INCO-CT-2004-509093

ADU-RES
Co-ordination Action for Autonomous Desalination Units Based on Renewable Energy Systems

Institutional and Policy Framework Analysis

GREECE

WP-7: Institutional & Policy Framework
Deliverable 7.2

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with support from WIP

May 2006

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Executive Summary

This particular report, was conducted in the framework of the 7th European Framework for the project INCO-CT-2004-509093 ADU-RES Co-ordination Action for Autonomous Desalination Units based on Renewable Energy Systems and concerns the state of the art relatively to water resources, energy by Renewable Sources and the development of desalination plants in Greece.

In describing the water resources of Greece, the key element seems to be the uneven distribution, both in time and space, of precipitation, activities and population. Western Greece is by far richer in water creating a water 'crescent' from the north to the south than the eastern part of the country, where the majority of population is concentrated. Some additional constraints may be imposed by the continuing increase of water demand as well as by environmental considerations.

On the other hand, energy production by Renewable Sources in Greece already makes very profound efforts on institutional, regulatory, engineering and funding level to meet the indicative target set by Directive 2001/77/EC through the yet fluid state brought about by the liberalization process of the electricity market dominated for more than half-a-century period by the sole public utility. Even though nowadays, the most common power source for electricity production in Greece is lignite and also diesel for the Greek Islands. The average values indicate that Greece is a country with generally affluent water recourses. However, this is a rather rough estimation since a careful study reveals the contrast concerning the supply and demand values in 14 water sectors. A thorough study of these values depicts the deficiency of water recourses in some of the sectors and mainly in the Aegean Islands.

Although desalination is a very promising technology that can comprise a reliable solution for the fresh water shortage problem of the most arid Greek areas, it is fairly developed in Greece. Only the recent years were materialized several important desalination plants in the Greek islands, while up to now the only existent applications were mainly experimental or pilot installations. Until the recent years, the preferable solution to cover the increased needs for fresh water due to the development of the tourism industry was the over exploitation of the ground water and the transportation of water with ships. The result of this policy was the serious degradation of the ground water quality due to the sea intrusion in the costal aquifers, and at the same time fresh water transportation was proven a very expensive practice.

The above reasons lead the authorities to search for other solutions in the form of integrated water management in a local scale incorporating all the appropriate solutions in order to decrease the water demand and to increase the available water resources. In this framework desalination technologies were evaluated again and recognized as viable and reliable solution in the case of small, dry islands. Production of fresh water using desalination technologies driven by renewable energy sources (RES) is also a viable solution to the water scarcity at remote areas without access to the electricity grid. In Greece almost all inhabited places are connected to the grid, but desalination units driven by RES, such as those driven by solar and wind energy, can offer environmental friendly production of fresh water in regions with severe water problems, like the south Aegean islands, which at the same time have large renewable energy resources potential while their electric grids are small and autonomous, and electricity production is mainly based on expensive and polluting liquid fuels (heavy fuel oil and diesel).

Although the legislation related to the water issues is very extended and modern, the actual situation is that the efforts made up to now to apply these laws were inadequate. Moreover, the charges for water use in Greece are generally lower than most of the European countries even if there are serious water scarcity problems.

The prices are also different for irrigation than they are for drinking water. Water prices for irrigation are most of the times not related with quantity of water consumed but with the area irrigated, a fact which evokes an increase on water consumption. The potential of a rapid future development in this field is clear, aside from the tensive need for fresh water in the arid zones of Greece, the existence and mainly the enforcement of a legislative and administrative framework could accelerate the development of desalinization plants in the country.

1 Introduction

Greece is located in the southeastern part of Europe. The country is comprised of the Greek peninsula as well as of the adjacent archipelago of approximately 3000 islands. The terrain is predominantly mountainous while the climate is typical northern Mediterranean with most of the precipitation falling during the winter months and increasing from southeast to northwest. The average annual rainfall ranges from 350 to 2150 mm/yr, with an approximate average of 760 mm/yr (Karavitis, 1992). In describing the water resources of Greece, the key element seems to be the uneven distribution, both in time and space, of precipitation, activities and population. Western Greece is by far richer in water creating a water ‘crescent’ from the north to the south than the eastern part of the country, where the majority of population is concentrated. Some additional constraints may be imposed by the continuing increase of water demand as well as by environmental considerations.

