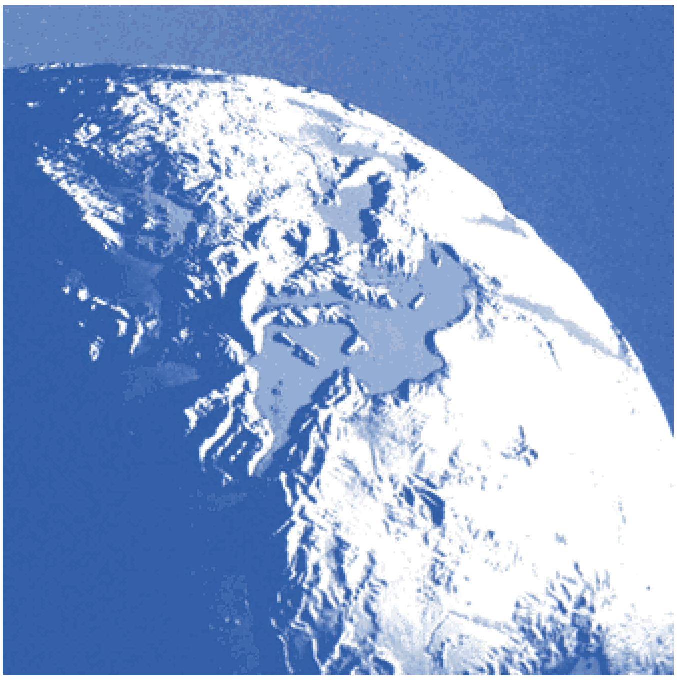
FORUM ON "PROGRESS IN WATER DEMAND MANAGEMENT IN THE MEDITERRANEAN" FIUGGI, 3-5 OCT. 2002

Economic tools for water demand management in the Mediterranean



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Global Water Partnership MED

Commissione Interministeriale Per La Politica Dell'Acqua Nel Mediterraneo

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Managing water demand by means of economic tools

1. WATER DEMAND MANAGEMENT AND ECONOMIC TOOLS

The Fréjus conference held on September 12th and 13th 1997 attempted to define the conditions for a balanced and sustainable management of water resources in the Mediterranean region. The balance between a supply which is already severely limited, and the growing demands from all sectors, can only be sustainably preserved by acting on demand; this means significantly altering traditional water management policies. The task and its difficulties are great. This document gives an overview of the work done in recent years in managing the demand by means of economic tools, and attempts to identify progress. Water demand management is taken to mean those actions that aim to modify the behaviour of consumers of water resources. This leads to the use of brackish and poor-quality water being considered as part of supply policy, though this classification may be debatable when it comes to reusing waste water.

Among the range of economic tools available, pricing is the most frequently employed; this derives from the necessity of recovering the costs of the service from users. This fact can be verified in all the Mediterranean countries. When other tools such as rationing or subsidies are used, they are always combined with pricing.

Nowadays the rationale for a pricing system extends to the incentives given to obtain a balanced management of the resource, while retaining the objectives of intensifying irrigated agriculture to secure the nation's food supplies, or balancing the budget of the service provider.

2. THE DEMAND FOR WATER AND THE PRIORITIES

The provision of drinking water is the first priority of all countries other than Egypt which continues to give priority to irrigation, and Turkey which has no overall policy for allocation between sectors. This is followed by a wider diversity of uses, from agriculture (Italy, Morocco, Israel, Lebanon) and industry to tourism (Tunisia) and the environment which is becoming a major concern in France with the proposed law on water. This variability between countries derives primarily from the countries' economic direction.

Nevertheless, because of the small amount consumed by the provision of drinking water in comparison to other uses, allocation between uses does not reflect national priorities, except in countries like Malta where water resources are very limited. On the other hand these priorities do give indications for future decision-making especially in countries where water demand management will be implemented. Table 1 shows that we are going to see a transfer from agricultural use towards the provision of drinking water as a priority use, or towards some other priority use: the environment in France, tourism in Tunisia.

Table 1: Amount of water consumed by sector and priorities of allocations

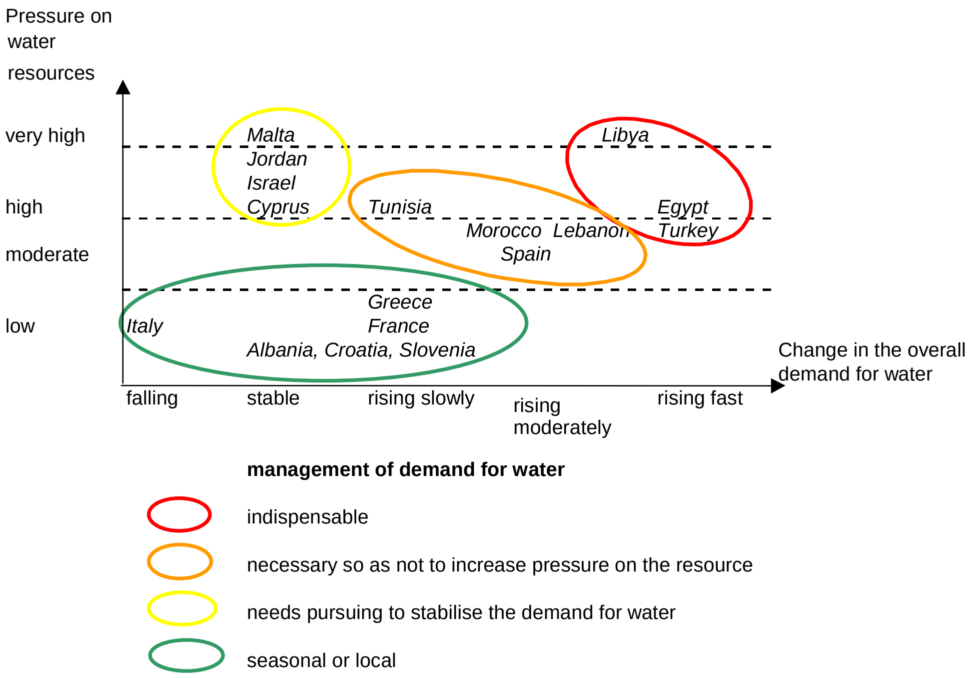
	Year	Agriculture %	Domestic use %	Industry %	Allocation priority	Sources
Spain	1998*	93	4	3	Drinking water, irrigation, electricity, industry	(Vergés, 2000) (Durand et al., 2002)
France	1995*	68	24	8	drinking water, environment	IFEN, Law on water
Greece	1997	87	10	3	Drinking water	(OECD, 2000)
Turkey	1997	74	15	11	No priority stated	(OECD, 1999b; Burak, 2000)
Israel	1986	79	16	5	Drinking water, irrigation	FAO aquastat, (Durand, Fonseca et al., 2002)
Egypt		82	8	10	Irrigation, drinking water	(Burak, 2000)
Tunisia	2001*	83	12	5	Drinking water, tourism, industry	(Durand, Fonseca et al., 2002)
Morocco	1991	92	5	3	Drinking water, agriculture, hydroelectricity	FAO aquastat, (Jellali, 1995)
Italy	1999	50	20	30	Drinking water, agriculture, others	(Massarutto, 2001)
Croatia	1996**	1	47	52	Drinking water	(OECD, 1999a)
Slovenia	1994**	2	68	30	Drinking water, industry, agriculture	(OECD, 1999b; Durand, Fonseca et al., 2002)
Albania		74	26			(Burak, 2000)
Malta	1995	12	87	1	Drinking water (groundwater)	FAO aquastat,(Burak, 2000)
Cyprus		75	19	6		(Socratous, 2000)
Palestinian Authority		71	26	3	Drinking water, agriculture and industry	(Burak, 2000)
Jordan	1997*	69	4	27	Drinking water, irrigation	(El-Naser, 1999)
Lebanon	1996	68	5	27	Drinking water, irrigation, industry	(Plan Bleu, 1999)
Libya		87	13		Drinking water and animals, agriculture, industry and mining	(Burak, 2000)

Notes: net consumption indicated by (*), total water used excluding hydroelectricity indicated by (**)

Pressure on the resource and the direction of demand

By comparing the trends in demand for water with the pressure on water resources[1] in Mediterranean countries, it is possible to define four types of country (Figure 1) where water demand management is important to a greater or lesser degree:

Figure 1: types of country and management of demand for water



Source : adapted from Margat and Vallée 2000; Nasser, 1990

Group 1: Egypt, Turkey, Libya. The pressure on the resource and the growth of demand are high, or even (in Libya) very high for the pressure on the resource; this makes the management of demand for water indispensable but probably inadequate to ensure a balance of supply and demand.

Group 2: Tunisia, Morocco, Spain, Lebanon. The pressure on the resource and the increase in demand are moderate, or else (in Tunisia) the pressure is high but the increase lower. The management of demand for water is necessary so as not to increase the pressure on the resource further, and not exceed the limit renewable resources.

Group 3: Malta, Jordan, Israel, Cyprus. Group 3 includes those countries where the pressure on the resource is high or very high, but where the demand for water has stabilised. The management of the demand needs to be continued so as not to return to an increase in demand which cannot be met by tapping new resources (other than non conventional, high-cost resources like desalination in Cyprus). In short, the limit of renewable water resources has been reached.

Group 4: Italy, Greece, France, Albania, Croatia, Slovenia. These countries have relatively low overall pressure on water resources and the demand is at most increasing slightly; in Italy[2] it even seems to be falling. However, the management of demand for water may be necessary locally or at specific times (e.g. Greece in summer) because of tensions arising from competition between uses or between uses and the environment. Also, the problem of water quality and aquatic environments needs to be taken into account in the management of demand.

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[1] Pressure on resources uses the classification of Margat, J. and Vallée D. (2000). Water for the 21st Century: Vision to Action. Mediterranean vision on water, population and the environment, Global Water Partnership, Plan Bleu. L'indicateur retenu est l'indice d'exploitation des ressources renouvelables (Pression faible: indice<40%, pression modérée: indice >40%, pression forte: indice >70%),"very great pressure" means the use of non-renewable resources.

[2] These data should be used with care and pose the question whether Italy belongs in this typology.

Tools used

IRRIGATION

1. PRICING SYSTEMS FOR AGRICULTURAL WATER

The economic tools used in the agricultural sector to manage demand for water are analysed according to two criteria: the pricing structure and the price level. A pricing system based on quantity, which should in theory be an incentive to water saving, will only work at a price level to which the user is sensitive. This price level depends on numerous factors: speculations, irrigation techniques and the added value of the products. These will be discussed in greater detail in the part relating to the effectiveness of economic tools in managing the demand for water.

