Agricultural water saving in Greece

Karamanos A., Dercas N., Londra P., Aggelides S.

in

Lamaddalena N. (ed.), Bogliotti C. (ed.), Todorovic M. (ed.), Scardigno A. (ed.).
Water saving in Mediterranean agriculture and future research needs [Vol. 3]

Bari : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 56 Vol.III

2007
pages 225-234

AGRICULTURAL WATER SAVING IN GREECE

A. Karamanos *, N. Dercas, P. Londra ** and S. Aggelides ****
***** Laboratory of Crop Production, Agricultural University of Athens, 75 Iera Odos,
11855 Botani**c**os, Greece. E-mail: akaram@aua.gr
** Laboratory of Agricultural Hydraulics, Agricultural University of Athens, 75 Iera Odos,
11855 Botanicos, Greece. E-mail: ags@aua.gr, ndercas1@aua.gr and v.londra@aua.gr

SUMMARY - In Greece 83% of the water resources are used in the agricultural sector. Due to the huge quantities used, an effort for saving water in this sector can contribute greatly to the water balance. Such effort should concern all levels from the resource to the system supply and up to the consumption. The water resources can be increased using dams and off-stream reservoirs, techniques that increase infiltration, as well as using non-conventional water. At the same time the conveyance and distribution systems can be considerably improved in order to reduce the water losses and introduce a more effective management. The farmers should use irrigation techniques allowing a better use efficiency. Finally the water pricing policy should encourage environmentally responsible water use behaviour as well as help to ensure an adequate supply of water. It is necessary to reorganize the water management system especially after the harmonization of the Greek water legislation to the EU Directive 2000/60 in order to introduce a system, which will be more flexible and effective than the previous one. Also, a campaign of information is necessary in order to present the benefits of water saving and call the farmers to participate in the collective effort for sustainable water use.

Key words: Water saving, irrigation systems, water supply, water consumption, Directive 2000/60.

RESUME*: En Grèce le 83% des ressources hydriques est utilisé dans le secteur agricole. A cause des quantités énormes qui sont utilisées, un effort d'économiser de l'eau dans ce secteur peut influencer fortement le bilan hydrique. Un tel effort doit concerner tous les niveaux, de la ressource d'eau au système d'approvisionnement et jusqu'à la consommation. Les ressources en eau peuvent être augmentées en construisant des barrages et des réservoirs, en utilisant des techniques qui augmentent l'infiltration ainsi que de l'eau non-conventionnelle. En même temps les réseaux de transport et de distribution d'eau peuvent être améliorés pour diminuer les pertes et introduire une meilleure gestion. Finalement la politique des prix d'eau peut encourager un comportement plus responsable au niveau environnemental et assurer un approvisionnement adéquat en eau. Il est nécessaire de réorganiser le système de gestion d'eau surtout suite à l'harmonisation de la législation Grècque à la Directive 2000/60 afin d'introduire un système qui sera plus flexible et efficace par rapport au système précédent. En plus une campagne d'information est nécessaire afin de présenter les avantages de l'économie d'eau et appeler les agriculteurs à participer à l'effort collectif de l'utilisation durable de l'eau.*

Mots clés*: Economie d'eau, systèmes d'irrigation, approvisionnement en eau, consommation d'eau, Directive 2000/60*

INTRODUCTION

The irrigated land in Greece covers an area of 1,430,000 ha and the annual water consumption has been estimated at 8.2 km^3/year, most of which are used in agriculture (83%), whereas the domestic, industrial and other uses are 13%, 2% and 2% respectively. Public networks serve approximately 40% of the irrigated area and 60% is supplied by private networks. The increasing demand for water cannot always be met despite adequate precipitation. Water imbalance is often experienced, especially in the coastal and southeastern regions, due to the spatial and temporal variations of precipitation and as a result of increasing water demand during the summer period. So, it

is needed to adopt water saving techniques and strategies based on the institutional frame of the Water Framework Directive 2000/60 and the Common Agricultural Policy of the European Union.