On the other hand, energy production by Renewable Sources in Greece already makes very profound efforts on institutional, regulatory, engineering and funding level to meet the indicative target set by Directive 2001/77/EC through the yet fluid state brought about by the liberalization process of the electricity market dominated for more than half-a-century period by the sole public utility. Even though nowadays, the most common power source for electricity production in Greece is lignite and also diesel for the Greek Islands.

In this environment Autonomous Desalination Units based on Renewable Energy Sources can be a key component for the integrated water resources management of the small arid islands beyond the important constraints raised from the complicated administrative and legislative framework.

The aim of this report is to present the status of water resources in Greece and to examine the feasibility of desalination plants in some parts of the Greek territory. The legislative and administrative framework are presented so as to illuminate the current situation in Greece regarding Autonomous Desalination Units based on Renewable Energy Sources.

2 Country Overview

2.1 Geography

Greece is a country in south-eastern Europe that forms the southern extremity of the Balkan Peninsula and it is bordered on the west, south, and east by the Ionian, the Mediterranean, and the Aegean seas, and on the north by Albania, the Former Yugoslav Republic of Macedonia (FYROM), Bulgaria, and Turkey.

Greece is predominantly an agricultural country, although less than one-third of its area is cultivated, but tourism is as well developed and is economically very important. Greece has an area of 131.944 square kilometres, with coastlines of more than 15.000 kilometres. Greece encompasses many island groups, including the Ionian Islands to the west and the Sporades and Cyclades to the east, as well as the larger islands of Crete, Lesvos, Rodhos, Samos, Samothraki, Chios, and Lemnos. The total number of islands is around 3000 out of which 63 are inhabited.