The extreme case, where structure is of little importance, is where water is free (Egypt and Albania), which does not encourage water saving at all. At the opposite extreme, Israel has introduced a pricing structure giving every incentive to save water (within the limit of the quota imposed) with a banded, volume-related pricing system. Between these two situations, a wide range of tools is used (in increasing order of effectiveness): a lump-sum pricing system; a lump-sum pricing system modified according to the crop being irrigated or other criteria; a uniform, volume-related pricing system; or a banded, volume-related pricing system (Table 2).

The lump-sum pricing system per hectare (Table 2) as often applied for gravity-fed systems (Spain, Greece, Italy, etc.) based on area, may well influence the decision whether to use irrigation but not the quantity of water applied per hectare. But, combined with a very low price and subsidies for the irrigated crop, this type of pricing system has rather encouraged the extension of irrigated areas and the increase of the demand for agricultural water in those countries. This is the form most commonly encountered when making improvements so as to encourage farmers to take up irrigation.

The lump-sum pricing system, modified according to the crop or irrigation techniques, does not encourage water saving for a given choice of crop or irrigation technique, but it does have more effect than the lump-sum pricing system on the choice of which crops to irrigate or which irrigation technique to adopt. It can be used to discourage the irrigation of certain crops for example, by applying a higher price to crops that consume a great deal of water (such as maize or tomatoes in Turkey for example).

In the end, volume-related pricing systems are the only ones to actually encourage water saving. A pricing system in progressive bands, where the price of water increases according to the volume consumed, can have a really dissuasive effect on the consumption of water depending on the progression of the prices and their level, but it is seldom applied to irrigation (Israel, Jordan). However, the price level determines the effectiveness of the pricing system implemented. The price of water applied by SARs (Regional development corporations) in France, although uniformly volume-related, may be more effective than the banded pricing system applied in Jordan on account of a higher average price.

When the pressure of demand on water resources is high and competition exists between uses of water, quota systems are generally imposed on agriculture. They then coexist alongside a pricing system whose only objective is to pay for the services of the water provider and possibly for the water itself.

Table 2: Structure of agricultural pricing systems and levels of price

Price structure	Country	Price US$/ha	Price US$/m³	Additional measures	Incentive to save water
Free	Egypt Albania				None
Lump-sum (ha)	France Greece Spain Lebanon	136 95-220 40-250 285	 0.03		Low
Lump-sum ha depending on crop	Turkey (and by region) Italy (and by type of soil)	20-100 30-250	0.2?		Low
Volume-related uniform	Spain (rare) Morocco (part) Tunisia (part) Cyprus France (ASA) France (SAR)		0.03-0.08* 0.02-0.05 0.09 0.12 0.06-0.07 0.06-0.3*	 Rationing possible Rationing possible	Low Low Low Moderate Moderate Moderate to high
Optional	France (SAR)	- 40 or - 25	- 0.07 or - 0.17	Choice of 2 contracts	Moderate
Volume-related in bands	Jordan Israel		0.03 0.13	 Rationing	Moderate Moderate, High within the limits of the quota

*Notes: * only the volume-related part of a dual pricing system*
Sources: see Table 3

Rationing guarantees a limit to consumption which will not be exceeded, at least if the penalties and the regulations ensure that it is followed (France, Neste). However it does not in general encourage water saving within the limits of the quota unless there is particular provision. This is because the user tends to use up all of his quota, and is even encouraged to in those cases where failure to use all of the quota can lead to it being lowered the following year (Israel). On the other hand, the option of carrying the unused quota forward into the following year (France, Beauce) can help to remove this negative effect by placing a limit on overall consumption but at the same time encouraging water saving.

2. PRICE-CHANGES AND PERSPECTIVES

An analysis of past price-changes and future perspectives enables us to discern the direction being taken by polices and the role of economic tools in the management of countries' demand for water. It also enables us to analyse the cost recovery rate and the objectives set for the future.

The increase in the price of water gives some hint of the scarcity of the resource, even if it forms part of a strategy to recover costs rather than a way of economising water resources, for which it is seldom used.

2.1. Introduction of pricing systems plus incentives on new areas

Most countries where water is free or the pricing system is little conducive to saving (lump-sum structures) do not display a strong policy to increase prices or to change their pricing system (Albania, Egypt, Spain). In Albania, there is no legal regulation for invoicing the price of irrigation water (Burak, 2000). In Greece, it is difficult to identify a coherent pricing system policy for irrigation water because of the institutional context, the complexity of the hydrological system and the importance of the use of underground water – 40% of agricultural demand – (OECD, 1999c). Certain countries however exhibit their intention to cover the complete cost of water (law of 1985 in Spain).

However, pricing systems that provide greater incentives can be introduced on new areas, with volume-related pricing systems which require metering systems to be installed. These changes are appearing in Spain, in Greece (OECD, 2000), and in the Lebanon with a dual pricing system in new areas of Beqaa Sud (Richard, 2001). In Spain, incentive pricing systems are being introduced locally as in the irrigation co-operatives of the Guadalquivir where there are a dual pricing system using rationing and penalty options, and a genuinely dissuasive price (0.8US$/m^3) if the volume allocated is exceeded by more than 10% (Maestu, 1999). This type of tool may be relatively effective in limiting the consumption of water, subject to the reservations on rationing discussed above.

Table 3: Recovering the costs for agricultural water, changes in prices, and prospects

	Type of irrigation scheme	**Cost recovery**		**Change in prices**	**Prospects**
		Operation and maintenance	**Capital**		
Spain	Small scale	Low (to partial?)	Nil to low		1985 Law: principle of covering full costs
	Individual (underground water)	Total	Total		
France	SAR ASA	Total	Partial	Stable	
Italy		Partial	Nil		
Greece	Collective (TOEV)	Partial	Nil		Introduction of a volume-related pricing system on new networks
	Individual	Total	Total l		
Malta	Poor water quality				Equipment grants for micro-irrigation
Cyprus	Small scale	Partial		+30 to +80% between 1990 and 1999	a 80% ↗ in prices by 2003, to cover 38% of the cost of water
	Private area	Total	Partial		
Albania		Subsidised			Pricing system to be defined
Turkey	Large areas	Partial (to total?)	Partial		
Lebanon		Low to partial			Prices: + 20 to 30% in 2002
Israel	Irrigation water (1999) Mekorot	Partial		↗ in price between 1986 and 1996, ↘between 1996 and 1999. Lowering of subsidy	
Egypt		Nil	Nil		
Tunisia	Private area (210000 ha)	Total	Partial		
	Small Scale (160000 ha)	Partial	Nil	+12% in nominal terms since 1983	Pricing system by hydro-agro-ecological areas. Capital cost in pricing system
Morocco	ORMVA	Partial to total	Partial	+ 0.001 to 0.004US$/m^3/year	Objective 100% for O&M and 40% for investment

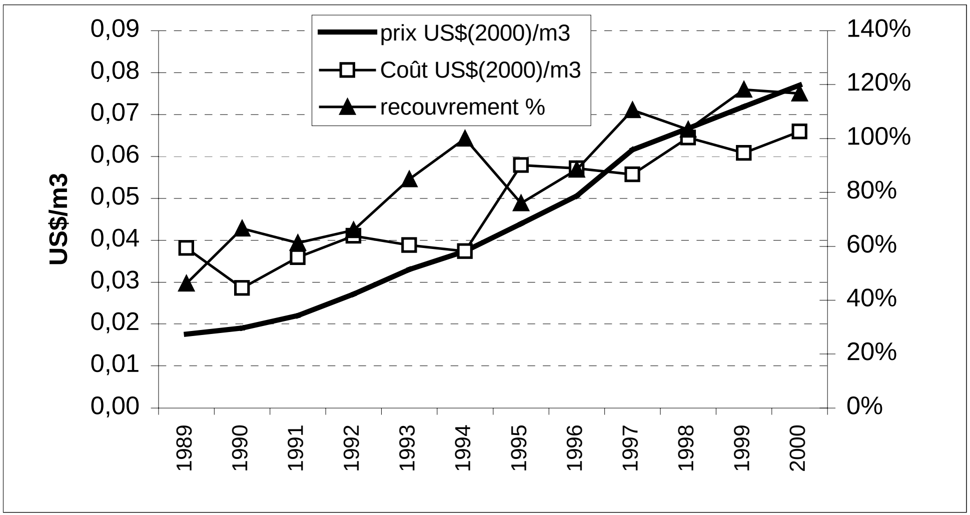
Source: Cemagref, 2002, Fiuggi

Notes: Irrigated Public Perimeters (IPP), Rural Development Societies (RDS), Authorised Syndicated Associations (ASA), Local Land-Enhancement Commissions (LLEC), Regional Offices for Farming Enhancement.

2.2. Planned increases in the price of water

Certain countries applying volume-related pricing systems are planning to increase prices (Tunisia, Morocco). In Tunisia, the regular increase in the price of irrigation water in the CRDA since the mid-1980s has been 12% a year in nominal terms (or about 6% in real terms) (Dinar and Subramanian, 1997; Belhaj Jrad, 2000). This has enabled the Tunisians to recover operation and maintenance costs (Figure 2) (Belhaj Jrad, 2002). In Morocco, the remedial pricing plan proposed for areas in financial imbalance should help to improve the covering of the cost of recurrent charges (operation, maintenance and renewal by 2010). The remedial plan is expected to achieve equilibrium within 1 to 6 years for areas in slight deficit, which represent 40% of irrigated land (Rieu, 2001).. On the other hand, in areas in severe deficit – 12% of land area, where water is raised to be put under pressure – it should reach a recovery rate of 65 to 80%.

Figure 2: Changes in the price of irrigation water and rate of cost recovery in Tunisia



Source: DGGR, Tunisia
Price in US$(2000)/m³
Cost in US$(2000)/m³
% recovery
US$/ m³

An increase in the price of water can however have a limited effect on the overall demand for water if there is recourse to alternative resources (underground water) as in Tunisia (see 4.).

Other countries have increased or expect to make increases from time to time, to recover more of the water costs: Cyprus, Lebanon, Israel, Jordan. In Cyprus, an increase of 80% in the price of water by the year 2003 is expected (Table 3). The price should then cover 22 to 38% of the average weighted cost, as against only 22% now (Socratous, 2000). A price increase of 20 to 30% is expected in Lebanon.

