations to their cropping patterns, without introducing excessive complexity into the market-based system itself. The price spread among both types of rights is only US cents 0.04 per m³, indicating that (in New South Wales at least) both sets of rights enjoy very similar levels of supply guarantee.

Spain is perhaps one of the most heterogeneous examples of the countries surveyed in this report. The prices reported in Table 4 for Spain include wholesale charges collected by the public basin agencies, as well as the retail prices that farmers pay to their irrigation districts. Typically, price variations across basins and irrigation districts are explained by the relative accessibility to the water source by different irrigation technologies, and by how old the irrigation district is. But even taking these particular factors into account, retail prices vary significantly across districts, some of which are located very near to each other.

Even in regions with relatively plentiful water resources (e.g. Castille), prices are in the upper range of those reported in Table 4. At the other extreme, farmers in the arid south-east are using desalinated water at US\$ 0.6-0.8 per m³ to irrigate specialty crops grown under completely artificial and closed-system conditions. Preliminary evaluations indicate that the application of the *EU* Water Framework Directive would eliminate entire irrigation areas, leaving others almost indifferent, simply because net returns are well in excess of US\$ 20-30 000 per hectare, and water prices already cover their total supply costs.

Agricultural water prices in the *US* are as variable, complex, and diverse as they are in *Spain*. Those farmers who hold historical rights pay little more than the specific costs incurred in retailing water within the irrigation districts. Apart from California and a few other States which exploit groundwater

resources (among which the most important is Texas), public pricing policies are virtually non-existent in the *US*. Besides these two cases, irrigators located in publicly-developed water districts of the Western States pay reduced prices, but which are sufficient to cover at least these districts' O&M costs.

California's agricultural water economy is quite unique, and encompasses extreme situations which range from farmers irrigating alfalfa in the dry Imperial Valley near the border with Mexico, to electronically-supported water marketing systems in the San Joaquin Valley (Olmstead *et al.*, 1997). The California Water Agency has offered the world one of the most commented-upon water banking experiments. This simple price-incentive scheme was sufficient to encourage the exchange of more than 700 million cubic metres of water in just a few months. However, public pricing policies began to be used only after the passage of the Central Valley Improvement Act of 1992. As a result of this Act, tiered-pricing was introduced with some success in several publicly-developed irrigation districts (Wilchens, 1991). However, the implemented price levels are fairly moderate in view of the other prices reported in Table 4. In sum, despite a few significant experiences, water pricing has not been given the importance in the US that already exists in *Australia*, or that might exist in the *EU*, if the Framework Directive is eventually approved.

Reforming agricultural water prices

Most OECD countries have taken decisions at various times which favour the agricultural sector, at the expense of other economic sectors, or of the general tax-payer. Although full-cost pricing will usually lead to improvements in both economic efficiency (by avoiding distorted allocations) and environmental efficiency (by internalising any negative externalities which may be associated with the irrigation), there are sometimes valid social, environmental, or economic reasons for continuing to subsidise agricultural water activities. These competing policy objectives need to be balanced against the desire for increased efficiency.

For example, the promotion of irrigation has long been at the centre of many OECD countries' rural development and agricultural policies. In many regions of such countries as *Spain, Greece, Turkey, Mexico* and *Portugal*, irrigated farming provides the basis of economic and social activity. Water-based agricultural production is a significant contributor to both employment and export development objectives in many regions. Irrigation is also generally acknowledged to provide some types of environmental benefits under certain local circumstances (e.g. flood control, erosion control). When irrigated agriculture generates net social returns, despite not covering its full "accounting" costs, the rationale for removing water subsidies loses much of its appeal.

On the other hand, concerns are increasingly being raised about the possibility that subsidies do not always achieve their stated goals, and that reforms may therefore be necessary. For example, a common cause of water scarcity is the fact that water is demanded at prices below supply costs. The "circularity" of this problem is clear: water supply ends up being insufficient to meet demands because: (i) users do not provide enough revenue to expand water supplies; and (ii) users demand increasing amounts of water, but suppliers cannot meet this demand without additional revenues. The main water supply problems which could generate arguments for water reform in such a context include the following:

- Water scarcity is caused by those who consume water. Hence, if consumers wish to avoid supply insecurities, they must "buy" their security through their contributions, generally by paying higher water charges.

- Water scarcity increases as the number of users grows, and/or existing users increase their consumption. Therefore, if new and/or spendthrift users can be identified, they should be made responsible for the additional pressure their actions generate.
- In addition, water rates based long-term marginal costs can be justified on the grounds that they help avoid further deterioration of water supply systems, as well as contribute to long-term financial stability.
- Using the “willingness-to-pay” approach, water needs could more easily be filtered out, so that only those services which are truly necessary would be provided.

