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CONVENTION AND PROMOTION OF WATER SAVING POLICIES AND GUIDELINES

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SUMMARY - The annual precipitation as a total in Greece is adequate. Water imbalance is often observed, due to temporal and spatial variations, especially in summer months when there is an increased demand for water. Many water saving aspects for increasing the quantity and improving the quality of limited water resources are described. Coordinated actions to promote water resources management and an integrated and effective planning are given.
Key words: water saving, limited water resources, water resource management

INTRODUCTION

Greece has a population of about 11,000,000 and occupies an area of 131,962 Km^2. The cultivated area is 34,962 Km^2 and the irrigated land occupies 14,305 Km^2 with crops, vegetables, trees and vines to cover 65.1%, 24.2%, 7.9%, and 2.8% respectively. The annual precipitation ranges from 400 mm in Athens and Cyclades islands to more than 1500 mm in the high mountainous areas with values of 700 mm in Eastern Greece and 1000-1200 mm in Western Greece and the Ionian islands. (National Statistical Service of Greece, 2001). The annual water consumption was estimated at 8,200 hm^3/year, most of which been used in agriculture (83%), whereas the domestic, industrial and other uses are 13%, 2% and 2% respectively. The increase demand for water cannot always be met despite adequate precipitation. Water balance is often experienced, especially in the coastal and southeastern regions, due to the spatial and temporal variations of precipitation and as a result of the increase water demand during the summer period as well as the high cost of transporting water. The water problem remains at the gates and there is great need for harmonization and application the water saving techniques and strategies.

WATER SAVING ASPECTS

Many water saving efforts have made in Greece to improve the use and management of water resources. Some of these efforts are given in brief below.

Increasing the drip irrigation systems

The irrigated land covers an area of 1,430,000 ha and irrigation of water is done by surface irrigation (19%), sprinkler irrigation (50.6%) and drip irrigation (30.4%). The general trends in the existing public networks (Fig. 1) and private networks (Fig. 2) are to gradually abandon the surface irrigation systems giving place to sprinkler and especially to drip irrigation techniques with higher application efficiencies than the former.