3. TAKING THE SCARCITY OF THE RESOURCE AND THE ENVIRONMENT INTO ACCOUNT

Recent changes, in particular at the European level with the Framework Directive on Water, imply that the scarcity of the resource and the environmental aspects are taken into account when using economic tools. This means setting up institutional devices (such as a water agency in Morocco), or technical and economic ones (such as the principle "the person who takes or pollutes, pays"). Thus, a fee for taking irrigation water exists in several countries – France, Spain and Italy – but the levels of fee remain very low (Table 4). In France, although a draft law on water proposes an increase in fees, the incentive to save water remains weak (Chohin-Kuper et al., 2001). In Italy, fees for drawing water even fell in real terms between 1993 and 1994. Other countries like Greece levy no fees. In Jordan, a tax has been introduced to control the over-exploitation of surface or ground water.

Table 4: Charges and taxes on water for irrigation

	Year	Type	Method	Amount	Source
Spain	law of 1985	Fee for drawing water			(Barraqué, 1995; Dinar and Subramanian, 1997) (OECD, 1997)
France	law of 1964 (since 1998 for irrigation)	Fee for pollution	Volume-related		
	Draft law on water 2002	Fee for excess nitrogen			Draft law on water
	law of 1992	Fee for consumption	Volume-related	0.001 to 0.03 US$/m³	(AFEID, 2001)
Morocco	In course of adoption	Fee for drawing water			
Tunisia		None			
Italy	1994 extension to underground water	Permits for drawing water: licences, annual tax	Volume-related or area-related tax for drawing water with reduction of 50% if the water percolates back into the soil.	0.4 US$/ha	(Massarutto, 2001)
Croatia		Water use charge			(Marušic, 1998; OECD, 1999a; Ostojic and Lusic, 2000)
		Water basin charge			
		Fee Concessions and permits			
Jordan	1999 underground water	Tax on water	Volume-related for drawing water in excess of the licence	0.35 US$/m³	(El-Naser, 1999)

Notes: the distinction between fees and taxes may refer to the allocated nature of fees compared with taxes. This is notably the case in France.

4. PRICE SENSITIVITY OF THE DEMAND FOR AGRICULTURAL WATER

The analysis of the effectiveness of economic tools in managing the demand for water is based on:

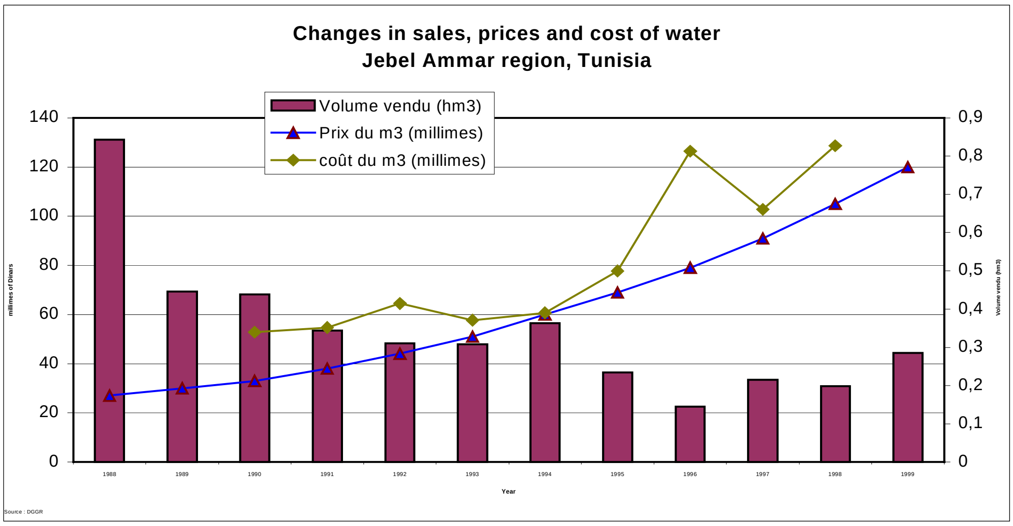
- Case studies showing the relationship between price rises and control of demand (irrigation water in Tunisia, or drinking water in Greece and France for example)
- Theoretical studies that reveal the factors involved in the sensitivity of water demand to price. The price-elasticity of demand for water corresponds to the percentage variation of the amount of water demanded in relation to the percentage variation in the price.

4.1. Price increases in practice

Price increases and lowering the demand for water in Tunisia

Some experiments on price increases for water show an impact on consumption. A four-fold increase in the price of irrigation water within the irrigated area of Jebel Ammar in Tunisia led to a drop in water consumption to a third (Figure 3).

Figure 3: Change in the demand for water in response to price increases in Tunisia



Source : DGGR
Amount sold (hm³)
Price per m³ (millimes)
Cost per m³ (millimes)

The limits: using underground water

An increase in the price of water can lead to the development of alternative resources, especially to using underground water as in Morocco and Tunisia.

In Tunisia (Bechtel/Scet-Tunisia, 1999) a trend towards using underground water can be observed when its cost is lower than the price of water (pumping cost from 0.031 to 0.095 DT/m³ depending on the depth of the well when the price per m³ is often higher). The use of underground water is encouraged by the reliability of the supply compared with surface water.

4.2. Factors in sensitivity for water demand

According to economic theory, the level of sensitivity of demand for irrigation water compared with the price of water depends broadly on:

- **The presence of alternatives.** A lack of alternatives (in terms of available water resources, the possibility of planting different crops or even leaving agriculture) gives farmers no flexibility in their reaction when faced with a price increase.
  Alternative crops
  - A comparison of demand curves for water between various regions of Spain (Arrojo, 1999; Arrojo and Carles, no date) shows very variable elasticity in the demand for water depending on the existence of alternatives - crops consuming less water and whether extensification is possible - and also on the structure of property (Table 5). In the Duero, where the number of possible crops is limited, the demand for water is relatively rigid. Use of the price tool alone does not significantly reduce water consumption on farms (Gomez-Limon and Berbel, 2000). More generally, in Spain, the farmers' incomes would need to fall by 25 to 40% before an increase in the price of water (7 to 14 ptas/m³) would lead to a lowering of water consumption (Berbel and Gomez-Limon, 2000).
  - Another study on Spain (Varela-Ortega et al., 1998) gives similar results: when the price of water increases, farmers generally react in the first instance by changing to crops that consume less water then to crops that need no watering, if this is possible. This is the case in Andalusia, a region in which large farms where alternatives are available and with a large production capability predominate. In Castile, a region where there are small family farms with limited production capability and a limited number of crops, an increase in the price of water leads directly to irrigation being stopped and a change to non-irrigated crops. In

Valencia, the very small specialist farms abandon the orchards or choose orchards that consume less water.
Alternative resources

An increase in the price of surface water used for irrigation may lead to an over-exploitation of underground water (see above).

- **Technical methods of irrigation used.** In Spain (Varela-Ortega, M. Sumpsi et al., 1998), the elasticity of demand for water is weakest in districts with modern irrigation because of the higher cost of improving technical efficiency compared with the old systems. However the adoption of irrigation techniques that use less water does not depend solely on the price of water but also on structural constraints, financial capability or agricultural conditions.
- **The cost of water weighted against the margin created by the irrigated crops**: the more these have a high added value (or the less the price of water represents a substantial proportion of costs), the more the demand for water is rigid when variations in price occur. Thus,
  - In Tunisia, an increase in the price for water leads to a lowering in the demand for crops with low added value in the North West and the South while the demand for water hardly falls in the North West and Centre West regions where vegetables with high added value are grown (Bechtel/Scet-Tunisia, 1999).
  - In Spain, in Jucar and Segura, vegetable and fruit crops with high added value, combined with the small size of farms make the demand for water inflexible (Arrojo, 1999).

Table 5: Price elasticity in the demand for agricultural water

Country/ Region	Method	Elasticity of demand for water	Lowering of gross margin	Lowering water consumption	Reference
Spain/ Andalusia	Institutional simulations of price	LP: -0.06; AP: -1.00			Garrido et al (1998) quoted in (Garrido, 1999)
Spain/ Andalusia	Dynamic mathematical programming	LP: -0.12; AP: -0.48			Garrido et al (1998) quoted in (Garrido, 1999)
Spain/Castile	Computer modelling	LP: -0.09; AP: -0.26			Garrido et al (1998) quoted in (Garrido, 1999)
Spain/Castile	Long term results	LP: -0.00; AP: -0.03			Garrido et al (1998) quoted in (Garrido, 1999)
Spain (Mid Guadalquivir and mid Duero valleys)	MLP in the short term (without risk)	From 0.05 to 0.09 US$/$m^3$	25-40%		(Berbel and Gomez-Limon, 2000)
Spain (Mid Duero valley, Northern Spain) modern irrigation unit	Programming weighted by objectives (with risk) (Elasticity of arc calculated)	0.014 à 0.04 US$/ m^3: -0.01 to -0.08 0.06US$/$m^3$: -1.5 Consumption nil for 0.4US$/$m^3$	7-20% 30%	 9 ptas, 35%	(Gomez-Limon and Berbel, 2000)
Spain (Castile, Andalusia, Valencia)	Dynamic multi-period model (17 models of typical farmers) – neutral to risk	Andalusia: elastic demand between 0.03-0.2US$/$m^3$ Castille: inelastic demand for prices <0.1US$/$m^3$ Valencia: inelastic demand for prices <0.23US$/$m^3$ Demand less elastic in modern area	-1 to -14%(1) -17 to -57% -6 to -69%	10%	(Varela-Ortega, M. Sumpsi et al., 1998)
Spain –Guadalquivir, Guadiana, Jucar, and Segura, Duero	Aggregate farm models (irrigation-users' association)	Guadalquivir: 0-0.07 US$/$m^3$ Guadiana between 0.07-0 .17US$/$m^3$ Júcar & Segura inelastic up to 0.23US$/$m^3$ Duero: inelastic up to 5-15 ptas/m^3			Sumpsi, 1999 quoted in (Arrojo and Carles, no date)
France, Beauce	MLP with risk	Elasticity from 0.014 US$/$m^3$ (0.10F/m^3)			(Morardet et al., 2001)
France, Charente	MLP with risk	Elasticity from 0.028 US$/$m^3$ (0.20F/m^3)			(Morardet, Rieu et al., 2001)
France,Adour	MLP with risk	Elasticity from 0.11 US$/$m^3$ (0.80F/m^3)			(Morardet, Rieu et al., 2001)
Israel	short term equilibrium Agricultural sectoral model	-0.18 to -0.49 to 0.20 US$/$m^3$ nil consumption for 0.75$/$m^3$	42% (net income)		(Amir and Fisher, 1999)
Tunisia	Agro-economic model	North East: -0.03 North West: -0.27 Centre East: -0.14 Centre West: -0.07 South: -0.34		From 4 to 25% for an increase in price of 50%	(Bechtel/Scet-Tunisia, 1999)
Turkey (Karapinar region central Anatolia)	MLP with risk (a representative farm)	Inelastic for a price < 0.005 US$/$m^3$ (77 TL) (1992)			(Eruygur, 2001)

(1) Revenue falls with a 10% fall in demand for water, range depends on the method of pricing and the district (modern, old-fashioned)
LP, AP: range of price of water low/average; MLP: Models from linear programming.

