Project:

ENORASIS

(Grant Agreement 282949)

"ENVIRONMENTAL OPTIMIZATION OF IRRIGATION MANAGEMENT WITH THE COMBINED USE AND INTEGRATION OF HIGH PRECISION SATELLITE DATA, ADVANCED MODELING, PROCESS CONTROL AND BUSINESS INNOVATION"

Funding Scheme: Collaborative Project
Theme: FP7-ENV

D2.1: IRRIGATION WATER GOVERNANCE

Authors:	Djuma, H., A. Bruggeman, D. Daskalakis, A. Hembury, J. Kozyra, J. Hammer, J. Bajkin
Issued by:	The Cyprus Institute
Issue date:	25/05/2012
Due date:	31/05/2012
Work Package Leader:	The Cyprus Institute

Start date of project: 01 January, 2012 Duration: 36 months

Document History *(Revisions – Amendments)*	
Version and date	**Changes**
Version 1.0, 31/05/2012	

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC)	

Table of Contents

List of figures

No table of figures entries found.

List of tables

1. Introduction

Globally, agriculture makes use of 70% of all water withdrawn from aquifers, streams and lakes (FAO, 2011). Agriculture accounts for 22% of freshwater abstraction in Europe, outnumbered only by freshwater abstraction for cooling in energy production (45%). In southern Europe, however, agriculture uses more than half of the total national abstractions, rising to more than 80% in some countries (EEA, 2010). Climate change is expected to stress the limited water resources of the Mediterranean countries even further, while increased precipitation variability will affect agriculture in many areas of the world (Kundzewicz et al., 2007). Thus, irrigation is becoming increasingly more important for improving and stabilizing agricultural production. Due to the sheer size of agricultural land, irrigation could rapidly grab a large share of a country's available water resources.

On top of this, FAO (2011) foresees a 70% increase in the demand for food by 2050, relative to 2009, as a result of population growth and economic development. The increase in agricultural output will to a large extent have to come from intensification of agricultural production. This will require widespread adoption of sustainable land management practices, and more efficient use of irrigation water through enhanced flexibility, reliability and timing of irrigation water delivery. FAO (2011) encourages both governments and the private sector, including farmers, to become much more proactive in advancing the adoption of sustainable land and water management practices, including the improvement of support services, research and knowledge exchange.

The application of technologies that could help crop producers achieve the highest return for the water they apply to their crops is a key issue for achieving food security and for safeguarding the sustainability of our water resources. However, if there is little control on water abstraction or if the cost of irrigation water is low, farmers will be less inclined to invest time and money into technologies that could optimize their water use. To improve our understanding of the opportunities and constraints for the implementation of advanced irrigation support systems, this report takes a look at water policies, prices, support measures and existing irrigation advisory services.

The objectives of this report were

- to assess policies, requirements and support measures related to water abstraction, water pricing and agricultural water management under the Water Framework Directive (WFD), Common Agricultural Policy (CAP) 2003, and CAP 2013 reform, in ENORASIS pilot countries and other selected EU countries;
- to capture and analyze irrigation scheduling methods, support services, and constraints of stakeholders (farmers, water management organizations and service providers), taking into consideration their current status and future opportunities and needs in relation to the above mentioned EU policies.

The current agricultural and irrigation situation of all countries represented in the ENORASIS project (Cyprus, France, Germany, Greece, Italy, Malta, Poland, Portugal, Romania, Serbia, Spain, Switzerland, Turkey), plus three more European Mediterranean countries with a large share of their cropland irrigated (Italy, Malta, Portugal) are presented in Chapter 2. A review of the European water and agriculture policies (WFD and CAP) is discussed in Chapter 3, whereas details on water governance and pricing in Cyprus, France, Greece, Italy, Poland, Serbia and Turkey are presented in Chapter 4. Chapter 5 provides a global review of current irrigation scheduling support services, based on literature and websites. This is followed by a brief chapter with information on irrigation stakeholders, practices and opportunities obtained from interviews and meetings with farmers, agricultural cooperatives, agricultural research and extension services, meteorological services, water providers, agro-businesses and researchers in Cyprus, Greece, France, Italy, Poland, Serbia, Switzerland and Turkey. Finally, chapter 7 provides a brief conclusion.

2. Agriculture, Water Resources and Irrigation

In this chapter, information about water resources, agriculture and irrigation in ENORASIS countries and in some additional countries are provided. In addition to ENORASIS countries (Cyprus, France, Greece, Serbia, Poland, Germany, Switzerland, Turkey, Romania and Spain) Malta, Italy and Portugal are included because of their similarities in water resources and agriculture to ENORASIS countries.

The data for each country is gathered from Aquastat, FAO's global information system on water and agriculture (http://www.fao.org/nr/water/aquastat/main/index.stm), and presented in Table 1. The most recent data, mainly after the year 2000, is presented. It is footnoted if the obtained data originates before the year 2000. The data comes from national sources that can be reports, publications or official websites. In addition, some of the data is estimated or modelled by Aquastat, which is also indicated in the footnote. It is possible to come across different values in national reports than the ones presented on the table. However, for the sake of comparison all the date is taken from Aquastat.

The purpose of the table is to provide overall information on each country in relation with agriculture. The information about surface area, population, economics, water resources and irrigation is represented. Some explanations are given in the following paragraphs for the purpose of clear understanding.

Total renewable water resources of a country are the sum of internal renewable water resources and external renewable water resources. Internal renewable water resources are long-term average annual flow of rivers and recharge of aquifers generated from endogenous precipitation and external water resources are the sum of the total natural external surface water resources and the external groundwater resources entering and leaving the country. Total renewable water resources correspond to the maximum theoretical yearly amount of water available for a country at a given moment.

Surface irrigation systems are based on the principle of moving water over the land by simple gravity in order to moisten the soil. They can be subdivided into furrow, border-strip and basin irrigation (including submersion irrigation of rice). Manual irrigation using buckets or watering cans is also included. Surface irrigation does not refer to the method of transporting the water from the source up to the field, which may be done by gravity or by pumping. A sprinkler irrigation system consists of a pipe network, through which water moves under pressure before being delivered to the crop via sprinkler nozzles. The system basically simulates rainfall in that water is applied through overhead spraying. These systems are also known as overhead irrigation systems. Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied water as a small discharge to each plant or adjacent to it. There are three main categories: drip irrigation (where drip emitters are used to apply water slowly to the soil surface), spray or micro-sprinkler irrigation (where water is sprayed to the soil near individual plants or trees) and bubbler irrigation (where a small stream is applied to flood small basins or the soil adjacent to individual trees). The following other terms are also sometimes used to refer to localized irrigation: micro-irrigation, trickle irrigation, daily flow irrigation, drop-irrigation, sip irrigation, diurnal irrigation. Both the total area equipped for full control irrigation and the area that is actually irrigated are presented in the table.

Three sources of irrigation water are represented in the table: surface water, groundwater and non-conventional water. Non-conventional sources of water are agricultural drainage, treatment and desalination plants. It is highly possible that in some countries different non-conventional sources are used. However, there was no data presented from the selected countries about this at the time of this report.

Table 1: Water resources, agriculture and irrigation in selected countries

Country name	Cyprus	France	Ger-many	Greece	Italy	Malta	Poland	Portu-gal	Roma-nia	Serbia	Spain	Swit-zerland	Turkey
Country area (10^3 ha)	925	54,919	35,712	13,196	30,134	32	31,268	9,209	23,839	8,836	50,537	4,128	78,356
Cultivated (10^3 ha)	121	19,396	12,145	3,699	9485	9.3	12,939	1,903	9,151	3,596	17,216	430.4	24,294
Cultivated area (% of country)	13.7	35.3	34	28	31.4	29	41.3	20.6	38.3	40.7	34	10.4	31
Area equipped with full control irrig. (10^3 ha)	45.8	2642	485	1,555	3,951	3.2	115.7	583.7	615.3		3,818	25	4,970
Area equipped with full control irrig. (% of cultivated area)	31.5	13.5	4.0	47.9	40.7	34.4	0.9	30.8	6.8		22.2	5.8	20.0
Economically active pop. (10^3)	553	28,230	41,914	5,276	25,787	173	17,396	5,650	9,500	4,802	22,538	4,284	24,566
Economically active pop. in agriculture (%)	5.6	2.1	1.6	12.5	3.4	1.2	17.5	9.4	9.7	13.4	4.7	3.3	33.3
Agriculture, value added to GDP (%)	2	1.7	0.8	3.1	1.8	3.1[6]	3.6	2.3	7.1	12.8	2.6	1.1	9.3
Av. precip. (mm/yr)	498	867	700	652	832	560	600	854	637		636	1,537	593
Renewable water resources (10^9 m^3/yr)	0.78[1]	211[1]	154	74.3[1]	191.3	0.05[1]	61.6[1]	68.7	211.9	162.2	111.5	40.4	213.6
Renewable water res. (m^3/inhab/yr)	715.6[1]	3,379[1]	1,869[1]	6,555[1]	3175	121.7[1]	1,610[1]	6,446	9,839	16,457	2,443	5,301	2,973
Agricultural water withdrawal (10^9 m^3/yr)	0.16	3.92	0.08[1]	8.46	20.01[2]	0.02	1.16	6.18	1.17	0.08	19.64	0.05	29.6
Agricultural water withdrawal (% of total withdrawal)	86.4[1]	12.4	0.2	89.3	40[2]	35.2[1]	9.6	73	17	1.8	60.5	1.9	73.8
Irrigation systems													
Surface irrig. (%)	4.3[7]	4.4			65.4[3]	3.5[4]			68.3[4]				92
Sprinkler irrig. (%)	4.3[7]	91.6			13.1[3]	4.7[4]							6
Localized irrig. (%)	77.7[7]	4.1	0.4[5]		2[5]	15.6[4]	3.5[5]	4[5]	0.8[4]		4.2[5]		2

Country name	Cyprus	France	Ger-many	Greece	Italy	Malta	Poland	Portu-gal	Roma-nia	Serbia	Spain	Swit-zerland	Turkey
Irrigation source													
Surface water (%)	41.6[7]				53.9[3]	0[4]							76.7
Groundwater (%)	44.3[7]				21.9[3]	15.1[4]							18.1
Non-conv. sources (%)	0.4[7]					8.8[4]							3

[1]Aquastat's estimation [2]Modeled [3]Data year 1965 [4]Data year 1990 [5]Data year 1991 [6]Data year 1993 [7]Data year 1994

The ratio of cultivated area over country area is higher in relatively water rich and economically less advanced countries (Poland, Serbia and Romania). Agriculture is an important source of income in these countries, contributing between 3.6% (Poland) and 12.8% (Serbia) to the national GDP. The percentage of the economically active population that is involved in agriculture ranges between 9.7% (Romania) and 17.5% (Poland) for these three countries. The agricultural work force is also high in Greece (12.5%) and Turkey (33.3%). Beside the climatic, economic and political influences, availability of land for agriculture plays an important role, since in developed countries the land for agriculture competes with the population's housing demand and demand for industrialized areas.