WATER SAVING IN AGRICULTURE

In order to save water in agriculture action must be taken both in the field of supply and consumption. Concerning supply, the improvement of the networks will allow the reduction of water losses. In addition, the development of infrastructure in order to store the winter runoff, to recharge the ground water aquifers and to harvest water will allow face the problem of restricted water resources in many areas.

Concerning consumption, the irrigation and the cultural techniques improvement, the use of non conventional water e.g. treated waste water, the introduction of plants with less water needs, the plant improvement using the breeding techniques, application of deficit irrigation, will allow to reduce the water consumption or to increase the water use efficiency.

Furthermore practices at farm level and at river basin levels, which increase infiltration, affect positively the water balance and finally save water. Also, measures improving the education of farmers as well as measures promoting the introduction of plants with low water needs or plants with high water use efficiency will have a positive effect on water consumption.

Water saving technologies with regard to supply

Improvement of conveyance and distribution systems

The conveyance and distribution of agricultural water are carried out using open channels, pipelines or a combination system of open channels and pipelines. In general for the big flow rates open channels are used in order to reduce the cost. In both situations (conveyance and distribution) the problem of water losses arises; in the case of open channels there is evaporation, infiltration (earth channels) and leakage (lined channels), while in the case of pipelines the losses are due to breaks and leakage.

In order to improve the stability and the hydraulics characteristics of the channels and diminish the losses very often are lined. The agricultural pipeline networks present also losses, but they are lower than those of the open channels network.

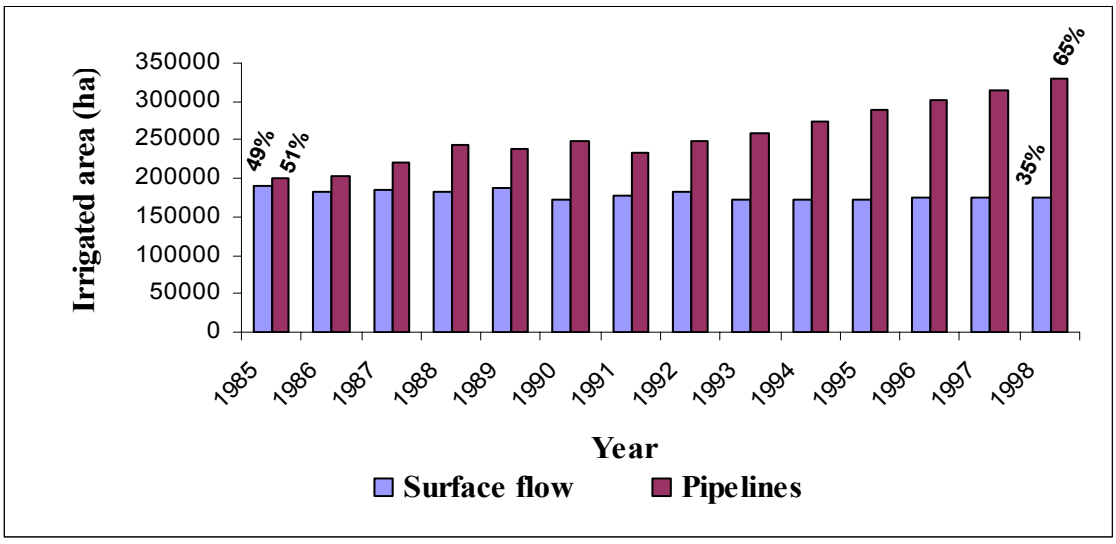

Fig. 1. Conveyance and distribution of irrigation water in public networks.

In Greece in order to reduce the water losses, the conveyance and distribution of irrigation water tend to be carried out more efficiently using pipelines instead of surface flow (Figs 1 and 2).