- **Features of pricing**. The consequences of an increase in the price for irrigation water on farmers' consumption depend on the level of the initial price, the size of the increase and how pricing is modified over time.
  - *The higher the initial price, the more demand is sensitive to price*. This observation should be linked to the convexity of production variables: the first units consumed are valued much more highly than the following ones, which gives a decreasing marginal values curve. Now, the marginal values curve represents the demand curve. Thus, in the short term, according to a feasibility study carried out in France on a dam in the south-west (Charlas) (Michalland, 1995), the elasticity is -0.078 for a marginal cost of water of 0.05 US$/m³ and of -0.41 for a marginal cost of water of 0.18 US$/m³. Similarly, in Jordan, the demand for water is practically inelastic for the price level currently practised (at a price of 0.024 US$/m³, an increase of 10% in the price of irrigation water leads to the quantity demanded being reduced by only 0.95%) but becomes practically immediately elastic if the price increases (for the mid-point price of 0.263 US$/m³, the elasticity is –1.49) (Doppler et al., 2002).
  - The wider the variation in price, the higher the elasticity of demand.
  - *As the period considered lengthens,* so the adaptation of means and production techniques becomes easier and *the elasticity of demand compared with price becomes higher*. This characteristic has enabled price increases in Morocco to be spread out over time so that the rise is no faster than that of technical progress in agriculture (Rieu, 2000; Belghiti, 2002). A study carried out in a area of South Western France (Michalland, 1995) shows that, (i) in the short term (since the crops grown are fixed, only the amount of water used can be changed), the demand for irrigation water compared with price is practically inelastic; (ii) in the medium term (since irrigation equipment has already been provided, the farmer decides to optimise the crops he grows), the demand for irrigation water is less rigid; and (iii) in the long term (the farmer chooses whether or not to irrigate and his irrigation equipment), there is a threshold of average value of water, below which demand is not at all elastic (0.18 US$/m³). Beyond this threshold, the demand is very elastic and becomes nil very quickly.

Appropriate methods of pricing may be considered, for example:

- a pricing system adjusted year by year, where the variable part varies according to the rainfall: low price in damp years and high prices in dry years to encourage the use of either surface water or underground water as necessary,
- a pricing system in bands for irrigation using bore holes so that ground water is not over-exploited.

DRINKING WATER AND SANITATION

1. STRONG DISPARITIES IN THE PRICE OF DRINKING WATER

The analysis of the pricing system for drinking water is based on the following criteria (see methodology, Box 1):

i) pricing structure (lump-sum, uniform, progressive banding). Since pricing systems for drinking water are very often structured in progressive bands, the progressiveness of the scale gives a more precise indication of the level of encouragement to save water;

ii) price level: a high initial price gives a clear incentive to save water.

Box 1: Method of comparison of pricing systems

The comparison of pricing systems combines two criteria: initial price level and progressiveness of prices. The initial price considered here is the average price of the first 30m³ consumed[3] and the progressiveness is determined by taking the price ratio between two amounts consumed (the same in each country): 30 m³ and 100 m³ per quarter.

Criterion	Rating
Price	
Low (<0.4 US$/m³)	1
Medium (< 1US$/m³)	2
High (>1 US$/m³)	3
Progressiveness (price ratio 100m³/30m³)	
None (ratio=1)	0
Moderate (1 to 2)	1
High (2 to 3)	2
Very high (>3)	3

A rating is allocated for each criterion. Then, an overall rating is calculated by giving 4 times as much weight to the criterion "price level" compared with the criterion of progressiveness. This is because it is price level which mainly determines the amount which the average consumer actually pays.

Countries can be classified into two main groups depending on the pricing system for their drinking water (including sanitation in certain cases) and the incentive to save water: very weak to weak; moderate, or very strong (Table 6, Box 1).

Lebanon has the pricing system that least encourages water saving, with a lump-sum structure and low price level, whereas most pricing systems are volume-related and banded, except in France and Croatia where the pricing systems are principally uniformly volume-related.

The pricing systems that most encourage water saving are those combining strongly progressive banding (**Erreur ! Source du renvoi introuvable.**) and a high initial price (Israel, Turkey) while the pricing systems in Tunisia and Egypt, although volume-related in bands, give relatively little incentive because of their low initial prices and a very moderate progressiveness of prices (**Erreur ! Source du renvoi introuvable.**). The application of a seasonal rate in Spain is also an additional factor which may encourage water saving at a time when it is most necessary.

[3] The volume considered in France corresponds to an average annual consumption of 120m³.

Table 6: Pricing system for drinking water, incentive to save water

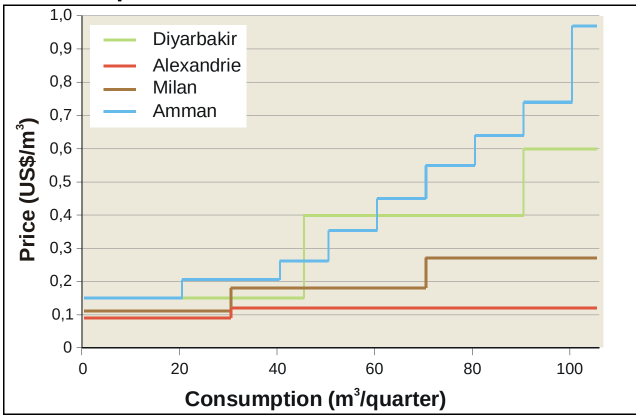
Country, location	Pricing structure	Price US$/m³ (first 30 m³)	Additional measures	Incentive to save water
Israel (Tel Aviv)	Banding	1.3		Very strong
Turkey (Izmir)	Banding	0.5		Very strong
France	Dual, uniform	2		
Palestine	Banding	0.7		Strong
Greece (Athens)	Dual banding	0.4	Limits of consumption depend on hydrological conditions	
Malta	Banding	0.3		Strong
Italy (Rome)	Dual banding	0.2		
Spain	Dual banding	1*	Seasonal rate	Moderate to strong
Morocco	Dual banding	0.3		
Jordan (Amman)	Banding (lump sum for 20m³) Dual banding	0.2		Weak
Italy (Milan)	Banding	0.1		
Egypt (Alexandria)	Banding	0.1		
Turkey (Diyarbakir)	Banding	0.1		
Tunisia		0.1	Levels depend on the band of consumption	
Croatia	Uniform	0.6		Very weak
Slovenia	?	0.7		
Lebanon	Lump-sum	0.2		

Sources: worked out from (ONEP, 1997; El-Naser, 1999; Lacroix, 1999; Plan Bleu, 1999; Burak, 2000; European Commission, 2000; Ghini, 2000; ICTAF, 2000; Kallis and Coccossis, 2000; Ostojic and Lusic, 2000; Limam, 2001; Durand, Fonseca et al., 2002)

Notes: * on the basis of the average price

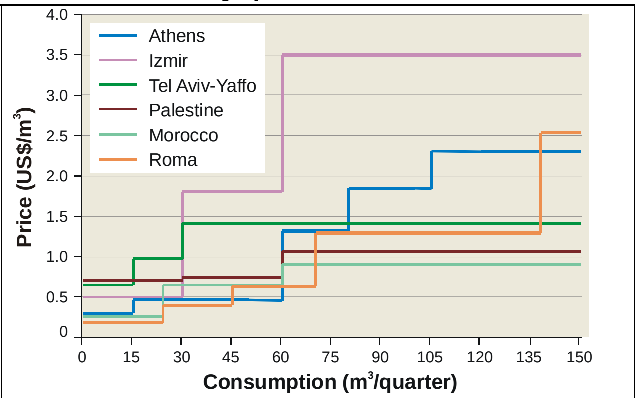
The countries represented in **Erreur ! Source du renvoi introuvable.** have progressive pricing systems which give little incentive to save water, with a price no greater than 0.6 US$/m³ for a quarterly consumption of 80 m³. For the countries in Figure 5, on the other hand, prices are 1US$/m³ or even more, if more than 60 m³/quarter are consumed (except for Morocco where the price lies part-way between the two Groups).

Figure 4. Pricing systems for drinking water with low price and little incentive to save water



Tariff structure favouring social goals : **low price level, little progressiveness between blocks**

Figure 5. Pricing systems for drinking water with medium to high price and incentive to save water



Tariff structure combining social and environmental goals: **average price high and strong progression between blocks**

Pricing systems are sometimes combined temporarily with other tools (see 5):

- limits of consumption in Greece, set by presidential decree since 1991, depending on the local climatic and hydrological conditions (OECD, 2000);
- "water rotas" in certain countries such as Jordan when the resource is too limited to satisfy need. This type of measure may however have the contrary effect by encouraging hoarding (construction of storage tanks) and often leads to wastage – the same can be observed in agriculture;

- in France, there are "green" pricing systems in certain local authorities for water that is not going to end up in the sewers (watering the garden and possibly filling the swimming pool).The green pricing system consists of only requiring payment for the drinking water part, and taxes to prevent households from turning to alternative resources such as drilling.

2. CHANGES IN PRICE AND PROSPECTS

Pricing systems for drinking water in the Mediterranean basin have changed and continue to change in two major ways: one concerns the average level of the price of water, the other concerns the price structure itself.

2.1. Greater or lesser increases in the price of the water: France, Egypt, Morocco

Firstly, Mediterranean countries have been faced to a greater or lesser extent over the last ten years with a rise in the average price of water. The major factors behind this are:

- To reflect the reality of water costs: the M49 accountancy rule in France imposes on local authority water services an obligation to balance their budgets;
- To face up to new expenses, taking sanitation into account and introducing stricter standards in Europe in general.This is so in France, Spain, Morocco,Tunisia, Egypt, etc.

For instance, in Egypt the price of drinking water rose by 130% in 1995 (Lacroix, 1999). After a period of increases lower than the general price level, France also saw a very steep increase in the price of its drinking water[4]: between 1991 and 2000, it rose by 70% in current prices, from 1.44 to 2.45 US$/m³ (at US$ 2000 equivalent), and by 48% in constant prices (DGCCRF, 2001). The rate of increase has however slackened; it was very sharp in the early 90s (+ 11% per annum), but is now tending towards a rate of growth in line with general prices (+ 1.7% between 1999 and 2000 as against 1.6% for inflation).