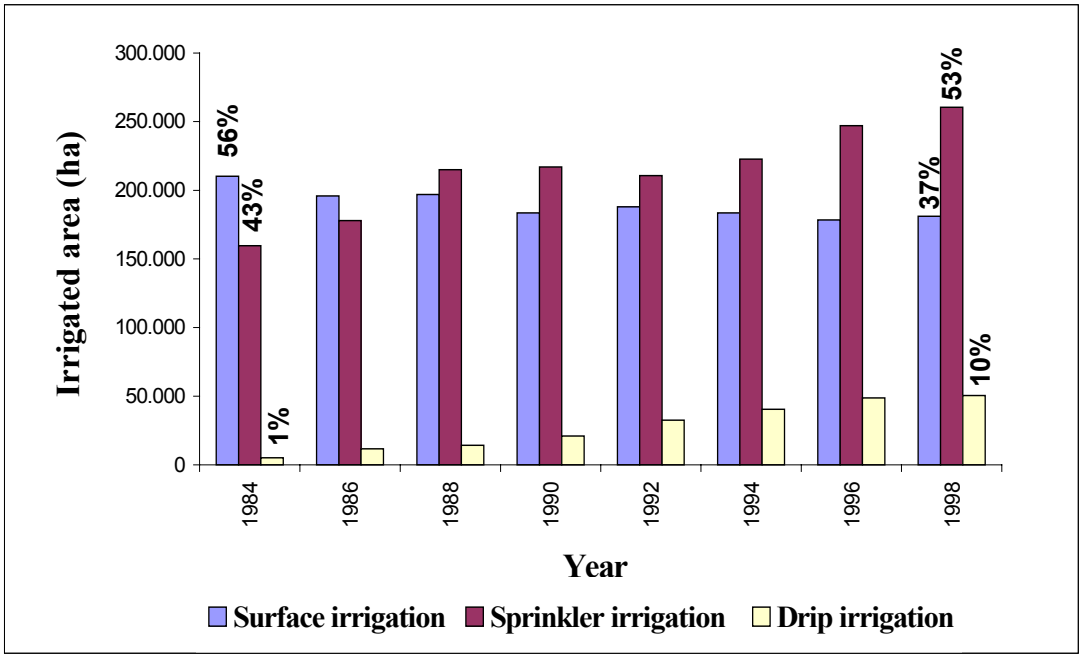

Fig. 1. The trends of irrigation techniques used in public networks

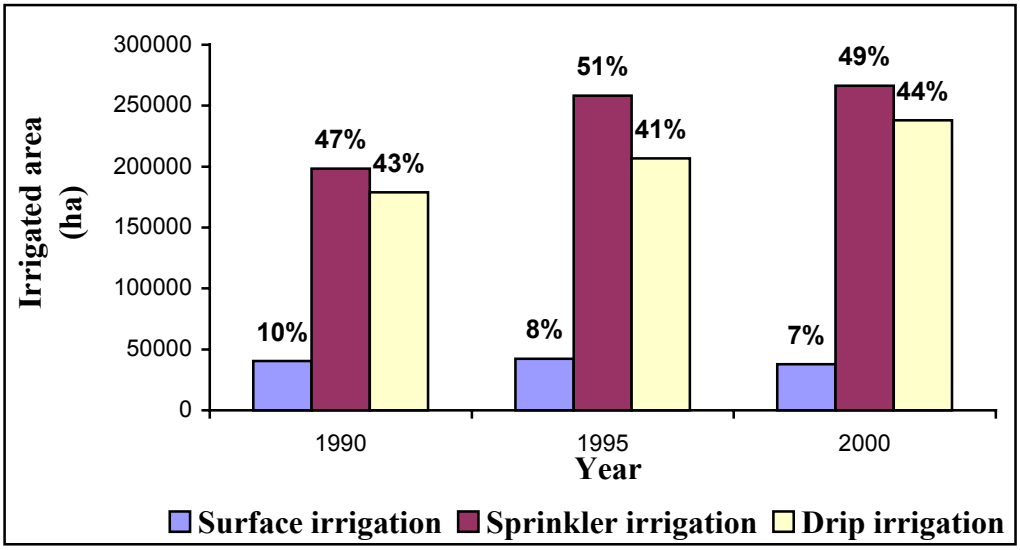

Fig. 2. The trends of irrigation methods used in private networks.

Additionally, the conveyance of irrigation water tends to be made by more efficient ways using pipelines instead of surface flow (Figs. 3 and 4).