Managing the reform process

Thus, even though irrigation subsidies are not inherently “bad”, several OECD countries have recently been taking steps toward *reforming* these subsidy regimes (but not necessarily *eliminating* them). Of course, the relevance of any particular reform to an individual country will depend on the specific economic, environmental, and social conditions in place in that country, including their relationship to local farming practices. Based on OECD experience, the common elements of the reform process seem to include at least some of the following elements:

- *Capping further diversions or abstractions* or, perhaps, capping any diversion which would require cost subsidisation. This implies that any user wishing to consume additional water would require some other right-holder relinquishing his/her existing water rights.
- *Estimating all cost components attributable to consumptive users.* This is perhaps one of the most difficult tasks to carry out, but is generally essential. The *Australian* reforms illustrate that assigning costs to individual users, and setting general guidelines are time-consuming processes. As a general principle, “sunk” costs are *not* taken into account in this estimation process, although capital replacement costs required to maintain existing water infrastructure should be included.
- *A decision is made regarding the percentage of the estimated costs that will be recovered from the irrigators or their WUAs.* It is generally a priority that users pay a high proportion of the costs of operations, maintenance and renewal. However, in many cases it is necessary or preferable to phase-in water pricing policies slowly, with irrigators not paying for the total costs attributable to them in the first phase. Where this option is accepted, three further requirements are generally imposed:
 - Remaining subsidies are made explicit, both in terms of their amounts, and in terms of any timetable for phasing them out.
 - The reasons for deviating from “full-cost recovery” prices is made explicit, and is preferably based on specific policy goals, such as support for less-favoured areas, evidence of public agency mismanagement not attributable to farmers or WUAs, or landholding structure.
 - No new irrigation districts are built with public subsidies.

- *Provision is made to account for drought situations, for farmers' inability-to-pay, farmers generating positive externalities, and for historical rights.* These exceptions are necessary because:
 - The occurrence of droughts can disrupt the collection of volumetric charges. Water charges in normal years can be set at levels slightly higher than costs, so that droughts do not impose revenue shortages on retail or wholesale suppliers. Alternatively, public agencies could issue two types of rights, so that “insecure” rights are cheaper than “secure” ones.
 - Water pricing policies can potentially push inefficient irrigators out of the market. If these farmers have been operating at subsidised rates, they might question why a given policy allowed them to use water cheaply for a prolonged period of time, after which they are forced to pay non-affordable prices. *Australia* has responded to this problem by allowing inefficient farmers to sell their water entitlements. This helps to release water resources for sale to more efficient farmers or users. However, if this approach leads to a serious risk of inflicting substantial damage on entire rural economies, water sales will probably have to be limited and/or the charges phased in at a slower pace. In parallel, however, rural development programmes could be used to encourage alternative sources of income and employment that help farmers move into more efficient and less water-intensive activities.
 - When irrigation farmers are thought to generate positive social effects — such as maintaining the rural landscape and traditions, supporting local economies or contributing to food security levels — subsidised water charges may be justified, but should, of course, be transparent.
 - The existence of historical rights makes the implementation of full-cost recovery prices very tricky. The reason is that historical right-holders are not generally the ones most responsible for letting water appropriations increase to excessive levels, nor for demanding more water works to meet these additional demands. Hence, a decision has to be made as to whether all users will be made equally responsible for the increased cost of supply, or whether each group of users will be charged on the basis of the marginal costs it itself imposes on the system. The first option is likely to be contested by historical rights-holders, and the second will be challenged on equity grounds, since it reinforces the vested interests of those who are already established in the water economy.
- *Promoting the involvement of Water Users' Associations in retailing water supplies.* Public irrigation units are often transferred to farmers or to WUAs during significant pricing reforms. However, before transferring the legal property to WUAs, governments need to contractually agree with these bodies on several important details:
 - an exact definition of the water rights and of the volumes/flow they are entitled to, specifying at which point in the whole water distribution system WUAs become responsible for the assets, and when water flowing through the system becomes their property.
 - the most precise definition possible regarding the security of the water rights; and