The ratio of area equipped with full control irrigation over cultivated area is higher in Mediterranean countries (Italy, Greece, Cyprus, Malta, Portugal, Spain and Turkey). Limited amount of precipitation and water availability are one of the main reasons for irrigation in these countries. Area equipped for full control irrigation is a good indicator for a country to be an ENORASIS product market. However, type of the irrigation system also plays an important role in implementing the ENORASIS products. Italy, Romania and Turkey have large areas of surface irrigation, which are less suitable for advanced irrigation scheduling techniques. Mediterranean countries also rank high in agriculture's water consumption over total water withdrawal, especially Cyprus, Greece, Portugal and Turkey. This shows the importance of agriculture and role of irrigation in such countries. Mediterranean countries, without a doubt, have great potential for ENORASIS products since 'more crop per drop' is and will stay the trend in irrigation practices.

3. European Water and Agricultural Policies

3.1 Water Framework Directive (WFD)

The European Union has adopted the Water Framework Directive (WFD) in 2000. It introduces a new legislative approach to managing and protecting water, based not on national or political boundaries but on natural geographical and hydrological formations: river basins. It also requires coordination of different EU policies, and sets out a precise timetable for action, with 2015 as the target date for getting all European waters into good condition. To achieve the objectives of the WFD, member states should implement the following actions (EC, 2000a; WDD, 2011):

- Define the individual river basins lying within their national territory, assign them to individual River Basin Districts (RBD) and define the competent authorities to apply the rules of WFD until 2003 (Article 3, Article 24).
- Characterize the RBD in terms of pressures and impacts and undertake an economic analysis of water use, establishing at the same time a Registry of Protected Areas within the RBD by 2004 (Article 5, Article 6, Annex II, Annex III).
- Carry out, jointly with the European Commission, the intercalibration of the ecological status classification systems by 2006 (Article 2 Paragraph 22, Annex V).
- Make the monitoring networks operational by 2006 (Article 8).
- Define a program of measures by 2009, to achieve environmental objectives of WFD cost-effectively, based on the monitoring and analysis of the RBDs characteristics (Article 11, Annex III).
- Produce and publish River Basin Management Plans (RBMP) for each RBD including the identification of Heavily Modified Water Bodies (HMWB) until 2009 (Article 13, Article 4.3).
- Implement water pricing policies, based on the economic analysis (Article 5), that enhance the sustainability of water resources by 2010 (Article 9).
- Make the measures of the Programme operational until 2012 (Article 11).
- Implement the Programme of Measures and achieve the environmental objectives by 2015 (Article 4).

To date, the member states have identified river basin districts and designated the competent administrative authorities. The next step was to produce River Basin Management Plans until 2009. The implementation of these management plans is expected to take place in three phases: 2009-2015, 2015-2021 and 2021-2027. However, although some member states have adopted their RBMPs, others have finalized the consultations but are still awaiting adoption, while there are also member states where consultations have not yet started or are still on-going (EC, 2003; EC, 2012).

3.1.1 Water Pricing

The Water Framework Directive encourages the use of water charging to act as an incentive for the sustainable use of water resources and to recover the costs of water services by economic sector. To play an effective role in enhancing the sustainability of water resources, water pricing policies need to be based on the assessment of costs and benefits of water use and to consider both the *financial costs* of providing services as well as *environmental* and *resource costs* (EC, 2000b). These financial instruments can be explained as such:

Financial costs of water services include the costs of providing and administering these services. They include all operation and maintenance costs, and capital costs (principal and interest payment, and return on equity where appropriate).

Environmental costs represent the costs of damage that water uses impose on the environment and ecosystems and those who use the environment (e.g. a reduction in the ecological quality of aquatic ecosystems or the salinisation and degradation of productive soils).

Resource costs represent the costs of foregone opportunities which other uses suffer due to the depletion of the resource beyond its natural rate of recharge or recovery (e.g. linked to the over-abstraction of groundwater).

The WFD suggests that the pricing structures should include a variable element (i.e. volumetric rate, pollution rate) to ensure they serve an incentive function to water conservation and reduction of pollution. This variable element may vary for different locations and periods of the year to account for differences in water scarcity and water stress problems. The weight of the variable element needs to be balanced against the need to ensure the recovery of financial costs and thus the sustainability of water services and infrastructure. This particularly applies in situations with highly uncertain water supplies or where prices lead to an effective reduction in consumption and pollution, and thence of financial receipts.

The WFD does, however, offer a certain level of flexibility, as its states that Member States may consider "the social, environmental and economic effect of cost recovery as well as the geographic and climatic conditions" (EC, 2000a).

Furthermore, the WFD acknowledges that the measurement programmes providing precise data on all users could be very costly and therefore unrealistic. For example, where meters could not be a practical or economic option for some regions and alternative technologies could be required for assessing current use and pollution (the use of satellite imagery can be used for assessing agricultural water demand). One of the WFD's suggestions for the irrigation water pricing is to calculate, at the appropriate geographical scale, a water quota per hectare and per crop grown, based on the best practice in water use. Farmers using more than the determined quota would be penalised by sharply increased water prices (EC, 2000a).

Member States need to report on the steps towards implementing water pricing policies that will contribute to achieving the environmental objectives of the WFD in the River Basin Management Plans (EC, 2000a).

The implementation of water prices for irrigation water as prescribed in the WFD is, however, not without problems. Between September and November 2011, the European Commission (DG Environment) sent Germany, Belgium, Denmark, Finland, Sweden, and Ireland a reasoned opinion, considering their implementation of the concept of water services as described in EU water legislation, which is leading to inappropriate water pricing (EC, 2011a; 2011b; 2011c). These countries apply cost recovery principles only to the supply of drinking water and the disposal and treatment of wastewater. Under the WFD, water abstraction for irrigation in agriculture, wells drilled for agricultural, industrial or private consumption, as well as the cooling of industrial installations, the restriction of surface waters for navigation purposes, flood protection or hydro power production are also considered water services that need to adhere to principles of cost recovery. The Commission has similar concerns regarding other Member States and had already issued communications to Austria, Estonia, Hungary and the Netherlands on their misinterpretation of water services (EC 2011d).

Also in September 2011, the Commission referred the shortcomings of Spain in transposing the Water Framework Directive into Spanish legislation, to the EU Court of Justice, after Spain had already received a communication earlier (EC, 2011).

3.2 Common Agriculture Policy (CAP)

Dating back to the early 1960s, the Common Agricultural Policy (CAP) is one of the oldest policies of the European Union. The CAP has gone through various rounds of reforms to adapt to the challenges of its time, most recently in 2003 and during the **CAP Health Check** in **2008**. The Europe 2020 strategy offers a new perspective. In this context, through its response to the new economic, social, environmental, climate-related and technological challenges facing our society, the CAP can contribute more to developing intelligent, sustainable and inclusive growth. The CAP must also take greater account of the wealth and diversity of agriculture in the EU's 27 Member States (http://ec.europa.eu/agriculture/cap-post-2013/index_en.htm).

The CAP is financed by two funds, which form part of the EU's general budget: the European Agricultural Guarantee Fund (EAGF) finances **direct payments** to farmers and measures to regulate agricultural markets such as intervention and export refunds, while the European Agricultural Fund for Rural Development (EAFRD) finances the **rural development programs** of the Member States (http://ec.europa.eu/agriculture/grants/index_en.htm).

The **2003 reform** of the Common Agricultural Policy introduced a new system of **direct payments**, known as the Single Payment Scheme, under which aid is no longer linked to production. The main aim of the single payment is to support farmers' incomes in return for them respecting standards of environmental protection, animal welfare, food safety and keeping the land in good condition. Specific support schemes have been introduced or maintained for a number of products such as durum wheat, protein crops, rice, nuts, energy crops, starch potatoes, milk and milk products, seeds, cotton, tobacco, olive groves and grain legumes.

The **Rural Development** policy for 2007 to 2013, is achieved through the use of National Strategy Plans, and is focused on three "thematic axes": (i) improving the competitiveness of the agricultural and forestry sector; (ii) improving the environment and the countryside; (iii) improving the quality of life in rural areas and encouraging diversification of the rural economy. A fourth axis, referred to as "Leader" supports the implementation of integrated, high-quality and original strategies for sustainable development with a strong focus on partnership and networks of exchange of experience.

Many national and regional Rural Development Programs (RDPs) include support for establishment of agricultural producers groups (measure 142) and for business creation and development (measure 312). These measures could benefit the development of ENORASIS businesses or user groups. It is expected that this support will continue also under the new CAP.