2.2. Alteration to the pricing structure: towards greater incentive to save water

In general, there is a trend towards greater incentives, expressed in practice by (1) a desire to abandon lump-sum pricing systems and to switch to a dual or even proportional pricing system (France), or (2) to increase the number of bands where a banded pricing system already exists (Tunisia, Greece and Morocco).

In Tunisia, the number of bands of consumption rose from two to five bands between 1974 and 1984, with five different price levels. To meet welfare objectives (see below) the number of price levels was reduced (from 5 to 2 maximum per band) between 1984 and 2000. The size of price increase depends on the consumption band, making the pricing system a strong incentive to water saving for heavy consumers who find their average price rising steeply when they move to a higher consumption band. When the threshold of consumption of 70m³/quarter is passed, the average price of water increases by nearly 80%.

In Greece, in Athens, the number of levels rose from 3 to 5 between 1989 and 1990 and the progressiveness of prices increased – the ratio between the maximum price (consumption band > 105 m³/quarter) and the minimum price (band 0-5 m³/quarter) went up from 3 to 8 (Ghini, 2000; Kallis and Coccossis, 2000). Average prices per m³ consumed rose steeply (in particular in 1975 and 1992[5]) and were multiplied by 3 to 8 depending on the consumption band (the price increased most for heavy consumers). These changes were part of a water saving strategy for the high

[4] The price of drinking water is in fact an average water price calculated from a typical bill for a standard consumption, defined by the INSEE as 120 m³.

[5] The drastic price increase in 1992 came after a major shortage.

consumption bands while keeping prices down for the more underprivileged. Though they represent only 20% of consumers, heavy consumers (more than 30 m³/quarter) account for half of the total consumption of drinking water (Ghini, 2000). Local authorities tend to practise the same type of banded pricing system with sometimes a fixed proportion, though there are some exceptions where the pricing system is uniform or lump-sum (Kallis and Coccossis, 2000). The pricing systems vary in the number of levels (from 2 to 9) and their progressiveness (the ratio of price between the top and bottom bands can vary from 2 to 10) which leads to a strong disparity in average prices per m³ (the price ranges from 0.3 to 1.8 US$/m³ on average for a quarterly consumption of 200 m³). Prices for heavy consumption are however generally lower than those applied on the Athens network.

In Morocco, the number of bands has risen to a limited degree: a fourth band was introduced in 1998. The first three bands have increased on more than 15 occasions since 1980 when they were created, with a 4 to 7-fold rise in price depending on the band (Plan Bleu, 2002). The steeper price increase for the upper bands strengthens the progressiveness of the price structure and the incentive to save water. The price ratio between the top band and the welfare band was as high as 4 in Casablanca in 1993 (World Bank, 1995). For all the major cities it was around 3 in 1995 (ONEP, 1997).

3. TAKING ACCOUNT OF THE SCARCITY OF THE RESOURCE, AND THE ENVIRONMENT

Taking account of the environment via sanitation and the treatment of waste water varies very greatly from country to country and is far from systematic; nor does it always cover the complete cost of this service.

3.1. Payment for sanitation that is far from routine

In France, sanitation and water treatment are invoiced routinely, while in Spain and Greece only the cities charge for sanitation and waste water treatment (Barraqué, 1995; Dinar and Subramanian, 1997). In Morocco, a pricing system for sanitation was introduced in 1995. Finally, some countries still do not take account of this cost as part of the drinking water provision (Lebanon).

3.2. Variable pricing which only partially covers costs

Sanitation represents about 30 to 40% of the price of drinking water (Table 7), or up to 50% in certain towns like Istanbul. This means a price of between 0.02 US$ in Alexandria in Egypt where the price of water is among the lowest, to 0.5 US$ in Israel and 0.8 US$ in France. In Egypt the price of sanitation is still low, despite an increase of more than 300% in 1995 compared with the old rate (Lacroix, 1999). In Spain, the average price of drinking water varies from 0.4 (La Coruña) to 1.70 US$/m³ (Barcelona) for towns with waste water treatment plants and from 0.1 to 0.95 US$/m³ for towns without waste water treatment plants (European Commission, 2000).

Table 7: Price and proportion of sanitation in the price of drinking water

	Pricing structure	Average price of sanitation and treatment: US$/m³	% of the average price of drinking water	Sources
France	Mainly volume-related (structures vary: uniform, progressive, dual or single)	0.8	31	(DGCCRF, 2001)
Spain		0.4	42	(Dinar and Subramanian, 1997)
Greece		0.3	28	(Massarutto, 1999)
Italy		0.3	40	(European Commission, 2000; Massarutto, 2001)
Slovenia	Volume-related			World water vision, 2000 quoted by (Durand, Fonseca et al., 2002)
Morocco	Dual	0.2		
Tunisia	Dual, banded	0.05*	30	(Limam, 2001; Durand, Fonseca et al., 2002)
Turkey			50% Istanbul 30% Ankara	(Burak, 2000)
Egypt		0.02	35	(Burak, 2000)
Israel		0.5	40	(ICTAF, 2000)

Notes: * Variable share only

In addition to taking account of sanitation, certain countries such as France apply a pollution fee and a resource fee which increase the price of drinking water (0.42 US$/m³ in France including 0.38 U$/m³ for the pollution fee alone) (DGCCRF, 2001) and provide an incentive to economise the resource, thereby financing action to counter pollution and develop resources.

4. PRICE-SENSITIVITY OF THE DEMAND FOR DRINKING WATER

In general, it appears that the price of drinking water is a factor in explaining water consumption but only to a limited extent. In France for instance, a price rise of 10% provokes a drop in water consumption of between 1% and 3.1%. More generally, data compiled by the OECD show typical price elasticity in the demand for water of -0.1 for domestic consumption (EMASESA, 2000). These findings need to be qualified, however, as we shall see from concrete experiences and studies carried out on price-sensitivity of the demand for drinking water.

4.1. Experience of lowered demand for water

In Greece, the price rises of 1992 and 1993 brought a drop in water consumption in Athens except among those consumers using less than 15m³/quarter (Ghini, 2000). As consumption bands of more than 30m³ represent nearly 50% of water demand, a policy of high prices can be effective in lowering the demand for water from consumers in those bands because of a relatively high elasticity in the demand for water (-0.8).

The effect of prices might however have a merely temporary effect on domestic consumption. In France, for example, "the major price rise around 1971 due to the inclusion of a sanitation tax (30 to 40%) was reflected in a slackening of the consumption curve; this was wiped out within 2 to 3 years" (Valiron, 1991).

4.2. Lessons from studies into the price elasticity of demand for water

A LIMITED SENSITIVITY TO PRICE IN THE LOWER CONSUMPTION BANDS, MORE PRONOUNCED FOR HEAVIER CONSUMERS

The various studies and analyses (Table 8) tend to show that demand for drinking water is relatively insensitive to price in the lower consumption bands because this is an indispensable commodity. Inversely, the higher the initial rate of consumption, the greater the sensitivity to price. High consumption in fact reflects the use of water for inessential purposes (for example watering the garden or filling a swimming pool) which can therefore be cut back if the cost is too high. To illustrate this, we can instance (Table 8):

- Athens cited above;
- the north-west of Spain where price sensitivity beyond a minimum consumption level is –0.34 as against –0.14/-0.17 when all levels of consumption are taken into account;
- France where water demand seems particularly insensitive to price for the most modest users consuming less than 63 m³ in 1995 (Pouquet and Ragot, 1997);
- Tunisia, where price elasticity is -0.08 for the lowest consumption band as against -0.6 for the upper band.

In Cyprus, the evidence seems to show the contrary: the households which consume the least water are those with the lowest incomes and the greatest elasticity to price. However, the model on which the elasticity calculations are based (Hajispyrou et al., 2001a) did not include a variable which seems to be important: the "possibility of access to an alternative source". Taking this into account would in all probability reverse the case.

Table 8: Price elasticity of the demand for urban water

Country	Region	Method	Elasticity of demand for water	Notes	Sources
Spain	north-west	Regression (OLS) Marginal price	-0.14 to –0.17 -0.34 -0.20	1993-1999 beyond a minimum consumption in summer	(Martinez-Espiñeira, 2000)
France[6]	Gironde	Regression (OLS)	- 0.17	1975	Point (1993) in (Nauges, 1999)
	Country	Regression (OLS)	- 0.10 to - 0.20* - 0.25 to - 0.35**	1975-1980-1985-1990	(Boistard, 1993)
	Country	Regression (OLS)	- 0.12 -0.32* - 0.31**	1989 1995	(Pouquet and Ragot, 1997)
	Yerres Basin	Regression (IV)	- 0.31	1995	(Le Coz, 1998)
	Gironde	Regression (IV)	- 0.08	1990 to 1994	(Nauges et al., 1998)
	Moselle	Regression (IV)	- 0.22	1989-1993	(Azomahou, 2000)
		Regression (Panel)	- 0.23	1989-1993	
Greece	Athens	Chronological regression series (macro elasticity)	-0.4 small consumers -0.8 large consumers	Consumption Band <15 m³ >60 m³	(Ghini, 2000)
Tunisia		Regression	Lower block: -0.06 to -0.15 (country: -0.08) Higher block: -0.28 to -0.91(country: -0.58)	Consumption Bands <70 m³ Consumption Bands >70 m³	(Matoussi and Baranzini, 1998)
Cyprus		Water demand model	-0.79 (for the lowest 10% of incomes) -0.39 (for the highest 10% of incomes)		(Hajispyrou et al., 2001b)

Notes: * in the short term (2-3 years),** in the long term (5-10 years); OLS = Ordinary least squares, IV = Instrumental Variables

SENSITIVITY TO PRICE LINKED TO THE SIZE OF THE INCREASE

[6] The studies described are all very partial and so may only with difficulty claim to be representative of French consumer behaviour towards drinking water.

In France, price sensitivity, while remaining relatively weak, seems however to have increased following a substantial increase in the price of water. The elasticity was stronger (-0.3) and the response to price changes of water consumption faster according to the study of Pouquet and Ragot for the year 1995 (the price of water had already seen an increase of 46% since 1991).