- specification of the consequences of failing to meet any obliged payments to the basin agency, or of failure to supply an adequate (wholesale) water supply service.
- *Recognising any externalities imposed by irrigation farming on drinking water suppliers, or on other basin users.* Salinity and other run-off pollutants can have negative effects on other users, and on ecosystems more generally. Water pricing can be used to “internalise” these costs.
- *Not financing any new irrigation districts nor providing new subsidies to farmers regarding water use or irrigation activities, once pricing policies are in force.* Two further clarifications are needed in this respect:
 - If the government is already involved in long-term projects which aim to expand irrigation acreage, these projects should probably be completed under the conditions initially specified, if the set of beneficiaries has already been identified. Alternatively, the projects should be finalised only up to the point where the already-invested capital becomes operational, provided that : (i) farmers commit themselves to cover the O&M costs; and (ii) there is reasonable evidence that farmers can afford these charges.
 - If new (non-irrigation) water works (e.g. flood protection or water transportation systems) are built, offering new opportunities for irrigators, farmers should be charged in accordance with the costs they impose on the system to enable it to meet their water demands, making sure that their specific asset’ costs are fully recovered, and that they contribute to total O&M costs.
 - *The design of easy and cheap systems for collecting water charges.* If surface charges are considered to be too blunt, or to be providing disincentives to conservation, differential charges – based on the combinations of crops and irrigation techniques in use — can be used instead, and at reasonable administrative costs. It is generally recommended that the financial stability of the system be based on annual surface charges, instead of relying on volumetric or other variable charges, which should only be used to reflect the service’s marginal costs.

BIBLIOGRAPHY

- AEUCKENS, V. (1997). Australia: Strategic Framework for the Reform of Australia's Water Industry: Australia's Experience. *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- AIELLO, G.M., G. CANÉ, G. FADDA, A. MURRAU AND V. ONANO (1997). "Caratteristiche dell'irrigazione collettiva in Sardegna". *Revista Irrigazione e Drenaggio* 44: 58-63.
- BRAGANÇA, J. (1998). *Personal communication*. Portugal.
- BREINDL, D. (1998). *Personal communication*. Austria.
- BRILL, E., E. HOCHMAN AND D. ZILBERMAN (1997). "Allocating and Pricing at the Water District Level". *American Journal of Agricultural Economics* 79(4): 952-963.
- CASTRO, J.E. (1995). "Decentralisation and Modernisation in Mexico: The Management of Water Services". *Natural Resources Journal* 35 (3): 461-487.
- CASTRO CALDAS, J. (1997). "Portugal". In *Water Pricing Experiences. An International Perspective*. (ED. A. Dinar and A. Subramanian). World Bank Technical Paper No. 386. Washington, DC. 99-103.
- CHAKARVORTY, U. AND J. ROUMASSET (1991). "Efficient Spatial Allocation of Irrigation Water". *American Journal of Agricultural Economics* 73: 165-173.
- COSSIO DÍAZ, J. R. (1995). "Constitutional Framework for Water Regulation in Mexico". *Natural Resources Journal* 35 (3): 439-99.
- COX, J.P. (1998). *Personal communication*. Australia.
- CUMMINGS, R.C. AND V. NERCESSIANTZ (1992). "The Use of Water Markets as a Means for Enhancing Water Use Efficiency in Irrigation: Case Studies in Mexico and the United States". *Natural Resources Journal* 32: 731-755.
- DESTRO, S. (1997). "Italy". In *Water Pricing Experiences. An International Perspective*. (ED. A. DINAR AND A. SUBRAMANIAN). World Bank Technical Paper No. 386. Washington, DC. 64-68.
- DINAR, A. AND D. ZILBERMAN (1991). *The Economics and Management of Water and Drainage in Agriculture*. Kluwer A.P: Norwell, Massachusetts.
- DINAR, A. AND A. SUBRAMANIAN (1997). *Water Pricing Experiences. An International Perspective*. World Bank Technical Paper No. 386. Washington, DC.

DSI (STATE HYDRAULIC WORKS; TURKEY) (1998). *Comments made by the Turkish Delegation.*

DUCHEIN A. (1997). "France: Partnership between the Agricultural Community and the Basin Agencies". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies.* Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.

DUBOIS DE LA SABLONIERE, F. (1997). "France: An Incentive Policy for Sustainable Management of Irrigation Water in the Loire-Brittany Basin". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies.* Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.

DUPUY, B. (1997). "Aspect économiques de la gestion de l'eau dans le bassin méditerranéens". *Options Méditerranéennes.* Serie A no.3, CIHEAM: Paris.

EUROPEAN COMMISSION (1997). *Commission Proposal for a Council Directive Establishing a Framework for Community Action in the Field of Water Policy.* (COM(97)49). Brussels.

FAIRLEY, B. (1997). "Water Use and Water Quality in National Agricultural Policies: Canada's Experience". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies.* Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.

FAO (1997). *Anuario.* Rome.

FARLEY, P.J. AND B.M. SIMON (1996). "Privatising Government Irrigation Projects in New Zealand". *Water Resources Bulletin* 32(3): 585-594.