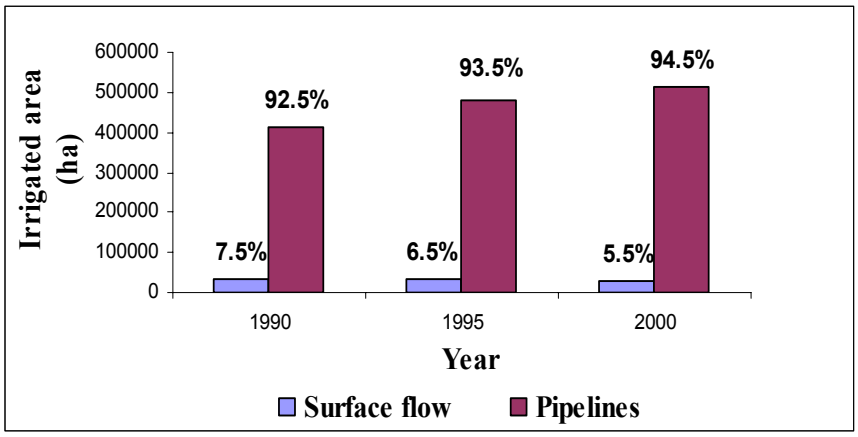

Fig. 2. Conveyance and distribution of irrigation water in private networks.

Construction of reservoirs for water saving in irrigation districts or regions

In countries like Greece with strong rainfalls, especially during the winter period, very few summer precipitations and topography characterized by high inclinations, it is essential to develop the necessary infrastructure for collecting the runoff (dams and off-stream water reservoirs). The Ministry of Agriculture has created 39 dams and off-stream reservoirs mainly in the islands that are used for domestic and agricultural purposes. This infrastructure has boosted agriculture and tourism in these regions.

Water harvesting

The techniques related to water harvesting in Greece can be divided into the following categories: a) Structures which harvest runoff from ground surfaces. These are micro catchments (contour earth bands) constructed for irrigation of olive trees. The same approach can be found in agricultural areas where the runoff of sloppy artificially impermeable surfaces is collected in citterns and is used for cattle breeding. b) Structures, which harvest the rain from the roofs and ground surfaces and deposit water in rainwater tanks of a capacity 50-500 m^3, for domestic use and vegetable production in Aegean islands and Crete. c) Techniques which collect discharge by diverting the ephemeral water sources and spreading within irrigation channels for olive trees (area of Amfissa).

Recharge of underground aquifers

Many aquifers suffer from over-pumping conditions, which result to the decrease of the underground water table. In addition, due to the very long Greek coastline the above-mentioned problem is aggravated with a sea intrusion effect. In order to face this problem it is necessary to control the excess of pumping and to recharge artificially the aquifers. In Greece, recharging has been applied in the region of Argos, East Peloponnesus, in 2000ha with very good results. Recharge takes place during winter. Following this technique the water quantity of the aquifers is increased and the quality is improved. Such plants cannot be made by individual farmers as large investments are needed.

Non-conventional water use

An alternative plan for saving water could include the use of non-conventional water resources such as the reclaimed wastewater originating from the wastewater treatment plants. This alternative

water use may provide sufficient water for irrigation, in order to prevent water shortage as well as intrusion of the pollution loads to the sea, rivers and lakes.

Greece has complied with the EU 91/271 Directive concerning urban wastewater treatment. Thus in the year 2002 more than 350 Municipal Wastewater Treatment Plants (MWTP) could serve about 65% of the country's population (Angelakis et. al. 2002). As a member of the EU, it was required to connect all agglomerations at sensitive areas with population more than 2000 to MWTP, by the end of 2005 (Tsagarakis, et. *al*. 2004). There are several MWTPs where effluents are used for direct irrigation of agricultural land (Tsagarakis et al., 2004). By reusing the effluent of the existing MWTPs, the reused water, particularly for irrigation of agricultural land, can be increased by 3.2% of the current total use of freshwater. Thus, the freshwater that is currently used for irrigation can be saved. This percentage will be substantially increased as the number of MWTPs increases.

Additionally, desalination systems based on renewable energy are used in some islands of the Aegean Sea. While agriculture provides the living basis for most of the rural population, tourism carries hopes for significantly increasing wealth and employment in the island. Therefore the water competition between the two sectors increases the demand of water. Using desalination water initiative will help overcome this water competition (MedWater Policy, 2003). The water from desalination is mainly used for domestic and tourist purposes. In the future, when the cost will be lower it would be feasible to use this water for irrigation purposes.

Also, brackish water can be used under certain circumstances. A good example is the use of brackish water mixed with fresh water and used in lemon orchards near to Poros island.