Price sensitivity dependent on possible or more or less easy access to an alternative resource

In Tunisia, the demand for domestic water is relatively sensitive to price for large consumers in economically dynamic areas who are able to use alternative sources of supply (groundwater). Thus we observe in the Greater Tunis and North Eastern areas elasticity of -0.77 and -0.59 (Matoussi and Baranzini, 1998). Elasticity could even be close to -1 for large consumers (Khrouf, 2001). An increase in price for the higher band of the pricing system may thus contribute to a slackening in the growth of demand. We should note, however, an undesirable effect: using groundwater water leads to over-exploitation, the pricing tool is thus not sufficient to conserve the resource and an appropriate policy to preserve groundwater is then essential.

This substitution of one water resource by another is also observed in France in residential areas which may have access to alternative resources (underground water, connection to an untreated water distribution system, or even recycling rainwater) (Montginoul et al., 2002; Montginoul and Rinaudo, 2002). In the same way in Cyprus, when households have access to sufficient quantities of high quality underground water, their consumption of drinking water is much lower (Hajispyrou, Koundouri et al., 2001a).

In Jordan, large consumers are tempted to use the black market if the price of water becomes too high (Durand, Fonseca et al., 2002).

Consistency and application of tools

WHAT TOOLS FOR WHAT TYPE OF COUNTRY?

The overview of polices according to type of country, as represented in Figure 1, reveals contrasting situations. The countries in Group 1 faced with strong pressure on the resource and growth in the demand for water do not seem to have put in place any polices to encourage saving of their water resources, particularly in agriculture. In Egypt water is still free. Turkey however differentiates the pricing system of drinking water which can provide a strong incentive to save water in some towns. Economic tools do not therefore appear to play a major role in the management of water demand in those countries, necessary though it may be to manage this demand.

Similarly, the countries in Group 2 have pricing systems for agricultural water which give no incentive to save, and pricing systems for drinking water whose effect may remain low, except for Morocco and Spain. Yet these countries have to face pressure and growth in the demand for water which require the demand to be managed. The proposed increase in the price of irrigation water in Morocco and Tunisia in particular, and the introduction of volume-related pricing systems militate for better management of demand for agricultural water by using economic tools, but is that enough? Additional measures such as restrictions on consumption in Spain serve to control the demand in times of severe shortage.

The countries in the third Group, having reached the limit of available resources, seem to be those which have adopted the tool most likely to encourage water saving, with banded pricing systems for drinking water which are relatively dissuasive of heavy consumption, together with high prices. In agriculture, the price of water and the type of tool (banding, rationing) also encourage water saving more than in most other countries.

Finally, the countries in Group 4 for which the pressure on the resource and the growth of demand for water are among the lowest, other than local or seasonal shortages, have especially adopted economic tools to encourage drinking water saving, as in Greece and Italy. In France, the high price of water reflects especially the target of balancing the budget, although it may also be an incentive not to waste the resource. Certain countries like Greece tend to have recourse to other measures than economic ones in the context of local or seasonal shortages, adopting restrictions, user awareness campaigns, etc. The other countries – Albania, Slovenia and Croatia – having very abundant resources, make little use of economic tools. Their prices are very low, and in Albania irrigation water is even free.

Table 9: Tools adopted according to country

Country	Group	Incentive to save water		Importance of economic tools	Other measures
		Agriculture	Drinking water		
Egypt	1	Nil	Low	Low	
Turkey	1	Low	Very high to low	Moderate	
Tunisia	2	Low	Low	Low	
Morocco	2	Low	Moderate to high	Moderate	
Lebanon	2	Low	Very low	Low	
Spain	2	Low	Moderate to high	Moderate	Seasonal restrictions
Malta	3	N/A	High	Moderate to high	
Jordan	3	Moderate	Low	Moderate	
Israel	3	Moderate to high	Very high	High	Restrictions possible
Cyprus	3	Moderate	N/A	Moderate	
Greece	4	Low	High	Moderate	User awareness Restrictions & bans possible
Italy	4	Low	High	Moderate	
France	4	Low to high	Very high	Moderate to high	
Albania	4	Nil	N/A	Low	
Slovenia	4	N/A	Very low	Low	
Croatia	4	N/A	Very low	Low	

Notes: N/A = data not available

INTERRELATIONSHIP WITH OTHER TOOLS

As we have seen, the pricing tool has its limits. In particular, it alone is unable to force users to save water, since in general sensitivity to price is fairly weak and price is not able to convey sufficient information when there is an isolated crisis on the resource. Other tools are used to augment it. We have already described cases where water rationing has been set up to respond to situations of structural shortages. Here we will deal with other tools, and make a distinction between "precautionary" and "remedial" tools:

- Measures to encourage water saving:
  - campaigns of user awareness for water saving (Cyprus, Spain or Greece, pilot schemes set up in the towns in Brittany, France),
  - installing private meters,
  - grants to install equipment that uses less water (WCs).
- Statutory measures to control demand:
  - restrictions on consumption by cuts in supply,
  - seasonal bans of some types of consumption (watering, washing cars etc)

The three major accompanying measures will be described more precisely, beginning with measures taken in quiet periods and moving on to those taken in time of crisis:

1. AWARENESS CAMPAIGNS: INSTALLING PRIVATE WATER METERS

In Tunisia and Morocco, the price increases were accompanied by a campaign to replace meters and install private meters. A lowering of 30 to 40% in consumption in apartment blocks was then observed in Tunis and Bizerte (Khrouf, 2001).

Installing a private water meter thus seems to be a factor in reducing the consumption of water (Burucoa, 1995), households then make an effort to reduce leaks and farmers rationalise how plants are watered or change to crops that need less or no water. There is abundant literature on the subject of the impact of meters on domestic water consumption, which will not be described here. It should merely be noted that, although the impact of installing a meter does not seem to be disputed, the permanence of its effect is: for some people, it is limited in time (familiarity effect:

after the first year of making an effort, the households become less vigilant about their level of water consumption), for others, it is lasting.

2. USER AWARENESS

Measures for user awareness of water saving may take place equally in quiet or in crisis periods.

In “quiet periods” we can note the measures taken in France by the agricultural industry to control irrigation or by the Water Boards and some towns such as those in Brittany (Agence d'Eau Loire-Bretagne and Conseil Régional de Bretagne, 1999). In this latter case, user awareness was wide-ranging: firstly by showing an example (local authorities installed equipment that used less water, and they also had an influence on water consumption in major buildings: sports facilities, primary and secondary schools, etc.) and then targeting particular groups (in schools, using an info-bus, etc.). Thus, the “info-bus” drove round apartment blocks and enabled people to ask for their water bill to be checked and to find out about equipment (WC with a double flush, flow-reducers on taps, etc.) which reduce the quantity of water consumed (Lorient, 2000). The key is not water saving for water saving’s sake but enabling people to reduce their water bill.

User awareness measures are sometimes also used in crisis periods. Thus, in Greece, the combination of a large price increase (2 to 3 times higher) and a user awareness campaign for water saving, especially during the drought of 1989-93, enabled a water crisis in Athens to be avoided with a estimated lowering of consumption by 24% in 1990 (Kallis and Coccossis, 2000). However, these measures have been accepted and effective as long as they seemed temporary. In the same way, the user awareness campaigns in Seville during the 1992-95 drought enabled consumption to be lowered by 25% compared with 1991 (EMASESA).

3. RESTRICTIONS AND BANS

The legal tool (ban) is kept for crisis situations. For example, it was used in France during droughts at the beginning of the 1990s when it was forbidden to use water for gardens or filling swimming pools. Similarly, in Seville (Spain), water was cut off for 12 hours per day during the drought of 1992-1995.

Finally, in Greece, during the 1992 drought, three types of measure were taken simultaneously:

- ban on using water for non-essential reasons (gardens, swimming pools etc.),
- rationing at 70% of the consumption for 1992, any infringement being penalised by a heavy fine, or even by cutting off the water,
- price increase in the >81 m^3/quarter band to a punitive level of about 6 US$/$m^3$ (Kallis and Coccossis, 2000).

In situations where there are structural constraints on the resource, restrictions may be effective in controlling the demand for water. In Israel, for example, administrative reductions may be effective in reducing the demand for agricultural water without reducing incomes at all (for example when there is an alternative to irrigated crops in winter) and allowing it to be reallocated to other districts that can use it better (Amir and Fisher, 2000).

IMPLEMENTING THE TOOLS

For water management tools to be applied, society must accept them. For this to come about, (1) they must not conflict with other national objectives, (2) they must be compatible with the income constraints of various users and (3) installing them must not be more costly than the benefits made (especially in terms of water saving).

1. TOOLS TAKING ACCOUNT OF OTHER POLICIES OR NATIONAL OBJECTIVES

The structure and level of pricing systems and their combination with other tools are chosen by taking into account other major national objectives such as land improvement or the wish to limit food dependency. In either case, this generally leads to a limitation in increases in price for irrigation water and drinking water to avoid rural depopulation and guarantee sufficient food production. Thus, in France, the FNDAE tax (National Fund for Developing Water Supply) levied on all water distributed throughout the country by the public drinking water system (urban and rural local authorities) was created in 1954 to finance the supply through the public drinking water system to rural areas.

2. TOOLS COMPATIBLE WITH THE VARIED INCOMES OF USERS

In every country, the issue of price reform (or of management tools) is restricted by the need to consider the impact on farmers’ income and guaranteeing access for all to drinking water.

2.1. A guarantee of an acceptable income for farmers:

To consider this restriction, we shall describe four policies:

- the *supply of free water* to farmers (Egypt);
- *increasing prices less than is necessary*: Thus, in Lebanon, the increase in price is limited to what users can pay; in Morocco there is a plan for a partial reimbursement of the price of irrigation water in areas where it is very scarce (Agro-Concept, C.I.D et al., 1999) where the cost of water would be too high (break even cost 0.07 compared with 0.02 US$/m³ in other areas);
- *the setting up of a special pricing* structure: a pricing system with bonus for water saving (pricing system simply by volume and a pricing system in bands) allows the impact on the farmers' revenues to be lessened while saving the same amount of water (Varela-Ortega, M. Sumpsi et al., 1998) In the region of Valencia in Spain, the drop in income thus changed from 70% to 30% or even 15% with a proportional pricing system, a proportional pricing system with bonus and a pricing system in bands with bonus respectively.
- the use of other tools such *as quotas*: although this tool does not encourage water saving, it does allow the quantity of water consumed to be limited

2.2. Access for all to drinking water:

A practice currently used in Mediterranean countries to ensure access to drinking water for everyone is the adoption of a welfare pricing system. This is applied in various ways:

- *a banded pricing structure*: a single pricing structure is offered to all domestic users, and the welfare price is represented by a particularly cheap bottom band. A variation is found in Tunisia where the "welfare tariff" of 0-20 m³/quarter is reserved only for those consumers who do not exceed 20m³, i.e. 40% of consumers (it would only represent about 30% of the actual cost of the water). These figures may lead one to ask the question: is the welfare pricing system simply an excuse for not making a large part of the population pay? To reveal the national polices which limit the amount of the low-price band which actually does correspond to the welfare band, the following indicators are used: (1) the amount of the bottom band compared with the minimum of "welfare" consumption, estimated at 15 m³/quarter; (2) the degree of progressiveness of the price between the first "welfare" band and the band above it.