GARDNER, B.D. (1997). "Some Implications of Federal Grazing, Timber, Irrigation, and Recreation Subsidies". *Choices.* Third Quarter: 9-14.

GARDNER, B.D. AND J.E. WARNER (1994). "The Central Valley Project Water Improvement Act and Water Markets: Two Steps Forward - One Step Back". *Choices.* First Quarter: 4-9.

GARRIDO, A., VARELA ORTEGA, C. AND SUMPSI, J.M. (1997). The Interaction of Agricultural Pricing Policies and Water Districts' Modernization Programs: A Question With Unexpected Answers". Paper presented to the *Eighth Annual Conference of the European Association of Environmental and Resource Economists,* Tilburg, The Netherlands, June 26-28.

GOLLEHON, N., W.QUINBY AND M. AILLERY (1996). "Water Use and Pricing". *Arei Water* (202): 219-413.

GRIEG, J. (1997). "Some Practical Perspectives on Water Pricing Reform From an Agricultural Viewpoint". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies.* Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.

HAGSTRÖM, E. (1998). Personal communication. Sweden.

- HARKER, D.B. (1997). *A Prairie-wide Perspective of Nonpoint Agricultural Effects on Water Quality*. Prairie Farm Rehabilitation Administration. Agriculture and Agri-Food Canada, Regina, Saskatchewan.
- HORBULYK T.M. (1997). "Canada". In *Water Pricing Experiences. An International Perspective*. (ED. A. DINAR AND A. SUBRAMANIAN). World Bank Technical Paper No. 386. Washington, D.C., 37-45.
- HORBULYK, T.M. AND L.J. LO. (1998). "Potential Water Markets in Alberta, Canada". In *Markets for Water - Potential and Performance*. (EDS. EASTER, K.W., M.ROSEGRANT AND A. DINAR): Kluwer Academic Publishers, New York, in press.
- INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD) (1998) "Germany: Water Taxes". <http://iisd.iisd.ca/greenbud/germany.html> 1998.
- JOHNSON III, S. H. (1997). "Irrigation Management Transfer: Decentralising Public Irrigation in Mexico". *Water International* 22: 159-167.
- KONTOS, G. (1998). *Personal communication, Greece*.
- KOPKE, A. (1998). *Personal communication, European Union*.
- LEKAKIS, J. (1998). *Personal communication, Greece*.
- MALAMAN, R. AND L. PROSPERETTI (1995). "I prezzi dell'Acqua". In R. MALAMAN (ED.) *La Gestione delle Risorse Idriche*. Il Mulino: Bologna.
- MASSARUTO, ANTONIO (1998). *Personal communication. Italy*.
- MASTRORILLI, M. (1997). "Italy: The Capitanata Irrigation Scheme in Southern Italy: Experience in Water Sustainability". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- MERGOS, G. J. (1997). "Sustainability, Cost Recovery and Pricing for Water in Irrigation Investment". *Options méditerranées. Serie A. No 31. CIHEAM, Paris*.
- MONTGINOUL, M. AND T. RIEU (1996). "Instruments de gestion de l'eau d'irrigation en France: exemple de la Charente". *Ingénieries-EAT* 8: 3-12.
- MONTGINOUL, M. AND T. RIEU (1996). "Instruments économiques et gestion de l'eau d'irrigation en France". *La Houille Blanche* 8: 47-54.
- MOORE, M.R., N.R. GOLLEHON, AND M.B. CAREY (1994). "Multicrop Production Decisions in Western Irrigated Agriculture: The Role of Water Price". *American Journal of Agricultural Economics* 76: 859-874.