Following the CAP Health Check, the new challenges of the Rural Development policy include **climate change** and renewable energy. With an additional budget of approximately €1 billion allocated to these challenges, measures related to these new EU priorities have been further strengthened in the national or regional Rural Development Programs (RDPs). In the country summary sheets related to these challenges almost all countries refer to support for improvement of water resources infrastructure and irrigation water management under measure 125 (infrastructure related to the development and adaptation of agriculture and forestry) as a contribution to climate change adaptation and/or mitigation (http://enrd.ec.europa.eu/themes/environment/climate-change/en/climate-change_en.cfm). Some countries also refer to water management under measure 121 (modernisation of agricultural holdings) and measure 114 (use of advisory services).

After a wide-ranging public debate the Commission presented on 18 November 2010 a Communication on "The **CAP towards 2020**", which outlines options for the future CAP and launched the debate with the other institutions and with stakeholders. A set of legal proposals was presented on 12 October 2011. The approval of the new regulations and implementing acts is expected by the end of 2013, following a debate in the European Parliament and the Council, with a view to having the CAP reform in place on 1st January 2014 (http://ec.europa.eu/agriculture/cap-post-2013/index_en.htm).

3.3 WFD and CAP Linkages

The Common Agricultural Policy (CAP) gives Member States the opportunity to take action on water use, by allowing them to ascribe environmental conditions to certain CAP payments allocated to farmers (Regulation 1259/1999, article 3 on environmental protection requirements). France has taken up such (cross-compliance) conditions and other Member States have also shown interest. Also, efficient water pricing should not be countered by agricultural product price policies and subsidies for irrigation and irrigated crops that negatively impact on the sustainability of water resources (EC, 2000b).

A somewhat pessimistic view of the linkages between the CAP and WFD is given by Mohaupt et al. (2007). They point out that agricultural cross-compliance standards do not cover all WFD aspects, and they identify also unmatching timetables and budgets as a constraint. Heinz (2007) reviewed the use of cooperative agreements between water authorities and stakeholders. He provides a positive view of cases where water authorities provided support to farmers to adjust their agricultural practices to improve the quality of the water resources.

4. Water Governance and Pricing in ENORASIS countries

In this chapter, information on water governance and pricing in ENORASIS countries is presented. Information under water governance includes the following; National Agricultural Authority (policy development), number of CAP Rural Development Plans (regions), national water authority (policy development), managing water authority (policy implementation), number of Water Framework Directive (WFD) river basin districts, water property rights, surface and groundwater use rights/regulations, irrigation water supply limitations/restrictions (e.g., during droughts). Most of the information was collected by project partners from WFD reports and river basin management plans, official reports, water laws and interviews with water authorities. Country specific information resources are given in the individual country sections.

Water prices are given per country and/or geographical or political locations (WFD basin, region, province, etc) in the case of Greece and France. Although it was not be possible for all the countries, it was tried to identify irrigation water prices before and after WFD, and financial, environmental and resource charges under the WFD. Water prices are presented for governmental, communal, commercial and individual supply. Water supply in irrigation water projects or networks should be charged by volume (m^3) to ensure the judicious use of water resources. However, if no water meters are present, as is the case in traditional open canal systems, water is sometimes charged per area, with different prices for different crops. In Cyprus the irrigation water price is a combination of a fixed per ha price and a flexible per volume price.

An overview of the irrigation water prices in the different countries is presented in Table 2. There is still a considerable amount of data missing in Table 2. As was already indicated in the previous chapter, some EU countries have not set prices for irrigation water, while non-European countries (Serbia, Switzerland, Turkey) have not developed environmental and resource prices. Also, for some countries the information was not accessible since RBMPs are not yet finalized or irrigation water prices are not included in the reports. Irrigation water is mainly supplied through governmental or communal organisations and/or abstracted individually by farmers. The difference in water prices between government and communal supply is not always clear because in some cases the government provide the supply for the communal organizations. Commercial irrigation water supply does not seem to exist in the analyzed countries. The prices are further discussed in the country sections.

Table 2 Irrigation Water Prices

Country	Cyprus	France	Greece	Italy	Poland	Serbia	Switzerland	Turkey
Government supply								
Financial cost (€/m3)	0.34		0.005-0.115					
Environmental cost (€/m3)	0.1		0-0.151					
Resource cost (€/m3)	0.01		0-0.334					
Final water price (€/m3)	0.24	0.23-1.50	0.054-0.645	0.12-0.80		0.001-0.006	0.05	
(€/ha per season)	66.1[1]			450-1705			2000[2]	
Water price before WFD (€/m3)	0.17		0.011-0.137					
(€/ha per season)	17.1							64-195
Communal supply								
Financial cost (€/m3)	0.3				0.57			
Environmental cost (€/m3)	0.16				0.03			
Resource cost (€/m3)	0.03				0			
Final water price (€/m3)	0.11	0.23-0.80			0.60		0.80 - 1.00	
(€/ha per season)				55-200				
Water price before WFD (€/m3)								
(€/ha per season)								
Individual supply								
Financial cost (€/m3)	NA[3]	NA	NA		NA			
Environmental cost (€/m3)	0.1				0.03			
Resource cost (€/m3)	0.01		0.007-0.021		0			
Final water price (€/m3)	0.11	0.0085-0.75	0.007-0.021		0.03			

[1] The irrigator pays both a variable per volume charge and a fixed per ha charge; [2] The irrigator pays both a variable per volume charge and a fixed per pump charge; [3] NA indicate that the cost is not included in the final water price

Cyprus

The Republic of Cyprus has transposed completely the WFD to National Legislation through the "Water Protection and Management Law of 2004" (L. 3(I)/2004) (WDD, 2004). According to this Law the Competent Authority to implement the provisions of WFD is the Ministry of Agriculture, Natural Resources and Environment (MANRE). Furthermore, with the Integrated Water Management Law (79(I)/2010) (WDD, 2010a) the water management was assigned to the Water Development Department (WDD). By the law, the entire authorization for water management (groundwater, surface water, sewage etc) was assigned to the WDD, which has now a primary rather than advisory role.

The entire island of Cyprus is considered a single river basin consisting of all 70 major river basins. It is noted that Cyprus as a whole entered the EU, whereas the acquits are suspended in the northern part of the island ("areas not under effective control of the Government of the Republic of Cyprus"). The area under effective control of the Government of the Republic of Cyprus includes 47 major watersheds (WDD, 2011a).

The issue of water abstraction is, in the case of Cyprus, very important, because excessive exploitation has led to the deterioration of a number of groundwater bodies (WDD, 2011a). The availability of irrigation water is always restricted (MANRE, 2010). For example, in 2009 when dams started to fill up again after the 2008 drought year, the provision of water from the main irrigation supply system (Southern Conveyor Project) covered just 40% of the needs for the permanent crops and 50% of the needs for greenhouses (WDD, 2009).

The Irrigation Water Supply Services are provided either through Government Water Projects (GWP) or outside them. The supply of water through Governmental Water Projects (GWP) is controlled by the WDD. In some cases, the consumer of the water services provided by the WDD may not be the end user but an intermediary organisation, which receives water on wholesale basis from the WDD and distributes it to its own end users (MANRE, 2010).

Regarding the supply of irrigation water through GWP, the WDD supplies water, either directly to private individuals (farmers, livestock operations etc), or to Agricultural Organisations. The supply of water to the users-consumers in areas not served by Governmental Water Projects takes place mainly through private groundwater abstractions primarily for irrigation purposes (either on a private individual level or local Irrigational Organisations), as well as from water abstractions or springs that are managed by Local Authorities (WDD, 2011a). The cost analysis, as well as the pricing policies analysis took this difference (GWP and outside GWP) into account (WDD, 2011b; MANRE, 2010).

The irrigation water prices were presented in the River Basin Management Plan (WDD, 2011a; 2011b). They are, however, not yet confirmed by the parliament. For the irrigation water prices in Cyprus see the Table 2.

France

SDAGE (Schémas Directeurs d'Aménagement et de Gestion des Eaux) were created to establish water policies in each hydrographical basin. The Metropolitan France is divided into 6 basins, according to the main French rivers: Artois-Picardie, Seine-Normandie, Rhin-Meuse, Loire-Bretagne, Adour-Garonne and Rhône-Méditérannée-Corse. Under the European WFD, Corse is identified as a separate river basin. Thus, there are 7 WFD river basins. The River Basin Management Plans (SDAGE) were adopted in December 2009.

Each SDAGE is planned out by a committee (Comité de bassin) involving end-users, state's delegates and elected representatives, industries' representatives, associations (for environment protection, consumers' protection etc.). The SDAGEs are managed by a Water Agency ('Agences de l'Eau') and local players (DREAL). The Water Agencies have to take into account the European Water Framework Directive and the local priorities at the basin scale.

The water agencies manage water resources at the level of the basin but they are not involved in the water supply or cleaning up. They are involved in both types of water management: drinkable and not drinkable. The Water Agencies collect charges for water use and grant financial assistance for fighting pollution, improving water resource management and restoring aquatic environments.

Concerning irrigation in France, it can either be individual (farmer scale) or collective. The collective irrigation is mainly represented by two different kinds of players (Amigues and Thomas, 2006):

- SAR (Sociétés d'Aménagement Régionales), such as SCP (Société du Canal de Provence), CNARBRL (Compagnie Nationale d'Aménagement de la Région du Bas-Rhône Languedoc) and CACG (Compagnie d'Aménagement des Coteaux de Gascogne) ;
- ASA (Associations Syndicales Autorisées).

ASAs are created either when on the request of the town hall or prefecture, or on the request of one or several farmers. The prefecture is always involved in the decision of such a creation (Rivière-Honegger, 2004). The average size of an ASA is of 20 subscribers. SARs are generally much bigger. One has to keep in mind that farmers are not the only subscribers of such entities. There can also be individuals our towns. (Agence de l'Eau Adour Garonne, 2007).

In France, half of the irrigation users in agriculture are connected to a collective network, the other half having individual irrigation. In the north and north-west of France, the proportion of individual irrigation farmers is much higher than in the south, and is related to new irrigated areas. (Brun, Lasserre and Bureau, 2006).