Prices policy

Water resources must be valued to reflect its status as a scarce resource, instead of being treated as a free or nearly free resource. As the Organization for Economic Cooperation and Development points out, proper pricing policies can encourage environmentally responsible water use behaviour as well as help to insure an adequate supply of water. To accomplish this, water should be valued appropriately in each of its various uses. The introduction of water markets and pricing mechanisms can have an immediate and lasting impact on water use.

The agricultural water in Greece is undervalued. Water, as a resource, is not priced at its economic value. As a result of this fact, the water consumed exceeds the needs of the users. Consumptions about 10,000 m^3/ha are usual. Data from relevant research pointed out that the effective (actual) needs of the crops do not exceed the 5,000 m^3/ha. Therefore, losses exceed 50% (SCP-GERSAR / Hydrosystem, 1997).

The pricing of water is usually based on the size of the parcel. This method is in a way obligatory and sufficient for surface networks but it is particularly problematic in irrigation networks under pressure. It does not create motives for saving water and energy. A usual characteristic of Greek irrigation networks is that the energy cost is higher than the cost for staff and maintenance. This fact is not in line with international standards concerning rational management (Karantounias and Dercas, 1998).

The problem of pricing according to the water volume consumed is difficult to be solved due to many technical problems: a) many farmers use the same inlet as a result of the small holdings, b) a lot of inlets are out of order for different reasons (acts of vandalism, insufficient maintenance).

The costing on a water volume consumption basis is not popular to farmers, who think that they will pay more than they pay today. Of course, there are also exceptions where each consumer has his private inlet and his private water meter (e.g. networks of Organization of Development of West Crete [ODWEC] in Chania-Crete, 1998).

In addition in certain networks (e.g. Pinios, Alfios) the pricing depends on the method of water application. When farmers use gravity irrigation methods in networks under pressure (this incident leads to over-consumption), it is obvious that the administrator of the organization will try to prevent such behavior and to charge these farmers with increased rate per water volume (Dercas, 2003).

Also, it must be noted than even in healthy administrative organizations, like ODWEC where projects are operative for both domestic and irrigation purposes, there are cases where actual charges are not attributed to farmers and the cost is transferred with increased value to domestic water. In this case the farmers are subsidized for social policy reasons.

In private networks, users seem to pay the total amount of the cost of water supply. However, they are not charged for the environmental cost caused by over- pumping and they are also strongly subsidized for buying irrigation equipment as well as for using energy appropriate for operation of the networks (oil, electricity) (Dercas, 2003).

It is important that the price per cubic meter depends on the volume consumed and it should be increasing with the increase of consumption. The low consumption must be calculated with the low price because the farmer, who uses the water rationally, should be rewarded for it. The rest of the volume consumed will be accounted according to a progressively high cost rating.

Water saving technologies with regard to consumption

Improvement of irrigation system design

In many cases the irrigation system design (furrow, sprinkler or trickle) is not appropriate, resulting to low water efficiency. The improvement of irrigation system design will allow the farmers to obtain better application uniformity, save water, avoid high percolation losses and reduce of underground water pollution. In general there is no irrigation technical assistance to the farmers. The latter use as consultants the dealers of the irrigation material companies. It is obvious that these consultants are not independent and their proposals do not always lead to an optimum solution.

Increase of the drip irrigation systems

Drip irrigation is a relatively new method (in comparison to furrow and sprinkler) where the water is laid directly on the ground surface.