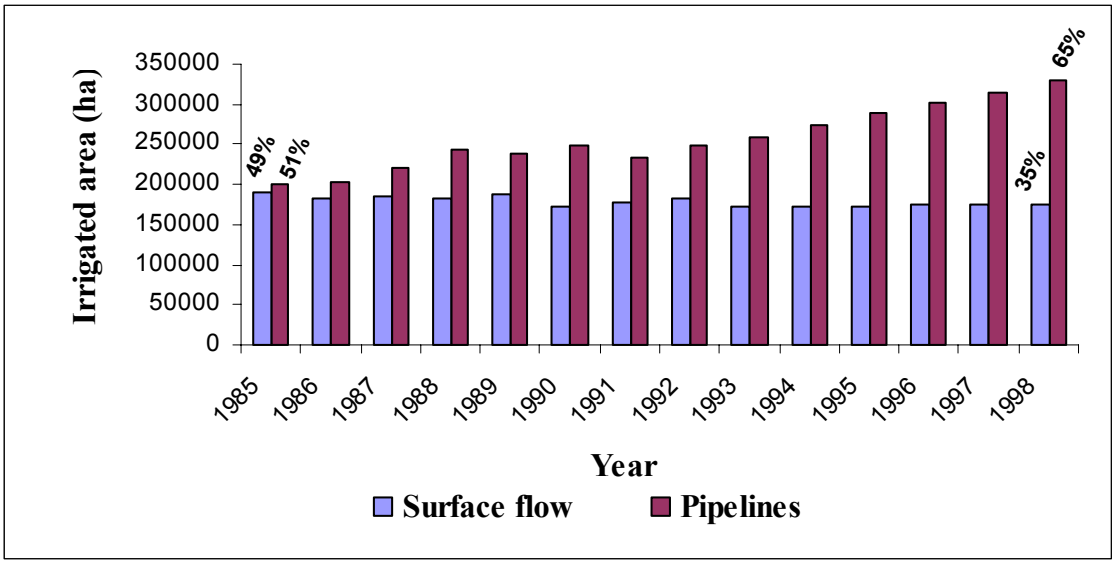

Fig 3. Conveyance of irrigation water in public networks.

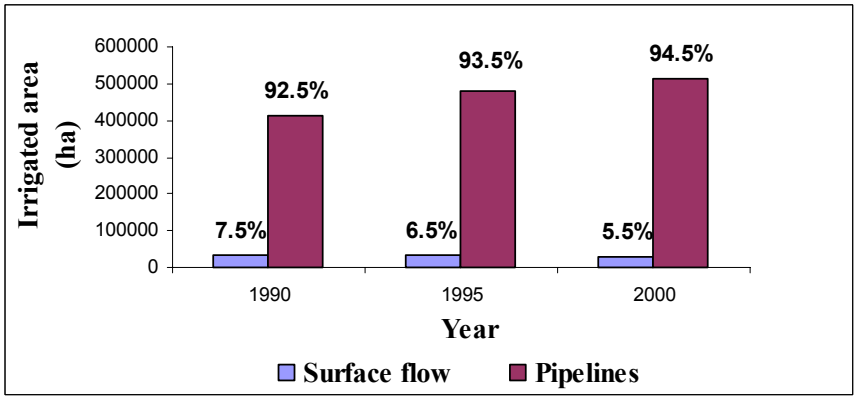

Fig. 4. Conveyance of irrigation water in private networks.

Increase the water use efficiency in irrigation networks.

The water application efficiencies for surface, sprinkler and drip irrigations are 75%, 85% and 90% respectively. Furthermore the water conveyance and distribution efficiencies are 70%, 85% and 95% for transportation of water with earthen, concrete channels and pipelines respectively (Ministry of Agriculture, Land Reclamation Service, 1991). These data must have been changed by now, by increasing some units.

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). More specifically in public networks, water and energy consumptions are generally increased as a result of considerable water losses in the course of water conveyance from the source up to the final application in the field. 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). A lot of canals in the network for surface irrigation earthen, although this situation is being improved. However, there are cases where water shortage has positively activated the involved users and losses have been reduced to the normal range of 15-20% (Organization of Development of the West Crete, 1998).

Water saving practices at farm level

There are several practices to save water

- Storage water in farm reservoirs
- Destroy the weeds by mechanical (cultivation) or chemical (herbicides) ways.
- Covering of the cultivated soil surface with plant residues (mulch).
- Using minimum tillage techniques.
- In order to prevent surface runoff and to increase the soil moisture, different types of terraces (stone-walled and earthen) have been constructed from ancient times up to now in hilly and mountainous farms of central and south part of the country as well as in many islands. The main cultivars are olive trees and grapes.

Water saving in irrigation districts or regions

- Construction of dams
- Construction off-stream water reservoirs.

These structures refer to whole regions and large investments are needed.

Water saving techniques related to water harvesting

The techniques related to the water harvesting in Greece can be divided into the following categories.

- Structures which harvest runoff from ground surfaces. These are micro catchments (contour earth bands) constructed for irrigation of olive trees.
- Structures which harvest the rain from the roofs and ground surfaces and deposit water in rain-water tanks of a capacity 50-500 m^3, for domestic use and vegetable production in Aegean islands and Crete.
- Techniques which collect discharge by diversion the ephemeral water sources and spreading within irrigation channels for olive trees (Amfissa).