The collective irrigation network can either be private or governmental, the most of them being largely private. In many cases they are managed by an association of farmers using irrigation (CEMAGREF, 2004). Around 50% of French farms have an irrigation system connected to a collective network. This figure is the lowest in Rhin-Meuse, and the highest in Rhône-Méditerranée-Corse (CEMAGREF, 2004).

The irrigation water pricing in France is quite complex. It involves a lot of different players (Agence de l'eau, Préfecture, DREAL, Conseils régionaux, Conseils généraux, Associations, private firms…), and as there is no consensus onto a national water price, the problem has to be seen at a very local scale. However, at a national level, France is following the European Water Framework and the Grenelle Environment guidelines. France has also in its policy a strong will to reducing the water consumption. Some more information on the irrigation water management situation in France can be find in the report prepared by NOVELTIS (Hembury, 2012).

What is interesting to note is that if the total water volume used decreases, in some cases, the relative price of water will increase because of the fixed costs being unchanged (fixed costs range from 52 to 280 euro/ha). On the other hand, when these fixed costs are low (material, equipment, network paid off), then a water consumption economy can be relevant. Table 3 represents the irrigation water prices in 4 different departments in France.

Greece

The main laws concerning irrigation practices in Greece are the L. 3199/2003 "Protection and water management-Compliance with Directive 2000/60/EC of the European Parliament and Council of the 23rd October 2000" (GMEEC, 2003) as well as the Presidential Decree 51 "Defining measures and procedures for integrated screen protection and water management in compliance with the provisions of the Directive 2000/60/EC 'on the framework for Community action in water policy' of the European Parliament and Council of October 23 2000" (EPC, 2007).

According to these laws, all water is vested to the state, which is has the property rights and management responsibilities. The regulations concerning groundwater rights provide availability of borehole permits for individuals, but all are controlled by Special Secretariat for Water (SSW), which is main the Greek water management authority (SSW, 2007). Abstraction volumes information is not available for ground water. Over-abstraction is a common practice, due to legal gaps for this issue. The regulations concerning surface water use provide permits for diversions from streams to irrigation associations, under control of SSW, nevertheless volumes information is not available.

The SSW is a branch of the Greek Ministry of Environment Energy and Climate change. Greece is divided into fourteen (14) Water Framework Directive (WFD) river basin districts, of which five (5) are connected with neighbor-countries (Albania, F.Y.R.O.M, Bulgaria, and Turkey). Each district is consisted of the local government water management associations. The above mentioned river basin districts are Western Peloponese, Northern Peloponese, Eastern Peloponese, Western Central Geece, Epirus, Attica, Eastern Central Greece, Thessaly, Western Macedonia, Central Macedonia, Eastern Macedonia, Thrace, Crete and Aegean Islands.

Table 3 Irrigation water prices in France

Region	**Haute-garonne**	**Pyrénées Atlantiques**	**Charente**	**Rhône-Méditerranée-Corse**
		Government supply		
Financial cost (€/m3)				
Environmental cost (€/m3)				
Resource cost (€/m3)				
Final water price (€/m3)	0.4-0.8			
€/ha per season				
Water price before WFD (€/m3)		0.23	0.23	0.0085-0.075
€/ha per season				
		Communal supply		
Financial cost (€/m3)				
Environmental cost (€/m3)				
Resource cost (€/m3)				
Final water price (€/m3)				
Final water price (€/ha per season)				
Water price before WFD (€/m3)		0.0365	0.109	
€/ha per season		79		52-280 depending on the community (SARs or ASAs)

Concerning the irrigation water pricing in Greece, the main sources of the data for this report were the official report document issued in 2008 by the SSW and the available public consultation reports issued in 2011 by the Water Framework Districts (GR01,2011a,b; GR02,2011a,b; GR03,2011a,b; GR04,2011a,b; GR05,2011a,b; GR08,2011a,b).Common characteristic of all reports is that they provide mainly Government supply data and in some cases Individual supply data. Furthermore, it is worth mentioning that there was no uniformity in the format of the WFD reports. Moreover, there are no records available for private drills, in order to view the pricing of individual drills. The official report of SSW (SSW, 2008) provided a large amount of data for all WFD river basin districts, but the cost analysis for irrigation water was constructed in an alternative methodology providing different results compared to the public consultation reports (apart from the financial, environmental and resource costs the subsidies cost is also included). For this report, the results of the WFD reports (where available) are preferred, since they are more recent and analytical. In the areas where there were no WFD reports, the data from the SSW were used. For some districts there were no available consultation reports, while for districts Western, Northern and Eastern Peloponese, Western Central Greece, Epirus and Thessaly the WFD reports were available (although not yet final). For the districts that there were no available costs for irrigation water per m^3, the costs were calculated by dividing the district cost to the amount of water used for irrigation in the area. In the areas Western Central Greece, Epirus and Thessaly costs per m^3, were provided directly in the reports. The irrigation water prices are presented in Table 4.

Table 4 Irrigation water prices in Greece

Region	**Western Peloponese**	**Northern Pel.**	**Eastern Pel.**	**Western Central Greece**	**Eastern Central Greece**	**Epirus**	**Attica**	**Thessaly**	**Western Macedonia**	**Central Mac.**	**Eastern Mac.**	**Thrace**	**Crete**	**Aegean Islands**
Government supply														
Financial cost (€/m3)	0.115	0.085	0.110	0.070	0.005	0.038	0.009	0.060	0.021	0.015	0.015	0.012	0.027	0.021
Environmental cost (€/m3)	0	0	0	0.151	0.005	0.123	0	0.085	0.018	0.029	0.006	0.008	0	0
Resource cost (€/m3)	0.001	0.004	0.002	0.008	0.027	0	0	0.194	0	0	0	0	0	0.334
Final water price (€/m3)	0.117	0.089	0.112	0.229	0.101	0.160	0.080	0.338	0.067	0.101	0.054	0.069	0.178	0.645
Water price before WFD (€/m3)	0.060	0.050	0.070	0.022	0.016	0.016	0.017	0.026	0.034	0.011	0.015	0.137	0.100	0.011
Individual supply														
Financial cost (€/m3)	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Environmental cost (€/m3)	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Resource cost (€/m3)	0.007	0.011	0.021	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Final water price (€/m3)	0.007	0.011	0.021	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Italy

In Italy, water distribution for geographic areas is not homogeneous: 65% of it is concentrated in the North of Italy, 15% in the Centre, 12% in the South and 8% in the big islands (Sicilia and Sardegna)(Zucaro, 2005). The difference between North and South is due to climatic and historical factors: regions in the Centre and in the North are characterized by favourable climatic conditions and a tradition of irrigation and drainage. On the contrary, Southern regions, characterized by a semiarid climate, have faced water availability problems and strong public action after the II World War. Numerous dams were financed and built from 1950 onwards (AAVV, 1999); nevertheless in Southern areas and in the islands there remains an asymmetry between water availability and water requirements.

With respect to irrigation water management, there are many public agencies operating in water system having different competencies that are not always well defined; sometimes agencies' competencies overlap creating coordination problems in planning and management water use (AAVV, 1999) . Moreover there is a high number of agencies (several hundreds), many very small (Zucaro, 2005).In all regions, in the same areas where public agencies operate, there is individual, private water abstraction (80% of farms in some areas) (AAVV, 1999). It creates a problem because this kind of water abstraction cannot be planned and controlled by authorities.

During the last years, for both private and public irrigation, there has been the problem of increasing groundwater withdrawals. This is due to climate changes that have caused an increase of drought events with consequent water availability reduction. In the last 20 years, the area of national territory that has suffered from drought events increased from 8% to 20%. This increase creates strong worries regarding agri-environmental problems like soil salinization and loss of fertility, desertification and subsidence on coastal areas (AAVV, 1999).

The efficiency level of water use management evidences some points of backwardness, except for some specialized areas. In a world where efficiency represents the most important aim, a critical factor is the weak diffusion of water use planning. In many cases, agencies do not have a deepened knowledge of water requirements and consumptions in the areas that they manage. Control instruments are lacking and no irrigation requirement calculation methods are diffused.

Furthermore, a critical factor is represented by the pricing system. In Italy no "pricing system" exist, but a "contributive" system, often based only on the extension of the area that farmers intent to irrigate, without considering water requirement of different crops or water consumption. This system does not assure an efficient water use, pursuing water saving objective (AAVV, 1999).

Concerning the WFD, Italy has identified 8 river basin districts, out of which 2 are international sharing water courses with France to the west, Switzerland and Austria to the north and Slovenia to the east. Each of the 8 river basin districts consists of more than 1 region. Italy carries out a consultation process first on regional water protection plans (piani di tutela delle acque). This process will be followed by the consultation on the River Basin Management Plans on river basin district level (piani di gestione). Consultation on some of the regional water protection plans (piani die tutela delle acque) is ongoing or has been completed (EC, 2012).

Poland

Irrigation in Poland has supplemental character; for fields crop it is used in short periods during the growing season, only in fruit and vegetable farming irrigation is essential every year (Łabędzki 2007).

In general the main water source recommended for irrigation in Poland remains surface water, which is exempted from environmental charges provided its resources are used without any damage to the natural environment. The use of both: flowing and standing surface waters as well as ground waters, which are considered as public good belonging to the state, requires a legal permission for so-called special use of waters. The permission covers also the allowance for irrigation equipment and remains the main administrative cost for newly building irrigation installations. The permit is not required in case the installed equipment's daily performance is lower than 5 m^3. The present legal regulations do not impose detailed limitations nor thresholds for water withdrawal, however such limits describing maximal water withdrawal levels safe for the environment are estimated locally for each of the areas of water resources in which legal water withdrawal permits are issued.

The transposition of WFD regulations to Polish legislation was carried out mostly by the Act of 18 July 2001 on Water Law (OJ of 2001, No. 115, item 1229 as amended) together with the executive acts.