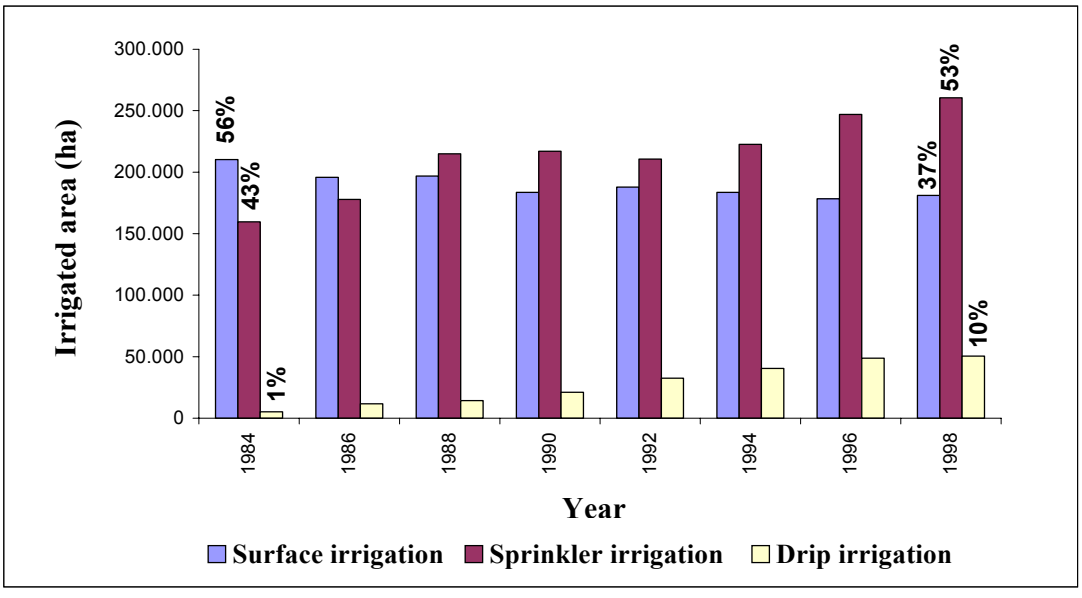

Fig. 3. The trends of irrigation techniques used in public networks

In comparison to sprinkler irrigation there are no spray losses through the atmosphere causing serious losses especially during the last hours of the day. The application water use efficiency depends on the irrigation system used and on its design. According to the Ministry of Agriculture,

Land Reclamation Service (1991) it is accepted that the application water efficiency for surface, sprinkler and drip is respectively 75%, 85, and 90%

In Greece the irrigated land covers an area of 1,430,000 ha and irrigation is made by surface irrigation (19%), sprinkler irrigation (50.6%) and drip irrigation (30.4%). The general trend in the existing public networks (Fig. 3) and private networks (Fig. 4) is to gradually abandon the surface irrigation systems giving place to sprinkler and especially to drip irrigation techniques with higher application efficiencies than the former.

In Greece the total water use efficiency is estimated to 60%, as the actual water use was 6.833 km^3 and the maximum calculated crop water requirements reached the value of 4.089 km^3 (Tsanis, 1996).

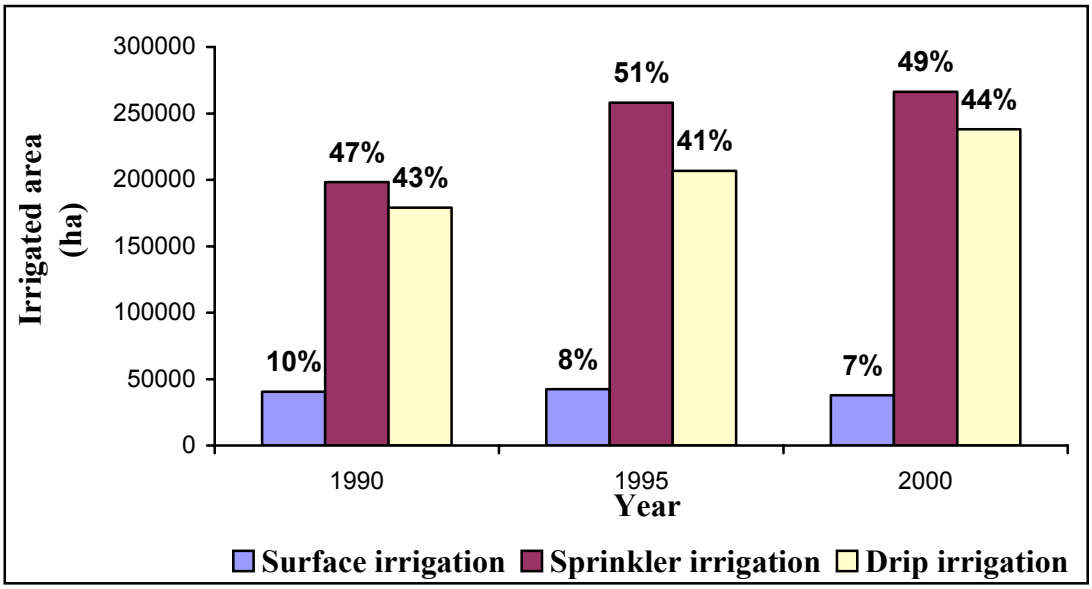

Fig. 4. The trends of irrigation methods used in private networks.