The amounts of the first band of consumption generally exceed the so-called "welfare" volume of 15m³ (Table 10). When the volume of the first band remains low – less than 20 m³ – the progressiveness of prices between the first two bands does not greatly encourage the limitation of consumption (Greece, Israel, Jordan). The price ratio is lower than two. It is in Malta, Morocco and Rome that the price-rise between the first two bands of consumption is at its greatest, and the first band is limited to 20-25m³. Thus their pricing system appears to correspond to a genuine welfare strategy. In Malta, the price of domestic water was heavily subsidised until 1994, before an increase in prices to reflect the full cost of the water. However, priority is given to access for all to drinking water by subsidising the lowest bands of consumption (subsidies of 90% and 75% respectively for the first two bands of consumption). This policy in fact subsidises more than the welfare band (European Commission, 2000).

In Turkey, the heavy differentiation in price between the low prices for the first band of consumption in underprivileged towns like Diyarbakir, and the wealthier towns like Izmir, also comes under this welfare policy. In this case too, the amount subsidised is relatively high (a band of 30 m³ at 0.1 US$).

Table 10: "Welfare" pricing systems for drinking water

Country	Region	Amount of 1st band	Price of 1st band	Price-ratio 2nd /1st band	Bill for 15 m³
Italy	Rome	23	0.2	2.2	3
Malta		21	0.2	2.5	4
Morocco		24	0.3	2.6	4
Tunisia		20	0.1	1.7	1.4
Turkey	Diyarbakir	45	0.1	4	1.5
Greece	Peania	11	0.2	1.2	4.0
Greece	Athens	15	0.3	1.1	4.5
Israel	Tel Aviv, Jaffa	16	1.2	1.1	17.5
Turkey	Izmir	30	0.5	2.4	7.5
Italy	Milan	32	0.1	1.6	2
Jordan	Amman	20	0.2	1.2	3
Egypt	Alexandria	30	0.1	1.3	1.4
Greece	Dyonisos	75	0.2	1.3	3.0

Sources: see Table 6

Finally, in Egypt and in Greece (Dyonisos), the volume that defines the first level is high, the initial price is low, and so is the progressiveness in pricing. These factors mean that a large part of the water consumption is charged at a low price.

- *a pricing system with rebates according to certain criteria*: in Seville (Spain) there is a dual, banded pricing system with 50% rebates for domestic consumption that does not exceed a certain threshold, and for families with more than 5 children who are charged at the price of the first band whatever their consumption (EMASESA); in Athens, the dual, banded pricing system takes great account of the welfare objective by putting a ceiling on the price for large families (more than three children) and providing the water free for the most underprivileged (OECD, 2000).
- *payment of the bill subject to the ability to pay*: in France, a welfare pricing system does not exist as such. The law of 29 July 1998 does however state that water may not be cut off from people or families at risk, and the Water Solidarity Charter allows debts to be written off for households unable to pay.

3. SETTING UP A SYSTEM CHEAPER THAN THE EXPECTED ADVANTAGES

The system must be less costly to set up than the benefits that it provides. The cost of setting up a system and the loss of well-being for certain sections of the population have to be compared with the benefits obtained (monetary or not).

The different costs to take into account are: the costs of informing the people concerned (identifying them and their behaviour vis-à-vis water resources, etc.) as well as the costs of applying the management tool (like installing meters) and the costs of control (metering, policing, etc.).

The loss of well-being involves those (users or not of the water) whose satisfaction diminishes after the implementation of the management tool.

The costs must be lower than the cost of providing the resource: very variable depending on the circumstances with the desalination of seawater at the extreme.

So far as is possible, the costs of transaction associated with introducing the tools and the costs of alternative measures (water saving, creation of new resources) if these are known need to be discussed.

Conclusion

The balanced management of water resources depends on the demands of the different sectors – agriculture, drinking water, industry or the environment – being matched by all the resources available. This balance can be obtained by tapping new water resources as has usually been the case, but also by water demand management. In the Mediterranean, the Fréjus conference held on September 12th and 13th 1997 made this its main recommendation because the restricted regional resources available no longer made it possible to develop supply-based policies without major cost to society, ecology or the economy.

In sum, the regional use of economic tools to support a policy of water demand management remains very modest. There is however a wide range of policies in individual countries. At the extremes, we find:

- One group of countries, major users of irrigation for agriculture, who are principally pursuing the traditional policy of developing the supply (Turkey, Egypt and Spain); this can go as far as the use of non-renewable resources (Libya);
- At the opposite extreme, other countries (Tunisia, Israel, Morocco) are engaged in a policy of managing water demand and are installing economic tools to encourage water saving, while this is used widely in countries that have come to the limit of their water resources such as Malta, Jordan, Israel and Cyprus;
- In all countries, the economic tools are never used in isolation but coexist with other tools and local policies to improve the supply: interconnecting distribution grids, reuse of waste water and the desalination of seawater.

Our survey also shows that the use of economic tools is more limited in the agricultural sector than in the supply of drinking water. This may appear paradoxical, contradictory even, given the respective potentials for saving water of the two sectors.

Nevertheless, there are positive experiences to show in the sectors of drinking water (Greece, Israel, Tunisia) and agriculture (Tunisia, Morocco, France). The main lessons to be learnt are:

Price reforms have led to a fall in the consumption of water where consumers are sensitive to price. The main conditions relate to the price levels and structures, and the existence of alternative patterns of behaviour,

The acceptability of the reforms depends very much on the conditions of their implementation and the impact on revenue. In Morocco, for example, price rises were spread out over time so that their rate of increase did not exceed that of technical progress in agriculture,

The price paid by the user tells him something about the scarcity of water resources, but communication with users is an essential complement to price changes, going as far as campaigns to raise awareness of water saving (Greece, Spain). These have often been carried out in a context of drought, which favours the perception of scarcity by users,

New and more motivating pricing structures are appearing in the drinking water sector (notably in Tunisia).

These experiences are full of lessons and clearly more work needs to be done to analyse them in more depth and clarify the debate on the relevance and efficacy of economic tools. A greater number of concrete experiences would help to consolidate the limits of application of economic tools as they appear today.

The rise in prices has in several instances led to increased reliance on alternative resources: the development of private reservoirs, recourse to groundwater or drawing from rivers. This behaviour has an environmental impact in aquatic habitats on the water resource and on the soils, threatening at times the sustainability of the natural resources concerned. The decisive factor here is whether or not a system of regulations exists to establish one single water resource.

Social policies to help the disadvantaged need to be put in place when the consequence of a rise in the price of water is to deprive them of access to drinking water or essential food.

Greater and more systematic understanding of the costs of implementing price reforms, and also the full cost of providing drinking water or water to produce food, is necessary to measure accurately the advantages of demand management policies.

Technical conditions, such as the price-elasticity of demand, need to be met if the pricing systems are to be effective. Meeting these conditions means using them in contexts where the resource is seen as rare, but also preferring rationing when the pressure on the resource is very high locally (France) or nationally (Israel).

Metering or calculating the amount consumed is a fundamental of volume-based management and constitutes an important condition for introducing a price system that encourages water saving. The experiences and the technological innovations expected do not restrict it to networks under pressure, and place the social acceptance of these mechanisms at the centre of pre-conditions for pricing reform.

References

AFEID (2001). L'eau pour la production alimentaire et le développement durable, Vision des acteurs français de l'eau. AFEID. 46p.

Agence de l'Eau Loire-Bretagne and Conseil Régional de Bretagne (1999). Economiser l'eau dans la ville et l'habitat: sur les traces de l'expérience des Villes-pilotes en Bretagne. Practical manual, 64 pages.

Agro-Concept, C.I.D and Scet-Maroc (1999). Tarification de l'eau d'irrigation du Maroc. Modalités de mise en œuvre de la nouvelle structure tarifaire (version provisoire). Royaume du Maroc. Ministère de l'Agriculture, du Développement Rural et des Pêches Maritimes. 38p+appendices.

Ahmad, M. (2000). "Water pricing and markets in the Near East: policy issues and options." Water Policy **2**: 229-242.

Amir, I. and F. M. Fisher (1999). "Analyzing agricultural demand for water with an optimizing model." Agricultural Systems **61**: 45-56.

Amir, I. and F. M. Fisher (2000). "Response of near-optimal agricultural production to water policies." Agricultural Systems **64**(2): 115-130.

Arrojo, P. (1999). The impact of irrigation water pricing policy in Spain. Conférence sur le prix de l'eau - Economie environnement et société, Sintra, Portugal 6-7 September 1999., pp177-193.

Arrojo, P. and J. Carles (not dated). "The impact of water prices on agricultural water in Spain."

Azomahou, T. (2000). Dépendance spatiale et structure de données de panel - Application à l'estimation de la demande domestique d'eau. European Doctoral Thesis in Economics. 251. UMR Cemagref-ENGEES en "Gestion des Services Publics" et Bureau d'Economie Théorique et Appliquée. Université Louis Pasteur.

Barraqué, B. (1995). Les politiques de l'eau en Europe. L. Découverte: 145 - 160.

Bechtel/Scet-Tunisie (1999). Etude du secteur de l'eau en Tunisie. Bechtel International Inc/SCET.

Becker, N. and S. Bishop (1999). Water pricing; the israeli experience. Pricing Water: Economics, Environment and Society, Sintra, 6-7 September 1999, European Commission, pp. 221-229.

Belhaj Jrad, M. K. (2000). La tarification de l'eau d'irrigation en Tunisie. République Tunisienne, Ministère de l'Agriculture, Direction Générale du Génie Rural. 8p+appendices.

Belhaj Jrad, M. K. (2002). La tarification de l'eau d'irrigation en Tunisie. République Tunisienne, Ministère de l'Agriculture, Direction Générale du Génie Rural et de l'Exploitation des Eaux. Presentation, Engref training session, Sidi Tabet, March 2002.

Berbel, J. and J. A. Gomez-Limon (2000). "The impact of water-pricing policy in Spain: an analysis of three irrigated areas." Agricultural Water Management **43**(2): 219-238.