Furthermore, WFD is also transposed also by the Environmental Protection Law (OJ of 2001 No. 62, item 627 as amended), the Act on public water supply and public waste water collection (OJ of 2001, No. 72, item 747 as amended) and the executive acts to these regulations (www.rdw.org.pl).(Polish Env. Prot. Law, 2001; Polish Water Law, 2001a,b,c)

In the case of the agricultural sector in Poland, the legal principles indicated in the WFD, "the polluter pays" and "the user pays", are not yet fully implemented. The withdrawal of surface water for agricultural irrigations are exempted from environmental charges. There are however two major cost sources bound to agricultural irrigation:

- environmental costs associated with the use of ground water for irrigation;
- infrastructural costs.

The farmers are obliged to report their water withdrawal amounts and undergo controls by the state agency – the Inspection for the Environment Protection. The rate of environmental charge for ground water withdrawal is established on annual basis by the Minister of the Environment and is continuously raising.

The infrastructural costs of irrigation are hard to estimate. The charges are paid on an annual basis and spend for maintenance of melioration infrastructure: drainage as well as subsurface infiltration irrigation, which was hitherto dominant form of irrigation on permanent grasslands.

Serbia

In the Republic of Serbia new water law was adopted in the National Assembly in 2010(Serbian Water Law, 2010). The new act came into power in May of 2011. Due to many laws that were recently adopted and are in accordance with the EU legislation, the actual implementation of these laws is somewhat behind the planned schedule. The same applies to the water law, which is in accordance with the EU WFD, but the supporting documents and actions are not fully completed yet.

Serbia officially has two provinces Vojvodina and Kosovo&Metohija. The third part is so called "inner" Serbia which is officially not a province. The way it works in the real life is that some territories have provincial government and government bodies, while others have only republic governmental bodies. The province of Vojvodina is the most important for agricultural crop production since majority of its territory is flat with arable land and climate that allows extensive agriculture. There are no centralized data, but according to the available information it can be said that most if not all of the irrigation is taking place in the province of Vojvodina.

Currently, it can be noticed that there are two irrigation water charges options. One is applied when there are no water meters, and then the flat rate of approximately 6 Euros per ha is charged to the users regardless of the used amounts. If the there is a water meter the charge is related to the actual consumption and is charged 0.001 Euro per cubic meter of used water.

All irrigation water goes through governmental (public) companies. The source is only surface water. Potentially some small farmers can use ground water and have to report their use to these public companies in order to be allowed this use and to be properly charged for the use of water.

Orum et al. (2010), who analyzed the economics of potato irrigation in Serbia, concluded that water-saving technologies were not yet profitable, due to the low marginal price for water. They pointed out that In Serbia, more water is available for irrigation than is actually utilized by farmers. Therefore, maintenance and investments in infrastructure canals and dams) and irrigation systems may be more important than technologies for optimizing water use. Quotas and high taxes on water could provide an incentive for farmers to adopt irrigation water technologies. On the other hand, this may also lead farmers to switch from high-value irrigated crops to rainfed crops or pastures.

Turkey

Tanriverdi et al. (2010) published an assessment of irrigation schemes in Turkey. These authors reported that since 1993, the operation of irrigation systems in Turkey has gradually been transferred from State Hydraulic Works (DSI) to Water User Associations (WUAs). Although some irrigation systems in different areas of the country have been transferred to irrigation cooperatives, municipalities, and village organizations, the government's ultimate goal is to transfer all irrigation systems to WUAs in a participatory approach. DSI in Turkey is a Government organization primarily responsible for the construction of irrigation projects. It is organized into 25 SHW regional directorates. DSI does not only construct but also administered irrigation projects. The financial cost of the DSI to Government has also increased over time. By transferring the responsibility for irrigation systems, the Government ought to ensure the continuity of the irrigation systems, improve performance, and reduce operation, management, and administration expenses and to ensure effective use of resources.

Cakmak (2010) has published a report on Turkey's irrigation water pricing, with the support of the OECD. The prices in Table 2 and the information below are obtained from this report. Development of water resources is under the responsibility of the state, except some privately owned small springs and waters. The use of groundwater resources (more than 10 meters below the ground) is arranged by a special law. Groundwater licenses are issued by DSI upon the request of the users for each reservoir. The licenses cover only right to use and they can neither be transferred nor sold.

Several legislations and regulations address specific issues, but they are far from forming an integrated framework for effective management of water resources. The existing laws and regulations do not provide proper definition of water rights. Extended drought periods caused full development of water resources in the western and central regions involving transfer of water from irrigation to domestic and industrial use. Large number of governmental and non-governmental organizations has direct and indirect interest in the aspects of water resources development and conservation. Institutional framework has three levels such as decision making, executive and users. Prime Ministry, State Planning Organization and ministries are at the decision making level. Governmental organizations under the ministries are at the executive level. Following the abolishment of General Directorate of Rural Services (GDRS), State Hydraulic Works (DSI) is left as the sole central agency for irrigation development. The responsibilities GDRS have been decentralized and transferred to Special Provincial Administrations. The impact of this transfer to local level on the irrigation development is yet to be seen. Village legal entities, municipalities, associations and cooperatives are the organizations at the water users level for the operation and maintenance of the projects. Any one of these legal entities may be used depending on the size of irrigation schemes and preference of the farmers. Users' organizations are responsible for O&M of irrigation transferred schemes according to the transfer agreement signed by DSI. DSI is also responsible for the monitoring and evaluation of the O&M activities undertaken by the transferred institutions. Almost all of the total irrigated area is managed by the users' organizations. The area developed by the GDRS and farmers themselves have been managed by the farmers. The transfer of O&M of the schemes developed by DSI has been completed. The transfer of O&M has been accomplished according to the law of establishment of DSI. The users' organizations are supposed to recuperate the estimated costs of O&M and fulfill the obligations for the investment costs if the area is developed by DSI.

Concerning the irrigation water pricing, it can be concluded that there is almost no volumetric pricing system in irrigation, whereas volumetric charges are common in domestic and industrial use. The user organizations determine the water charges based on expected operation, maintenance and investment cost for the year. There are basically three major water user groups in Turkey. Irrigation associations took over the O&M responsibility of the DSI managed schemes using surface water. Irrigation cooperatives were the preferred legal entity for the transfer of the management for the irrigation facilities using groundwater. DSI collects data on several aspects of irrigation on the transferred schemes, including pricing, water use, yields and budgets of the irrigation associations. The transferred area developed by DSI makes about 60 percent of the total irrigated area in Turkey. The data on the area developed by GDRS and by the farmers are scanty. The following description of water pricing reflects the situation in the irrigation schemes developed by DSI and transferred to various water users' organizations. Irrigation organizations calculate the fee per hectare by simply dividing the expected costs of O&M expenses during the following to the total area irrigated. Depending on the heterogeneity of the crop pattern, the irrigation organizations can determine a flat fee per hectare or depending on the cultivated crop. The determined charge is expected to cover just the O&M expenditure. The expenditures on durable equipment (i.e. trucks, other equipment) are charged separately depending on farmers' area of irrigated land. Real water charges for gravity irrigation increased by almost 30 percent between 2001-06, whereas the same figure for gravity was 12 percent. As expected the disparity between gravity and pumping water charges is significant. The farmers using pumping water face 2.5 times higher water charge per hectare then the gravity water users. The schemes using pumping are usually transferred at the early phase of development. The irrigation associations are generally responsible for schemes using gravity conveyance and most of them may be considered to be at a transition phase in terms of management abilities which explains partly the high increase in real water charges. The increasing trend in real water charges is leveling off in the recent years. Water Users' Organizations (Irrigation Associations and Irrigation Cooperatives) have been satisfied in keeping up the charges with the rate of inflation.

In 2012, in order to go along with the WFD, the Turkish Ministry of Forestry and Water Works has published a draft river basin management plan (TMFW, 2012). According to this report the irrigated area was 2.3 million ha in 1970 and it has increased 2.4 times in the last 40 years to 5.5 million ha. In total there is 8.5 million ha irrigable land and 65% of it is irrigated by the end of 2011. All of the 8.5 million irrigable land is planned to be in use by the end of 2023. Currently, in general, 85 % of irrigation water is supplied from surface water. Half of this is from the dams. Open canal irrigation is the main practice but it is acknowledged in the plan to invest in less water consuming irrigation techniques such as drip irrigation.

5. Irrigation Scheduling Support Services

Some of the similar or related projects and literature are reviewed and summaries are represented concerning the irrigation advisory services.

Some notes can be presented from FAO's workshop on irrigation advisory services and participatory extension in irrigation management, 2002, Canada. A review of experiences on management responsibilities in irrigation advisory services has been provided by Smith (2002). It is mentioned that many governments have adopted policies to transfer the management of irrigation systems to the beneficiaries and farmers, as government agencies have proved unable to maintain in a sustainable manner the irrigation system. A process of management transfer has been initiated in many countries with the formation of Water Users Associations as the local organization to take over responsibility for operation and maintenance of the irrigation schemes. Tollefsan et al. (2002), for example, explained the trends of responsibilities in irrigation advisory services in Canada. Historically, the Agricultural Extension Service was the responsibility of the public sector, but more recently the private sector has become increasingly involved. Increased private sector involvement has often resulted in more rapid acceptance, higher efficiency and increased profitability. It is concluded that the public sector should also be involved, however, to ensure that the service is extended to needy farmers. Smith (2002) has also highlighted participatory irrigation management as a guiding principle with appropriate legislation put in place to facilitate the transfer process. Financial and managerial capabilities of the water users associations is however often poor, resulting in low-performance and failures. Therefore, it can be concluded from the note that the target group aimed for in the irrigation advisory services will determine to a large extent the way the process of technology adoption and transfer is taking place and the communication means selected.