Use of Sub-surface irrigation (S.I.S)

One of the highly effective and resource preserving techniques of micro-irrigation is the developed subsurface irrigation system by modification of the conventional drip irrigation systems.

The main problems were and still are the penetration of roots into the water outlets and the block up by soil particles. The advantage of this technique is the high water use efficiency (Barth, 1999) and its compatibility with the disposal for irrigation of the low treated wastewater of agricultural or municipal origin (Campos et al, 2000, Oron et al, 2000, Jnad et al, 2001).

This system was first to be used in some hotels in Greece (irrigation of the green spaces) and some farms (e.g. farm in Samos island) allowing safe disposal of the treated waste water. The later is an important problem in some areas e.g. Aegean islands. Additionally research is carried out for its introduction in various agricultural crops.

Reusing return flows in furrow irrigation

The reusing return flows is a system applied in the graded furrow irrigation method. Furrow irrigation is often characterized by low efficiency. This may result from unskilful management and operation or from poor design (deep percolation and runoff losses).

Reasonably high distribution uniformities are generally obtained when the initial discharge and furrow length are properly designed. However, controlling runoff may be a problem even when cut-back is practiced. Excessive runoff (for a given distribution uniformity) results in a low application efficiency at a time when water is becoming scarce and costly. For this reason runoff reuse or recovery systems are becoming popular. Such systems, when used in combination with automated gated-pipe irrigation, reportedly achieve very high efficiencies. There is no data concerning the use of the system reusing return flows in furrow irrigation in Greece.

Water saving practices at farm level

There are several practices to save water at farm level: a) to store water in farm reservoirs, b) to avoid the use of sprinkler irrigation during hot and/or windy periods of day c) to destroy the weeds by mechanical (cultivation) or chemical (herbicides) ways, d) to cover the cultivated soil surface with plant residues (mulch), e) to use minimum tillage techniques, f) to apply deficit irrigation techniques g) to prevent surface runoff and increase the soil moisture, by plowing according to the contour lines, h) to cultivate in zones and i) to construct different types of terraces (stone-walled and earthen). These terraces have been adopted from ancient times up to now in hilly and mountainous farms of the central and southern part of the country as well as in many islands. The main cultivars are olive trees and grapes.

WATER SAVING AND THE NEW LEGISLATIVE FRAMEWORK

The framework applying to the government and the farmers is the new legislation (Law 3199/2003, introduced in order to adapt the Greek water legislation to the EU Directive 2000/60) and the EU Common Agricultural Policy (CAP).

The Directive 2000/60 is environmentally oriented and its main objective is to ensure good quality water resources. In order to allow the sustainable water management the Directive introduces the water price as a genuine reflection of the economic cost involved, including the environmental and resource cost. This approach has the meaning to fully implement the “polluter-pays principle”.

On the other hand, the CAP reduces progressively the subsidies (it will suspend them completely up to 2013), and it orients the farmers towards environment-friendly practices that are included in the cross-compliance (e.g. reduction of nitrates leaching, agrochemicals use, rational water use, management of the packages, record/tracing of all the cultural practices etc). In order to help the farmers in their effort it introduces the institution of “agricultural consultant”.

Under this view it is evident that Directive 2000/60 and the CAP have a common target, aiming both at environmental protection and rational water use. Working on this orientation there is a possibility for big improvement in water management in Greece. It is important to develop the environmental behavior of the farmers and more generally of all the population. The farmers must realize that the underground water found in their field is a public good and that they can only use it up to cover their needs. The rest of the water quantities belong to the community. This approach is not a new one in the Greek legislation. It was already expressed in the pre-existing legislation, but it was not applied in practice: the farmers have created a big number of illegal drills, the over-pumping of the aquifers is a common situation, the low maintenance of public networks and the inappropriate irrigation practices result to a high water consumption.