Recharging the degraded aquifers

During the last decades, in some Mediterranean countries attempts have been made to recharge mainly coastal degraded aquifers in order to increase water tables. In Greece, recharging has been applied in Argos region in East Peloponnesus with very good results. Recharge takes place during winter when there is enough rainfall. Following this technique the water quantity of the aquifers is increased as well as the quality of ameliorated groundwater 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 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 271/91 directive on 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 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).

Use of desalination water

Desalination systems based on renewable energy were used in some islands of 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.

Affecting the water balance

The total annual precipitation as it can be seen in Table 1, is estimated to be 116,689 hm^3 with 50.9% to be lost by evaporation, 31.9% by runoff and only 17.2% is infiltrated into soils (Ministry of Development, 2002).

Table 7. Water balance per water district (hm^3).

Water district	Precipitation	Evaporation	Internal runoff (rainfall infiltration)	Runoff
1. W. Peloponnesus	8031	3614	1285	3132
2. N. Peloponnesus	6404	2824	1661	1918
3. E. Peloponnesus	6563	3290	1847	1426
4. W. Central Greece	14340	5450	3825	5065
5. Epirus	17046	6818	4290	5938
6. Attica	1642	1150	241	251
7. E. Central Greece	9516	5257	1695	2564
8. Thessaly	10426	6255	973	3202
9. W. Macedonia	10470	5654	1239	3578
10. Central Macedonia	6068	3034	428	2606
11. E. Macedonia	4917	2722	524	1671
12. Thrace	8574	5325	530	2719
13. Crete	7500	4874	1068	1558
14. Aegean Islands	5192	3104	527	1562
Total	116689 *(100%)*	59371 *(50,90%)*	20133 *(17,20%)*	37190 *(31,90%)*

Any attempt to increase the infiltrated water into the soil, reduces the runoff of water and positively affects the water balance. This can be done by applying the following measures:

- Application of appropriate agricultural practices in the slopping cultivated areas in order to minimize runoff of rainfall, i.e. plowing according to the contour lines, cultivation in zones, using minimum tillage techniques, leaving mulch on the soil surface, etc.
- Low rock dams in winter water courses in order to slow down the rain flow and increase infiltration time.
- Measures to avoid forest fires.

The combination of these techniques and plans affects the water balance, especially in regions like eastern-south Greece and islands, where people are needed to increase “saved water” yields.

Application of rational agricultural practices

The application of appropriate agricultural practices by the farmers provides a lot of benefits by protecting the land from soil erosion and the ground water from chemical pollution. Fertilizers must be rationally applied, especially nitrates that affect the quality of the environment by polluting the ground waters. Agrochemicals must be used with a sparing hand and administrative measures must be applied in order to avoid the chemical degradation of groundwaters.

BENEFITS OF WATER SAVING OPTIONS. PROPOSITIONS ON MEASURES

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

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

2) The increase of water use efficiency can be achieved by applying the following measures:

a) Training of young farmers in water management techniques.

b) Pricing of irrigation water in public networks is based on the size of the parcel. Farmers should pay on water volume consumption basis, instead.

3) Constructing dams and off-stream water reservoirs as well as recharging of coastal aquifers projects need large investments. Nevertheless, by converting a dry or degraded land to irrigated one the family income is increased by more than 70% as well as the employment at a rate of 20% in the perimeter of the project district. In addition a reduction in labor cost was observed as a result of automations (Naftemporiki Newspaper, 2004).

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

5) Desalination water can be used in some Cyclades islands in order to overcome the competition between the vital economic sectors of agriculture and tourism.

6) Encouraging and subsidizing any measure or technique that affects positively the water balance.

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

The possible water saving opportunities in Greece can be obtained mainly from:

- The reuse of effluents from Waste Water Treatment Plants by 3.2% of current total use of freshwater.
- The reduction of water losses in the irrigation networks by 10% to 50% of the water used for agriculture.
- The different water saving options by an inestimable proportion.

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