The California Irrigation Management Information System (CIMIS), perhaps the eldest known web-based irrigation scheduling advice services, has also published experiences on the Role of Technology in Irrigation Advisory Services (Eching, 2002). An important issue, especially in developing countries, has been identified as technology transfer. Small farmers would most likely need considerable hand-holding by agricultural extension agents or irrigation service providers. The technology can benefit large farms that have had exposure to some level technology. As any irrigation scheduling technique, weather-based irrigation scheduling should not be use exclusively by itself, rather it should be an integral part of a comprehensive irrigation management program.

As pointed out by McCann et al (2007), the internet has enabled easy access to up-to-date weather information and evapotranspiration estimates from automated climate stations, making the use of evapotranspiration-driven water balance models for irrigation scheduling more generally applicable. Examples of online networks include CIMIS (California Irrigation management Information System, www.cimis.water.ca.gov); AGRIMET (www.usbr.gov/pn/agrimet/) in the northwest states; and AEMN (Automated Environmental Monitoring Network, www.griffin.uga.edu/aemn) in Georgia, all from the United States, and www.agric.wa.gov.au in Western Australia. Climate station networks may also include irrigation scheduling programs that can directly use the climate data, such as WISE (Washington Irrigation Scheduling Expert, www.sis.prosser.wsu.edu/wise.htm); AZSCHED (Arizona Irrigation Scheduling System, www.ag.arizona.edu/crops/irrigation/azsched/azsched.htm) and Wateright (www.wateright.org). Another approach is to use a spreadsheet, such as Kansched and KISCORN from Kansas (www.oznet.ksu.edu/mil/ToolKit.htm).

In the study of Manero (2008), funding is acknowledged as one of the major issues that planners have to deal with when looking into innovative strategies in agricultural water use efficiency. In California for example, within the CALFED Framework for Agreement it was established that the state and the federal governments would fund the implementation of water use efficiency measures at a level of 25% each, while local agencies would be responsible for the remaining 50%. It is emphasized that small and less resourceful agricultural water customers often struggle to adopt innovative water management practices and retrofit their existing irrigation systems. In such cases, local agencies are often unable to provide the required 50% funding for the designed projects. It is highlighted that, besides technical feasibility and cost-effectiveness, water use efficiency practices need to be correctly implemented and managed to achieve their maximal potential savings. Therefore, education and willingness of farmers play a key role in agricultural water efficiency programs. For example, weather-based irrigation scheduling requires additional installation and maintenance labor, as compared to time-automated systems.

A relevant example can be found in Crete, as presented by Chartzoulakis et al. (2008). This work presents the development and operation of a tele-information system for farmer's irrigation scheduling.

The defined constraints for adoption by farmers were: sociological, such as culture and irrigation tradition, formation level and age of the farmer, the presence of technicians in Farmers Associations and assurance levels and their maintenance; financial, such as high investment requirements, local and particular experimentation, staff needs; demonstration effect among farmers; diffusion (courses, congresses, talks, leaflets, etc.); and linking and collaboration with research Institutes and Universities. Integration and leadership of Farmers Associations is suggested to be absolutely necessary, along with the Regional Agricultural and Environmental Council.

An Australian project, the Irrigation water management by Satellite and SMS2 (IrriSatSMS) addresses also many of the possible new technology application obstacles particularly those of cost, complexity and communication problems (Hornbackle et al, 2009). Australian companies have turned much of the knowledge of irrigation and soil scientists such as soil moisture probes into commercial products that are now sold world-wide. However, when it comes to local adoption of soil moisture monitoring or irrigation water management techniques and practices, uptake has been surprisingly slow and low. Stirzaker (2006) has identified and described seven obstacles to adoption of soil moisture monitoring equipment in Australia, which in many ways are linked and equally applicable to overall water management and therefore ENORASIS. Based on his surveys the obstacles are summarised as:

- Importance of scheduling could not be seen due to limited data on the amount of water actually used, or the amount which should be used;
- Reliance on inherited knowledge, happiness with status quo, and entrenched culture of resistance to change;
- Little confidence that investments in improved irrigation scheduling would actually pay off;
- Structural barriers that make it harder to start and adopt;
- Concern about the complexity of tools and which ones would suit best;
- Communication and conceptual problems and differences between irrigators' and scientists' perspectives; and
- Possibly a wrong extension model.

Proposed IrriSatSMS approach is based on strong network capabilities and a modular design which provides a great deal of flexibility and a range of advantages especially when it comes to implementation. Four theoretical case studies covering a spectrum from government run to purely private sector implementations as well as hybrid or a mixed system in between were presented. Ownership, funding, maintenance, communication and management issues play an important role when considering the various implementation scenarios and may override technical imperatives.

Montoro et al (2010) has highlighted some of the practical challenges of implementing irrigation support systems. The major problem with the provision of irrigation support systems was that of adoption (Shearer and Vomocil, 1981). One reason was the lack of motivation on the part of the farmer to conserve water, but the costs of the irrigation support systems relative to the perceived benefits were an even greater barrier (Fereres, 1996). When the irrigation support systems were provided for free, the uptake of this technology was quick and increased the irrigation management skills of growers, but, in the past, when the irrigation support systems programs were discontinued due to lack of funding, they were not generally demanded by growers who were not ready to cover the costs. While the emphasis of many irrigation support systems was to conserve water, it should be noted that the primary goal for adopting new irrigation technologies is to increase yields, not to save water. In fact, the use of more efficient technologies often increases, rather than decreases, water consumption (Whittlesey 2003; English et al., 2002). A recent survey undertaken in Alberta (Canada) to determine the uptake of improved irrigation technologies and management practices showed that the major drivers of adoption were to ensure water supply during droughts, to increase crop yields and quality, and to reduce costs, while the major impediments were related to financial constraints (Bjornlund et al., 2009).

6. Irrigation Stakeholders, Practices and Opportunities in ENORASIS countries

Information collected by the partners in Cyprus, France, Greece, Italia, Poland, Serbia and Switzerland, through websites, reports and interviews provides insights in the role and characteristics of the different people and organization that could play a role in the implementation and use of ENORASIS systems in the different countries.

Irrigation Water Supply Services

Irrigation water supply could be provided and controlled by different entities. This affects the cost of the water, and thereby also the incentive to increase no-farm irrigation water use efficiency, and also to a certain extent the control over the availability of the resource. Three options occurred in the analyzed countries:

a. Government water supply authority
b. Farmer water user association
c. Individual farmers, pumping their own water

In Cyprus a large part of the water is supplied through the Government Irrigation System, but still many farmers pump groundwater while a small number of farmers divert water from streams, a few smaller supply systems are managed by water user associations. In France all three options exist. In Greece the irrigation water supply entity depends on the region. Communal water supply (water user associations) seems to be the most common irrigation water supply mode. This is also the case in the Vojvodina province in Serbia. In Mazowieckie and Łódzkie region in Poland, where they have irrigated orchards, farmers pump groundwater, while there is also communal water supply. In the Veneto region in Italy water is supplied by the government, while in Piemonte e Lombardia and Est Sesia water supply is managed by water user associations. In Unteres Aaretal in Switzerland there is both government water and individual farm supply. No commercial irrigation water suppliers were encountered in these countries.
The majority of the individual water users pump their water from groundwater wells, except for Serbia, Basin 3 and 4 in Greece, Puglia (Cons. Bon. Stornara e Tara - Taranto and Bari) and Serbia.

Meteorological observations

Meteorological stations and rain gauges can be used to update soil water balances for computing irrigation requirements. These stations are managed by various organizations in the different countries and regions, although government meteorological organizations and in some regions also agricultural research and extension services were the most common. The management of a meteorological and rain station by commercial irrigation support service occurred only in Switzerland. Farmer organizations were found to manage a rain gauge in Serbia and in meteo station in Piemonte region in Italy. In none of the surveyed regions or countries did a commercial water supply company manage meteorological stations.

Weather Forecasting Services

In most regions and countries, weather services are provided by the Government. But these Government organizations are often not flexible enough to expand or improve their services. In Greece and Poland the Agricultural Research and Extension Services also provided weather forecasting services. In Switzerland there was also a commercial irrigation support service providing weather forecasts.

Two of our ENORASIS University partners are running weather forecasting services in an operational mode. So this option should probably also be explored a little further.

Some of web-based weather forecasting services provide weather data that can be downloaded in various formats. Our colleagues in the WaterBee project (http://www.waterbee.eu/) are making use of global web-based weather services (e-mail exchange with (John J O'Flaherty, 22-23 April 2012). They have found www.worldweatheronline.com to be stable, reliable, global and free. However, the website provide almost no technical information on the data and models used for the weather forecasts. The www.accuweather.com looks scientifically more solid, and its premium or platinum services looks interesting. The WaterBee project has also looked into using the Google API, but found it technically not stable enough yet for their service's needs, see http://googleweather.riaforge.org/. An interesting list of Weather APIs can be found at http://www.programmableweb.com/apis/directory/1?apicat=Weather. It could be useful to look into the quality and coverage of these different services.

Irrigation support services

The Adour-Garonne Water Agency in France gives some funds to state bodies and associations (Chambre d'Agriculture, CACG) so they can provide a decision support aid on irrigation to about 70% of the irrigation users. This service has been evaluated to cost 50 euro per user and per year. This service has allowed a 10% decrease in the volumes used (Hembury, 2012). The Water Agency of Adour Garonne also finances some diagnoses on irrigation equipment or collective irrigation. These diagnoses can either be achieved by private companies with authorizations or by someone chosen and paid by the Water Agency. (Hembury, 2012).