Under these circumstances, in order to improve the situation it is necessary to introduce an effective mechanism in order to ensure proper implementation of Directive 2000/60.

Firstly, the National Water Committee was set up, which will take the political decisions for water management at the higher level. In this Committee the Ministers of Environment, Physical Planning and Public Works, of Rural Development and Food (old title: Ministry of Agriculture), of Development, of Health and Welfare and others participate. The National Water Board was set up, whose members are representatives of political parties, the Technical Chamber, the Public Power Corporation S.A., the National Agricultural Research Foundation etc and its President is the Minister of Environment, Physical Planning and Public Works. This Board shall be consulted for national subjects on

environmental protection and water resources The Central Water Service was created in the Ministry of Environment, Physical Planning and Public Works and it is under organization. Furthermore, Water Boards of consultative role were created in the Regions level (Periferia level) where the General Secretary of the Region, representatives of the General Organizations of Land Reclamation, the Agricultural Associations, the local Authorities etc participate. In addition, in the Region the Direction for water is set up.

According to our opinion but also according to other researchers (Tsakiris, 2006) it is essential to create an Agency or Company of Public Utility with a flexible status, which will apply in practice the decisions of the Water Committee (at governmental and regional level) and at the same time will act as a technical consultant to the above mentioned bodies and to the irrigation networks operators. The latter need technical, economic and commercial management assistance for the public networks.

In addition, the farmers need irrigation consultants who will be independent of the irrigation material firms. An authority is needed in order to control the irrigation practices and the irrigation material used in the various irrigation districts. It is necessary to stop the actual situation where every farmer can use any system he likes. Many times the specifications of the irrigations systems used do not meet the public irrigation networks standards and the farmers apply inappropriate methods (put out the pressure regulators and the flow controls of the hydrants) creating major problems to the networks. For these purposes a Local Irrigation Bureau must be created in every irrigation district.

In parallel with the legislation (which is characterized by a very pronounced environmental approach) its application should be flexible and effective. The local authorities should participate in the bodies where the political decisions are taken but the application should be left to independent agencies (Companies of Public Utility) with specialized staff and technical-economical know-how. This last remark is based on the bad experience, as the local authorities (prefects) were not as strict as it is needed with the water users and very often they do not themselves apply their own decisions! (Goumas, 1996).

The creation of Water Management Plan at river basin level will allow us to know the natural resources (qualities and quantities), the consumptions, the efficiency of use, the water losses and finally to plan more efficiently the necessary actions and the new investments.

A proper water pricing policy in the public irrigation networks will allow the network operator to reduce the water consumption, improve the maintenance of the infrastructure, and create new infrastructure (dams, out-stream reservoirs). At the same time the farmers will be obliged to use more efficient irrigation systems in order to save water and reduce the corresponding cost.

The introduction of the environmental and the natural resources costs in the water pricing policy for private drills water will reduce the quantities pumped and it will improve the management of the aquifers. Additionally, the recharging works of aquifers and the control of sea intrusion will be easier to be funded. It must be noted that there is an obligation of every member state of EU to guarantee the balance of water resources-consumption of its aquifers.

The use of treated waste water will allow the farmers to save water resources and at the same time to protect the environment and give a safe solution to the major problem of water waste disposal. Considerable quantities of polluted elements (N, P, heavy metals etc) can be used by the crops and at the same time do not reach the surface of underground water resources.

The introduction of EU Directive 2000/60 in the Greek reality and the EU CAP are a very good framework in order to change substantially the water management situation. The main objective should be the introduction of an effective structure in order to apply the rules of the sustainable water use.

It is essential to forward rapidly in the following subjects:

1) Quick and complete harmonization of the Greek law with Directive 2000/60.

2) Development and fully operational organization of the bodies and agencies involved in water management.

3) Immediate creation and application of the water management plans at a river basin level.

4) Information of the farmers on the EU Directive 2000/60 and on the benefits resulting from a sustainable water management.

5) Pilot applications of the water management plans and promotion of the results obtained.

Finally this effort should be combined with a more general action at the school level and presentations in the media (radio and TV) in order to sensitize the population with the water problems and benefits of a sustainable management.