- NAKASHIMA, Y.J. (1997). "The Japanese Experience with Sustainable Water Use in Agriculture: Existing Systems and the Possibility of Introducing Market Mechanisms. *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- NATIONAL REFERENCE CENTRE FOR AGRICULTURE (1998). "Water Pricing in the Netherlands: Current Costs and Benefits. Informatie en Kennis Centrum Landbouw: Ede.
- NYS, R. (1998). *Personal communication*. Belgium.
- OECD (1987). *Pricing of Water Services*. OECD: Paris.
- OECD (1997). *Water Subsidies and the Environment*. OCDE/GD(97)220: Paris.
- OECD (1998). *Sustainable Management of Water in Agriculture: The Athens Workshop*. OECD: Paris.
- OECD (1999). *Water Pricing: Current Practices and Recent Trends*. OECD: Paris.
- OLMSTEAD, J., D. SUNDING, D. PARKER, R. HOWITT, AND D. ZILBERMAN (1997). "Water Marketing in The '90s: Entering the Electronic age". *Choices*. Third Quarter, 15-19.
- PÉREZ-DÍAZ, V., J. MEZO, B. ÁLVAREZ-MIRANDA (1996). *Política y economía del agua en España*. Círculo de Empresarios: Madrid.
- PIGRAM, J.J. AND B.P. HOOPER (EDS). (1990). *Transferability of Water Entitlements*. Proceedings of an International Seminar and Workshop. The Center for Water Policy Research: University of New England, Armidale, July 4-6.
- PIGRAM, J.J., R.J. DELFORCE, M.L. COELLI, V. NORRIS, G. ANTONY, R.L. ANDERSON, AND W.F. MUSGRAVE (1992). *Transferable Water Entitlements*. The Center for Water Policy Research: University of New England, Armidale.
- PIGRAM, J.J. (1993). "Property Rights and Water Markets in Australia". *Water Resource Research* 29(4): 1313-1319.
- POULOVASSILIS, A. (1997). "Water Resource Management for Sustainable Agriculture in Coastal Areas". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- RAINELLI, P. AND D. VERMERSCH (1998). *Irrigation in France: Current Situation and Reasons for its Development*. Unpublished manuscript from a study submitted to OECD Environment Directorate.
- RASKIN, P.D., E. HANSEN AND R.M. MARGOLIS (1996). "Water and Sustainability: Global Patterns and Long-range Problems". *Natural Resources Forum* 20, (1): 1-17.

- REDAUD, J.L. (1997). "Indicators to Measure the Impact of Agriculture on Water Use Pricing and Cost of Water Services". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- RECH, T. (1998). *Personal communication*, Austria.
- REES, J. (1997). "United Kingdom". In *Water Pricing Experiences: An International Perspective*. (ED. A. DINAR AND A. SUBRAMANIAN). World Bank Technical Paper No. 386. Washington, D.C., 139-143.
- ROSEGRANT, M.W. AND H.P. BINSWANGER (1994). "Markets in Tradable Water Rights: Potential for Efficiency Gains in Developing Country Resource Allocation". *World Development* 22 (11), 1613-1625.
- SAMPATH, R.K. (1992). "Issues in Irrigation Pricing in Developing Countries". *World Development*, 22(7): 967-977.
- SCHAILBLE, G.D. (1997). "Water Conservation Policy Analysis: An Interregional, Multi-Output, Primal-Dual Optimization Approach". *American Journal of Agricultural Economics* 79(1): 163-177.
- SCRIMGEOUR, F. (1997). "New Zealand". In *Water Pricing Experiences: An International Perspective* (ED. A. DINAR AND A. SUBRAMANIAN). World Bank Technical Paper No. 386. Washington, DC. 85-91.
- SELIANITIS, P. (1997). "Greece: Sustainable Management of Water in Agriculture: Issues and Policies". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- SIEGRIST, H. (1998). *Personal communication*, Switzerland.
- SONNTAG, B.H. (1996). *Interim communication report*. PFRA: Regina.
- SUMPSI, J.M., A. GARRIDO, M. BLANCO, C. VARELA, E. IGLESIAS AND L. AVELLÁ (1996). *Estudio sobre la economía del agua y la competitividad de los regadíos españoles*. Informe Final para la Secretaría General de Desarrollo Rural y Defensa de la Naturaleza. M.A.P.A.: Madrid.
- TSUR, Y. AND A. DINAR (1997). "The Relative Efficiency and Implementation Costs of Alternative Methods for Pricing Irrigation Water". *The World Bank Economic Review* 11(2): 243-62.
- USDA (1997). "A Case Study of the American US West: Water Management for Agriculture". *OECD Workshop on the Sustainable Management of Water in Agriculture: Issues and Policies*. Directorate for Food, Agriculture and Fisheries and Environment Directorate, Athens, Nov. 3-6.
- USDA (1993). *RTD UPDATES: Irrigated Land in Farms*. Economic Research Service: Washington, December, no.2.
- VACCA, G., M.A. ATZORI, AND A. LINOLI (1994). "L'irrigazione Pubblica in Italia: Tariffe e Copertura dei Costi: Risultati di un'indagine". *Irrigazione e Drenaggio*, Parte II.

- WAHL, R. (1989). *Markets for Federal Water: Subsidies, Property Rights, and the U.S. Bureau of Reclamation*. Resources for the Future: Washington, D.C.
- WILCHENS, D. (1991). "Increasing Block-rate Prices for Irrigation Water Motivate Drain Water Reduction". In *The Economics and Management of Water and Drainage in Agriculture* (Eds. A.Dinar and D. Zilberman). Kluwer A.P: Norwell, Massachusetts.

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