In Italy, a new web-based irrigation scheduling support service has started operating in January 2012, in seven regions, covering nearly half of the country (http://www.irriframe.it/irriframe). The website is hosted by the Associazione Nazionale delle Bonifiche delle Irrigazioni e dei Miglioramenti Fondiari. The tool has currently 1800 subscribers (farmers, irrigation technicians). Farmers register coordinates, type of corps, type of irrigation system, piezometer and pluviometer if available. Advice (daily mm of water required) is given based on water balance and evapotranspiration calculations for specified crops. If a piezometer is available (initial) water table will be taken into account. Climate data is provided to Irriframe by the irrigation consortia. The tool does not take into account weather forecasts. Famers are advised to evaluate and take into account weather forecasts. Farmers receive an sms with the daily required water needs. Farmers have been encouraged to sign up for a newly established web-based irrigation scheduling support service to show that they follow good agricultural practices, as a required for receiving CAP support.

In Poland agricultural companies are making use of SMS to provide farmers with information on the management of pests and diseases. This indicates that there are opportunities for expanding this kind of mobile agricultural support services.

Some of the analyzed countries are characterized by many small farms and often also older farm holders. These farmers could be less inclined to invest in advanced irrigation scheduling Thus, cooperative agreements and additional support may be needed. The Eurostat farm structure survey also indicate that Cyprus, Greece, Malta, Poland and Romania have a large percentage of small farms (more than 50% of the utilized agricultural area is occupied with holdings with less than 20 ha) (Martins and Tosstorff, 2011). These numbers should be considered indicative though, because they do not distinguish between crop farms and livestock farms, whereas the last group could cover either large areas of pastures or small areas with intensive animal housing units.

7. Conclusions

We can conclude from the literature and the information collected by the partners is the different regions and countries that the situation in the irrigation sector is very diverse. Thus, it would be preferred to develop ENORAIS as a flexible modular system that could be managed by various government or commercial entities.

Various support measures in the CAP support investments in irrigation infrastructure and systems, but also the establishment of small enterprises and producer organizations, which could either provide or cooperatively support irrigation support services.

Irrigation advisory services are already in place in parts of Spain, France (Adour-Garonne) and as of January 2012 also in Italy. It is important to consider these systems and developments to avoid unnecessary competition. The situation in Poland serves as an excellent example of a country where new investments in irrigation are currently being made and new irrigation support services could play an important role. The development and implementation of water prices for agriculture as required by the WFD is clearly not yet in place in all countries. However, the European Commission is taking non-compliance with the WFD serious and has been sending the countries reasoned opinions, followed by referrals to the European Court. Thus, increases in the cost of irrigation, which could serve as an incentive for investing in support services that make irrigation more productive, could be expected in the near future.

8. References

AAVV. 1999. Un futuro per l'acqua in Italia, Istituto di Ricerca sulle Acque del Consiglio Nazionale delle Ricerche

Agence de l'Eau Adour Garonne, 2007. Quelles stratégies d'action pour les structures collectives d'irrigation en Midi-Pyrénées ?; p.23-28 (in French)

Amigues J.-P. and Thomas A., 2006. Usages agricoles et resource en eau; Sécheresse et Agriculture, chap. 1.2. INRA 2006, p. 130-135 and 163-168 (in French)

Bjornlund H., Nicol L., Klein KK. 2009. The adoption of improved irrigation technology and management practices-a study of two irrigation districts in Alberta, Canada. Agric Water Manage 96:121–131

Brun A., Lasserre F. and Bureau J.-C., 2006. Mise en perspective compare du développement de l'irrigation aux Etats-Unis et en France ; Géocarrefour, vol. 81/1 (in French); published online on September the 1st 2009. http://geocarrefour.revues.org/1701 [Accessed 29 Mar 2012].

Cakmak, E. H. 2010. Agricultural Water Pricing: Turkey. MTU. Middle East Technical University in Ankara. Background reports supporting the OECD study. Sustainable Management of Water Resources in Agriculture. http://www.oecd.org/water [Accessed 29 May 2012].

CEMAGREF, 2004. Les structures tarifaires des petits réseaux collectifs d'irrigation, Méthodologie et test sur le bassin Loire-Bretagne ; December 2004, p. 1-5 (in French)

Chartzoulakis K., I. Kasapakis, I. Tzobanoglou. *2008.* Improving water efficiency: The irrigation advisory service of Crete, Greece. The 3rd International Conference on Water resources and Arid Environments and the 1st Arab Water Forum. NAGREF-Institute for Olive Tree and Subtropical Plants, Dept. of Irrigation and Water Resources, Crete, Greece.
http://faculty.ksu.edu.sa/72005/Papers%20of%20Interest%20Water/Improving%20water%20efficiency%20The%20irrigation%20advisory.pdf [Accessed 24 Apr. 2012]

Eching S. 2002. Role of technology in irrigation advisory services: the CIMIS experience. In: Proceeding of workshop on irrigation advisory services and participatory extension in irrigation management. FAO-ICID, Montreal, pp 1–12

English M, Solomon K, Hoffman G. 2002. A paradigm shift in irrigation management. J Irrig Drain E-ASCE, pp 267–277

European Commission (EC). 2003. Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document 11. Planning Process. Working Group 2.9. European Communities, 2003, Luxembourg.

European Commission (EC). 2000a. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy. Official Journal of the European Communities L 327/1.

European Commission (EC). 2000b. Pricing policies for enhancing the sustainability of water resources. Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee, 26.07.2000 COM(2000), 477 final report, Brussels.

EC. 2011a. Environment: Commission asks Germany to apply cost recovery obligations to all water services. Press release, 29/09/2011.
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/1101&format=HTML&aged=0&language=EN&guiLanguage=en [Accessed Mar 2012]

EC. 2011b. Environment: Commission asks Belgium, Denmark, Finland and Sweden to recover costs of all water services. Press release, 27/10/2011.
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/1264&format=HTML&aged=0&language=EN&guiLanguage=en [Accessed Mar 2012]

EC. 2011c. Environment: Commission asks Ireland to recover costs of all water services. Press release, 24/11/2011.
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/1433&format=HTML&aged=1&language=EN&guiLanguage=en [Accessed Mar 2012]

EC. 2011d. Environment: Commission urges Spain to complete legislation for river basin management plans. Press release, 29/09/2011.
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/1105&format=HTML&aged=0&language=EN&guiLanguage=en [Accessed Mar 2012]

European Commission (EC). 2012. River Basin Management Plans 2009-2015 - information on availability by country. http://ec.europa.eu/environment/water/participation/map_mc/map.htm [Accessed 01 Mar. 2012]

European Environmental Agency (EEA). 2010. Water resources: quantity and flows In: The European environment — state and outlook 2010, State of the environment report (SOER), EEA, Kopenhagen. http://www.eea.europa.eu/soer/europe/water-resources-quantity-and-flows

European Parliament and Council (EPC),2007."Presidential Decree 51. "Defining measures and procedures for integrated screen protection and water management in compliance with the provisions of the Directive 2000/60/EC 'on the framework for Community action in water policy' of October 23 2000" (In Greek) Athens, Greece
http://www.ypeka.gr/LinkClick.aspx?fileticket=5fyCnT46Wg8%3D&tabid=248&language=el-GR [Accessed Mar. 2012]

Fereres E. 1996. Irrigation scheduling and its impact on the 21st century. In: Camp CR, Sadler EJ, Yoder RE (eds) Proceedings of the international conference on evapotranspiration and irrigation scheduling. ASAE, San Antonio, pp 547–553

Food and Agriculture Organization of the United Nations (FAO). 2011. The state of the world's land and water resources for food and agriculture (SOLAW) - Managing systems at risk. FAO, Rome and Earthscan, London.

Greek Ministry of Environment Energy and Climate change (GMEECC), 2003. Law 3199/2003, "Protection and water management-Compliance with Directive 2000/60/EC of the European Parliament and Council of the 23rd October 2000" (In Greek) Athens, Greece
http://www.ypeka.gr/LinkClick.aspx?fileticket=1RobHrsUDLY%3D&tabid=246&language=el-GR [Accessed Mar. 2012]

Heinz, I. 2008. Co-operative agreements and the EU Water Framework Directive in conjunction with the Common Agricultural Policy. Hydrol. Earth Syst. Sci., 12: 715-726.

Hembury, A. 2012. ENORASIS T2.1/T1.2/T2.2-partly: OPPORTUNITIES, BUSINESS MODELS, AND USER REQUIREMENTS. Noveltis, France.

Hornbuckle, J. W., J. N. Car, E. W. Christen, M. Stein, B.Williamson. 2009. IrriSatSMS. Irrigation water management by satellite and SMS - An utilisation framework. Cooperative Research Centre for Irrigation Futures Griffith, NSW, Australia. Technical Report No. 01/09, CSIRO Land and Water Science Report No. 04/09. http://www.irrigateway.net/publications/irrisatsms_v_60_finalwAppendix.pdf [Accessed 24 Apr. 2012]

Łabędzki L. 2007. Irrigation in Poland – current status after reforms in agriculture and future development, J. Water Land Dev. 11: 3-16.

Manero, A. 2008. Comparative water management practices in California and Spain. Minor thesis, Technical University of Cataluña. http://hdl.handle.net/2099.1/6053 [Accessed 24 Apr. 2012]

Martins, C and G. Tosstorff. 2011. Large farms in Europe - Issue number 18/2011, Eurostat, Luxembourg. http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/publications

McCann, I., A. Bruggeman, T. Oweis, and M. Pala. 2008. Modification of the FAO-56 spreadsheet program for scheduling supplemental irrigation of winter crops in a Mediterranean climate. Applied Eng. Agric., 24(2): 203-214.

Ministry of Agriculture, Natural Resources and Environment,Cyprus (MANRE). 2010. Water Framework Directive, Reporting sheets on economics. Nicosia, Cyprus.
http://www.moa.gov.cy/moa/wdd/wdd.nsf/all/11E4F13527A4185BC22578BD002FAB66/$file/EU-summary_Economics-FINAL%201.pdf?openelement (accessed 21 Mar. 2012)

Mohaupt, V. G. Crosnier, R. Todd, P. Petersen, and T. Dworak. 2007. WFD and agriculture activity of the EU: first linkages between the CAP and the WFD at EU level. Water Science and Technologies, 56(1): 163-170.