CONCLUSIONS

Water saving requires coordinated actions in order to promote water resources management through an integrated planning framework:

1) Replace the old surface irrigation systems with drip irrigation ones and save a reasonable quantity of water. This policy can be improved by subsidizing the purchase and establishment of drip irrigation systems.

2) Increase the water use efficiency by applying the following measures:
   a) Train the young farmers in water management techniques.
   b) Price the irrigation water in public networks according to the volume consumed.

3) Construct dams and off-stream water reservoirs and recharge the coastal aquifers. These actions need large investments.

4) Use effluents to irrigate crops, forestry and amenities, as far as for industrial needs. Thus the freshwater that is currently used for irrigation can be saved by 3.2%.

5) Use of desalination water in some Aegean islands in order to overcome the competition between the vital economic sectors of agriculture and tourism.

6) Encourage and subsidize any measure or technique that affects positively the water balance.

7) Apply administrative measures in order to avoid the environmental degradation of ground waters from nitrates, herbicides, fungicides and pesticides as well as of forests from fires.

8) Quick and complete harmonization of the Greek low with Directive 2000/60.

REFERENCES

Barth, H.K, (1999). Sustainable and effective irrigation through a new subsoil irrigation system (S.I.S) Agricultural Water Management 40, 283-290

Campos, C., Oron, G., Salgot, M., and Gillerman, L. (2000). Behaviour of the fecal pollution indicators in a soil irrigated with treated wastewater under onsurface and subsurface drip irrigation, Water Science and Technology, 42, 1–2, 75–79.

Dercas N. 2003, Sustainable Irrigation. The water in the 21st Century: Problems and Prospective. Proceedings of Geotechnical Chamber of Greece. Crete, 21-23 March 2003, Greece.

Goumas K. 1996, The Management of Water Resources in Thessalia and the Operation of the Legislative Framework (Law 1739/87). Proceedings of the 2nd Hellenic Congress of Geotechnical Chamber of Greece, Land Reclamation Works, Management of Water Resources, Mechanization of Agriculture, Larisa, 24-27 April 1996, 104-131.

Jnad, I., Lesikar, B., Kenimer, A. and Sabbagh, G. (2001). Subsurface drip dispersal of residential effluent: II. Soil hydraulic charachteritics, Transaction of the ASAE, 44, 5, 1159–1165.

Karantounias G. and Dercas N., 1998. Problèmes de fonctionnement et de gestion des réseux d'irrigation en Grèce, ICID Journal, No 2, 11-32.

Medwater Policy 2003. Policy Initiative to Overcome Water Competition between the Vital Economic Sectors of Agriculture and Tourism in the Mediterranean. EC Contact No. ICA3- CT2000-30002.
Ministry of Agriculture, Land Reclamation Service, 1997. SCP-GERSAR/Hydrosystem,. Sprayer irrigation system of Pinios River (Ilia). Restructuring plan.
Ministry of Agriculture, Land Reclamation Service, 1991. Technical guidelines for conducting agrotechnical studies for land reclamation works.
Organization of Development of the West Crete (ODWEC), 1998. Costing of water of Organization of Development of the West Crete.
Oron, G., Armon, R., Mandelbaum, R., Manor, Y., Campos, C., Gillerman, L. Salgot, M., Gebra, C., Klein, I. and Enriquez, C. (2000). Secondary wastewater disposal for crop irrigation with minimal risks, Water Science and Technology, 42, 10–11, 387–392.
Tsagarakis, K.P., G.E. Dialynas and A.N. Angelakis., 2004. Water Resources Management in Crete (Greece) Including Water Recycling and Reuse and Proposed Quality Criteria. Agricultural Water Management, 66: 35-47.
Tsakiris G. 2006 (Ed), Hydraulics Works, Design and Management, Volume II, Land Reclamation Works, Symetria, Athens, pp 773.
Tsanis, I.K., P.A. Londra and A.N. Angelakis, 1996. Assessment of Water Needs for Irrigation in the Island of Crete. 2nd International Symposium on Irrigation of Horticulture Crops, 8-13 September, 1996, 41-48.