Boistard, P. (1993). Qualité et prix des services publics de distribution d'eau potable. Approche d'un prix de la qualité de l'eau et de la desserte. Doctorat en Sciences et Techniques de l'Environnement. 347. Ecole Nationale des Ponts et Chaussées.

Burak, S. (2000). Water politics in Mediterranean countries. Monographs. Plan Bleu, UNEP. 118p.

Burucoa, V. (1995). Economies d'eau. CIS Schlumberger.

Chohin-Kuper, A., G. Gleyses, T. Rieu et M. Tauber (2001). "Impact économique de la modification de la redevance prélèvement pour les irrigants." CEMAGREF. MATE.

DGCCRF (2001). Evolution des prix de l'eau 1995/2000. Ministère de l'Economie, des Finances et de l'Industrie.

Dinar, A. and A. Subramanian, Eds. (1997). Water Pricing Experiences. An International Perspective. World Bank Technical Paper.

Doppler, W., A. Z. Salman, E. K. Al-Karablieh et H.-P. Wolff (2002). "The impact of water price strategies on the allocation of irrigation water: the case of the Jordan Valley." Agricultural Water Management **55**(3): 171-182.

Durand, J.-M., C. Fonseca and F. Karma (2002). Retour d'expériences des politiques et outils économiques de maîtrise de la demande en eau dans les pays Méditerranéens. ENGREF. TGE report to Cemagref, 160p.

El-Naser, H. (1999). The Jordan case study. Second regional seminar on policy reform in water resources management, Amman, Jordan, May 8-11, 1999, The MENA/MED Water Inititative, 41p.

EMASESA Metropolitan Areas and Sustainable Use of Water. Water demand management: the experience and activities of EMASESA. 27p.

EMASESA (2000). Metropolitan Areas and Sustainable Use of Water. The Case of Seville. EMASESA, Municipal Water and Sanitation Company of Seville. METRON PROJECT.

Eruygur, O. (2001). Comparaison de différentes politiques de tarification de l'eau dans la région de Karapinar en Turquie. CIHEAM/IAM. Master of Science thesis, 78p+annexes.

European Commission, Ed. (2000). Towards sustainable and strategic management of water resources.

Garrido, A. (1999). Pricing for water use in the agricultural sector. Conférence sur le prix de l'eau - Economie environnement et société, Sintra, Portugal 6-7 September 1999., pp105-117.

Ghini, M. (2000). Demand elasticity of water supply in respect to water price change: case study in Athens. Europe of water, Water of the Europeans, Lille, 13th and 14th September 2000.

Gomez-Limon, J. A. and J. Berbel (2000). "Multicriteria analysis of derived water demand functions: a Spanish case study." Agricultural Systems **63**(1): 49-72.

Hajispyrou, S., P. Koundouri and P. Pashardes (2001a). Household demand and welfare implications of water pricing in Cyprus. University of Cyprus. Working Paper, 25 pages.

Hajispyrou, S., P. Koundouri and P. Pashardes (2001b). Household Demand and Welfare. Implications of Water Pricing in Cyprus. Working Paper, 25p.

ICTAF (2000). Metropolitan Areas and Sustainable Use of Water. Tel Aviv-Yaffo Case Study. European Commission. ICTAF at Tel-Aviv University. METRON PROJECT CONTRACT ENV4-CT97-0565.

Jean, M. (1999). Pricing policy and practical application: the example of the Canal de Provence. Pricing Water. Economics, Environment and Society, Sintra, Portugal, 6-7 September 1999, Eurpopean Commission. Instituto da Agua, 141-147.

Jellali, M. M. (1995). Développement des ressources en eau au Maroc. Atelier aspects économiques de la gestion de l'eau dans le bassin méditerranéen, Marrakech 17-19 May 1995, IAV Hassan II, CIHEAM, UE-DG1, p51-68.

Kallis, G. and H. Coccossis (2000). Metropolitan Areas and Sustainable Use of Water. The Case of Athens. European Commission. Environmental planning laboratary. University of the Aegean. METRON PROJECT CONTRACT ENV4-CT97-0565.

Khrouf, M. L. (2001). Etude sur l'économie d'eau à domicile - Rapport de Synthèse. IME. 56p.

Lacroix, G. (1999). The price of water and environmental policies in the Mediterranean region. Conférence sur le prix de l'eau - Economie environnement et société, Sintra, Portugal 6-7 September 1999, pp91-98.

Le Coz, C. (1998). Valorisation des fonctions de l'eau. Application à l'eau domestique sur le bassin versant de la rivière Yerres. Doctoral Thesis. 338. Sciences de l'Environnement. ENGREF.

Limam, A. (2001). L'aspect social de la tarification de l'eau potable. Tarification et lutte contre la pauvreté (eau et assainissement), Cairo, Egypt, 19-20 December 2001, SONEDE - Tunisia,

Maestu, J. (1999). The political economy of the implements of changes in pricing in Spain: what can we learn ? Pricing Water: Economics, Environment and Society, Sintra, Portugal 6-7 September 1999, pp. 247-255.

Margat, J. and D. Vallée (2000). Water for the 21st Century: Vision to Action. Mediterranean vision on water, population and the environment, Global Water Partnership, Plan Bleu.

Martinez-Espiñeira, R. (2000). Estimating water demand under increasing block tariffs using aggregate data and proportions of users per blocks. Water Resource Management - Efficiency, equity and policy, University of Cyprus, Nicosia, Cyprus, 20.

Marušic, J. (1998). Organisation, financing and implementation of water management plans in the Republic of Croatia. International symposium on water managemenent and hydraulic engineering, Dubrovnik, 14-19 September 1998, pp1-12.

Massarutto, A. (1999). Comparing water pricing policies in the EU: a positive analysis. Pricing Water: Economics, Environment and Society, Sintra, 6-7 September 1999, 79 - 91.

Massarutto, A. (2001). Water Institutions and Management in Italy. Université des Etudes de Udine. Département Sciences économiques. Working paper N° 01-01-eco.

Matoussi, M. S. and A. Baranzini (1998). Economie environnementale: Incitations et évaluation. International Academy of the Environment, Geneva, Switzerland. Working Paper W61F.

Michalland, B. (1995). Approche économique de la gestion de la ressource en eau pour l'usage d'irrigation. 445 pages + appendices. Université Bordeaux I.

Montginoul, M., Y. Lunet de Lajonquière and P. Garin (2002). Impact de la présence d'un réseau de distribution d'eau brute sur la consommation en eau potable. Le cas de la commune de Gignac (34). UMR GSP Cemagref-ENGEES. 27 pages.

Montginoul, M. and J.-D. Rinaudo (2002). Impact de la tarification sur les stratégies de consommation et d'approvisionnement en eau des ménages. Colloque SHF "Economie et eau", Paris,

Morardet, S., T. Rieu and G. Gleyses (2001). Instruments de régulation de la demande en eau des agriculteurs et politique agricole commune. Colloque PIREE " Les instruments des politiques environnementales ", Sophia-Antipolis, 5-6 April 2001, 23 pp.

Nauges, C. (1999). La consommation d'eau potable en France: analyse économétrique de la demande domestique. Doctoral Thesis. 308. Université des Sciences Sociales de Toulouse.

Nauges, C., A. Reynaud and A. Thomas (1998). Consommation domestique d'eau potable et tarification. INRA Sciences Sociales. 4 pages.

OECD (1997). Examens des performances environnementales: Espagne.

OECD (1999a). Environmental performance review - Croatia. Economic Commission for Europe - United Nations.

OECD (1999b). "Examen des performances environnementales de la Turquie." 51 - 71.

OECD (1999c). "Tarification de l'eau à usage agricole dans les pays de l'OECD." Direction de l'environnement.

OECD (2000). Examens des performances environnementales - Etudes par pays: Grèce.

ONEP (1997). Secteur de l'eau potable au Maroc. 1er forum mondial sur l'eau - L'eau, patrimoine de l'humanité, Marrakech, 20 au 25 March 1997,

Ostojic, Z. and M. Lusic (2000). Summary of water pricing policies in Croatia. Economics instruments and water policies in central and eastern Europe: issues and options, Szentendre, Hungary, September 28-29, 2000, The Regional environmental center for Central and Eastern Europe, 27 - 32.

Plan Bleu (1999). Analyse des stratégies de gestion de l'eau au Liban. Plan Bleu. 20p.

Plan Bleu (2002). Rapport d'analyse de l'étude de cas sur l'approvisionnement en eau potable de la zone côtière de Rabat Casablanca. 13 pp.

Pouquet, L. and K. Ragot (1997). "Les ménages sont-ils devenus plus sensibles au prix de l'eau ?" Cahiers de Recherche du CREDOC **104**: 63-168.

Richard, A. (2001). La gestion des eaux du système Litani - Awali par l'Office national du Litani - Etat des lieux et pré-étude d'une modélisation pour une aide à la décision. ENGREF. 47p.

Sghaier, M. (1995). Tarification et allocation optimale de l'eau d'irrigation dans les systèmes de production de la région oasienne de Nefzaoua (Sud de la Tunisie). Doctoral Thesis. 235 pp + appendices. Sciences Biologiques Appliquées. Université de Gent.

Shevah, Y. and G. Cohen (1997). Economic considerations for water use in irrigation in Israël. Water: Economics, management and demand. F. T. a. S. L. Kay M., E&FN Spon**:** pp27-30.

Socratous, G. (2000). Water pricing in Cyprus. Symposium Water Resources Mangement. Efficiency, Equity and Policy, University of Cyprus, Nicosia-Cyprus, 22-24 September, 2000, Ministry of Agriculture, Natural Resources and Environment, European Commission DG XII, 8 pp + appendix.

Tardieu, H. and B. Préfol (2001). "Full cost or "sustainability cost" pricing in irrigated agriculture. Charging for water can be effective, but is it sufficient." ICID Journal (forthcoming).

Valiron, F. (1991). Gestion des eaux. Coût et prix de l'alimentation en eau et de l'assainissement. Paris.

Varela-Ortega, C., J. M. Sumpsi, A. Garrido, M. Blanco and E. Iglesias (1998). "Water pricing policies, public decision making and farmers' response: implications for water policy." Agricultural Economics **19**(1-2): 193-202.

Vergés, J. C. (2000). "Le juste prix de l'eau en Espagne." REMn°191-3/2000 **48**(191): 217 - 233.

Ville de Lorient (2000). Les économies d'eau à Lorient. Actes: 15 pages.

World Bank (1995). Morocco - Water sector review. World Bank.