Montoro, A., P. López-Fuster, and E. Fereres. 2011. Improving on-farm water management through an irrigation scheduling service. Irrigation Science 29(4): 311-319.

Orum, J. E., Boesen, M. V. Jovanovic, Z., Pedersen, S. M., 2010. Farmers' incentives to save water with new irrigation systems and water taxation—A case study of Serbian potato production. Agricultural Water Management 98: 465–471.

Polish Environmental Protection Law. 2001 (Prawo Ochrony Środowiska; Dz. U. nr 62, poz. 627 z 27 kwietnia 2001r).

Polish Water Law. 2001a. The Act of 18 July 2001 on Water Law (OJ of 2001 No. 115, item 1229 as amended)

Polis Water Law. 2001b. The Act of 27 April 2001 on Environmental Protection (OJ of 2001 No. 62, item 627 as amended)

Polish Water Law. 2001c.The Act of 7 June 2001 on public water supply and public wastewater collection (OJ of 2001 No. 72, item 747 as amended)

Rivière-Honegger A., 2004. La gestion de l'eau par les associations de propriétaires fonciers. Méthodologie pour un inventaire régional ; in RUF Th., RIVIERE-HONEGGER A., « La gestion sociale de l'eau, concepts, méthodes et applications », Territoires en mutation, n° 14, 20 p. (in French)

Serbian Water Law. 2010 (in Serbian). http://www.vodevojvodine.com/img/story_file_137zakon-o-vodama_OR.pdf

Shearer, M.N., and J. Vomocil.1981. Twenty-five years of modern irrigation scheduling promotional efforts. In: Phene CJ, Stegman EC (eds) Proceedings of an irrigation scheduling conference on irrigation scheduling for water and energy conservation in the 1980s. ASAE, Chicago, pp 208–212

Smith M., G. Muñoz. 2002. ICID Irrigation Advisory Services For Effective Water Use: A Review of Experiences. Irrigation Advisory Services and Participatory Extension in Irrigation Management Workshop, organised by FAO Montreal, Canada. http://www.fao.org/nr/water/docs/ias/paper9.pdf [Accessed 24 Apr. 2012]

Special Secretariat for Water (SSW). 2008. Implementation of the financial aspects of article 5 of EC Directive about water 2000/60/EC in Greece, Athens, Greece (In Greek) http://www.circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/wfd_reports/member_states/greece/article_5/economic_analysis/economic_270308pdf/_EN_1.0_&a=d [Accessed Mar. 2012]

Stirzaker, R. 2006. Soil moisture monitoring: state of play and barriers to adoption. CRC for Irrigation Futures, Irrigation Matters Series No. 01/06, 27 pp.

Tanriverdi C., Degirmenci, H., Sesveren, S., 2010. Assessment of irrigation schemes in Turkey based on management types. African Journal of Biotechnology, 10(11): 1997-2004.

Tollefson L. C., D. Tomasiewicz, J. Linsley, B. Paterson, and R. Hohm. 2002. ICID Irrigation Advisory Services (A Canadian Model)). Irrigation Advisory Services and Participatory Extension in Irrigation Management Workshop, organised by FAO Montreal, Canada.
http://www.fao.org/nr/water/docs/ias/paper5.pdf [Accessed 24 Apr. 2012]

Turkish Ministry of Forestry and Water Works (TMFW) (in Turkish), 2012. Draft river basin management plan. http://www.cem.gov.tr/erozyon/Files/ulusalhavza2.pdf [Accessed 30 May 2012]

Water Development Department, Cyprus (WDD). 2004. Water protection and management law of 2004 (L. 3(I)/2004). Nicosia, Cyprus. (In Greek.)
http://www.moa.gov.cy/moa/wdd/wdd.nsf/legislation_en/legislation_en?OpenDocument [Accessed Mar. 2012]

Water Development Department, Cyprus (WDD). 2009. Annual report (English summary). http://www.moa.gov.cy/moa/wdd/Wdd.nsf/annualrpt_en/annualrpt_en?OpenDocument [Accessed Mar. 2012]

Water Development Department, Cyprus (WDD). 2010a. Integrated water management law of 2010 (L.79 (I)/2010), Nicosia, Cyprus. (In Greek.)
http://www.moa.gov.cy/moa/wdd/wdd.nsf/legislation_en/legislation_en?OpenDocument [Accessed Mar. 2012]

Water Development Department, Cyprus (WDD). 2010b. Cost assessment pricing of water services in Cyprus, Summary. March 2010.
http://www.moa.gov.cy/moa/wdd/wdd.nsf/all/976F9C1E98086281C22578E2002B9D1B/$file/SUMMARY.pdf?openelement [Accessed Mar. 2012]

Water Development Department, Cyprus (WDD). 2011a. Cyprus River Basin Management Plan. WDD, Ministry of Agriculture, Natural Resources and Environment, Nicosia, Cyprus.
http://www.moa.gov.cy/moa/wdd/wdd.nsf/all/1AE1F4E1B33E432CC22578AF002C0E71/$file/RBMP_EN.pdf?openelement [Accessed Mar. 2012]

Water Development Department, Cyprus (WDD). 2011b. Water Framework Directive, Article 11, 13, 15. Annex I: Detailed River Basin Management Plan. (In Greek). Nicosia, Cyprus.
http://www.moa.gov.cy/moa/wdd/Wdd.nsf/all/1AE1F4E1B33E432CC22578AF002C0E71/$file/ANNEX-I_low.pdf?openelement [Accessed Mar. 2012]

Water District of Western Peloponnese (GR01). 2011a. Intermediate phase 1, Deliverable 3, Economic analysis of water uses and identification of the current level of cost recovery for water services. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/52508927/KeimenaTekmiriosis/Paradoteo_3_YD01.pdf [Accessed Mar. 2012]

Water District of Western Peloponnese (GR01). 2011b. Intermediate phase 1, Deliverable 4, preliminary analysis of alternative proposals for flexible pricing policy. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/52508927/KeimenaTekmiriosis/Paradoteo_4_YD01.pdf [Accessed Mar. 2012]

Water District of Northern Peloponnese (GR02). 2011a. Intermediate phase 1, Deliverable 3, Economic analysis of water uses and identification of the current level of cost recovery for water services. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/52514924/KeimenaTekmiriosis/Paradoteo_3_YD02.pdf [Accessed Mar. 2012]

Water District of Northern Peloponnese (GR02). 2011b. Intermediate phase 1, Deliverable 4, "Preliminary analysis of alternative proposals for flexible pricing policy (In Greek). Athens, Greece http://dl.dropbox.com/u/52514924/KeimenaTekmiriosis/Paradoteo_4_YD02.pdf [Accessed Mar. 2012]

Water District of Eastern Peloponnese (GR03). 2011a. Intermediate phase 1, Deliverable 3, Economic analysis of water uses and identification of the current level of cost recovery for water services. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/52511356/KeimenaTekmiriosis/Paradoteo_3_YD03.pdf [Accessed Mar. 2012]

Water District of Eastern Peloponnese (GR03). 2011b. Intermediate phase 1, Deliverable 4, "Preliminary analysis of alternative proposals for flexible pricing policy. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/52511356/KeimenaTekmiriosis/Paradoteo_4_YD03.pdf [Accessed Mar. 2012]

Water District of Western Central Greece (GR04) 2011a. Intermediate phase 1, Deliverable 3, Economic analysis of water uses and identification of the current level of cost recovery for water services. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/50948065/GR04_v18-11-2011/3-4/3o_Paradoteo_GR04_v18-11-2011.pdf [Accessed Mar. 2012]

Water District of Western Central Greece (GR04).2011b. Intermediate phase 1, Deliverable 4, Preliminary analysis of alternative proposals for flexible pricing policy. Athens, Greece. (In Greek).
http://dl.dropbox.com/u/50948065/GR04_v18-11-2011/4-4/4_Paradoteo_GR04_v18-11-2011.pdf [Accessed Mar. 2012]

Water District of Epirus (GR05). 2011a. Intermediate phase 1, Deliverable 3, "Economic analysis of water uses and identification of the current level of cost recovery for water services" Athens, Greece. (In Greek)
http://dl.dropbox.com/u/50953375/GR05/3-5/3o_Paradoteo_GR05_v18-11-2011.pdf [Accessed Mar. 2012]

Water District of Epirus (GR05). 2011b. Intermediate phase 1, Deliverable 4, Preliminary analysis of alternative proposals for flexible pricing policy. Athens, Greece. " (In Greek)
http://dl.dropbox.com/u/50953375/GR05/4-5/4o_Paradoteo_GR05_v18-11-2011.pdf [Accessed Mar. 2012]

Water District of Thessaly (GR08). 2011a. Intermediate phase 1, Deliverable 3, Economic analysis of water uses and identification of the current level of cost recovery for water services. Athens, Greece. (In Greek) http://dl.dropbox.com/u/50959275/GR08_v18-11-2011/%CE%A0_3-8/3o_paradoteo_GR08_v18-11-2011.pdf [Accessed Mar. 2012]

Water District of Thessaly (GR08). 2011b. Intermediate phase 1, Deliverable 4, Preliminary analysis of alternative proposals for flexible pricing policy. Athens, Greece. (In Greek)
http://dl.dropbox.com/u/50959275/GR08_v18-11-2011/%CE%A0_4-8/4o_paradoteo_GR08_v18-11-2011.pdf [Accessed Mar. 2012]

Whittlesey, N. 2003. Improving irrigation efficiency though technological adoption: when will it conserve water? In: Alsharhan AS, Wood WW (eds) Water resources perspectives: evaluation, management and policy. Elsevier Science, Amsterdam, pp 53–62

Zucaro, R, 2005. Italian policy framework for water in agriculture. OECD workshop on agriculture and water: Sustainability, market and policies. Session 5. Information on the Workshop is accessible though the OECD Password Protected website at: http://www.oecd.org/agr/env [Accessed 29 May 2012]