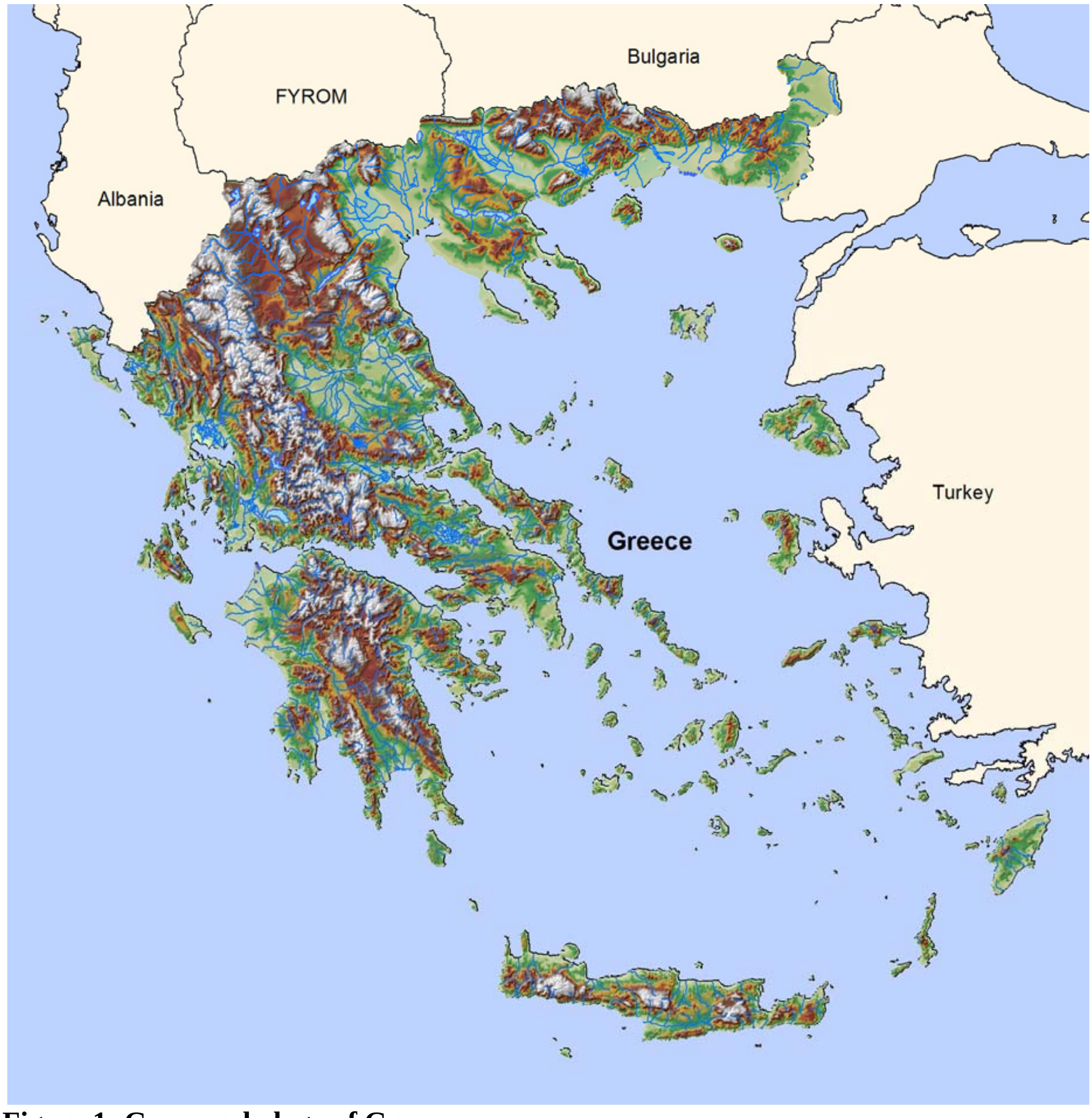

Figure 1: Geomorphology of Greece

Greece is a mountainous country, with flat land restricted to many small coastal plains. The mountains, which form part of the Alpine system, generally stretch from northwest to southeast. They are highest and most rugged in the northwest, where the Grammos Mountains rise to 2.519 m and the Pindhos to over 2.285 m, although the highest mountain in the country, Olympus (2.917 m), is in the east central Greece. The mountains are interrupted by the long, narrow Gulf of Corinth, which almost cuts off southern Greece the Peloponessos from the rest of the peninsula. But the mountains continue south of the gulf and terminate in the three headlands of southern Greece. The mountain ranges, extending in the same direction, are continued offshore, and their highest portions appear as the chains and groups of islands that dot the Aegean. The Cyclades continue the eastern ranges toward the Turkish mainland, and Crete and Rhodes are continuations of the more westerly ranges. Both mountains and islands are composed of sedimentary rocks, mainly limestone and sandstone. Only near the northern boundary of Greece are igneous rocks significant in the landscape.

The largest plains are those of Macedonia, Thessaly, and Thrace, all of which border the Aegean Sea. The soils in Greece are thin and poor, and over much of the country the bare rock shows at the surface. The only good soils are on the small coastal lowlands. These are mainly alluvial soils, but their productivity is greatly reduced by the long summer drought. Few rivers exist in peninsular Greece; all are small, and most dry up in the summer. Only those rivers that rise farther north in the Balkan Peninsula and flow through northern Greece to the sea, for example, the Evros, Axios, and Strymon, have significant summer discharge.

The small size and seasonal character of most rivers is the primary reason for their limited use for irrigation. Of the several lakes within the mountains - many of them in northern Greece - most occupy basins that were formed by the dissolution of limestone. Naturally occurring vegetation is adapted to the climate and consists largely of xerophytes, which are plants that are able to withstand the summer drought by the storage of water. Spring is the primary growing season, and flowering plants make a brilliant show during this time, before withering under the summer heat. The mountains are mostly clothed with a relatively dense scrub brush (called maquis). Evergreen forests may once have covered much of the land but have been largely destroyed in southern Greece. Extensive forest is found only in the mountains of northwestern Greece, where large stands of fir occur. About 19 percent of the total area of the country is forested.

2.2 Climate

The climate of Greece is typically Mediterranean. Summers are long, hot, and dry. The average temperature in July in Athens the capital is 26.7 degrees C, but is much lower in the mountains.

Winters are mild; the average January temperature is 9.2 degrees C. Winter temperatures are also much lower in the interior; in mountain valleys averages are close to freezing, and prolonged frosts may occur. Snow is not uncommon away from the coasts. Snowfall is most common in the country’s highlands, and February is the month during which most of the snowfalls occur. Precipitation varies greatly. In Athens it averages 394 mm annually, but it is much higher away from the east coast and rises to more than 1.200 mm in the higher mountains (See figure 2). In all parts of the country rainfall is seasonal, most of it coming in late fall and winter months. Only in Macedonia and Thrace is there a significant summer rainfall, where in the rest of the country there is no rain in summer times.

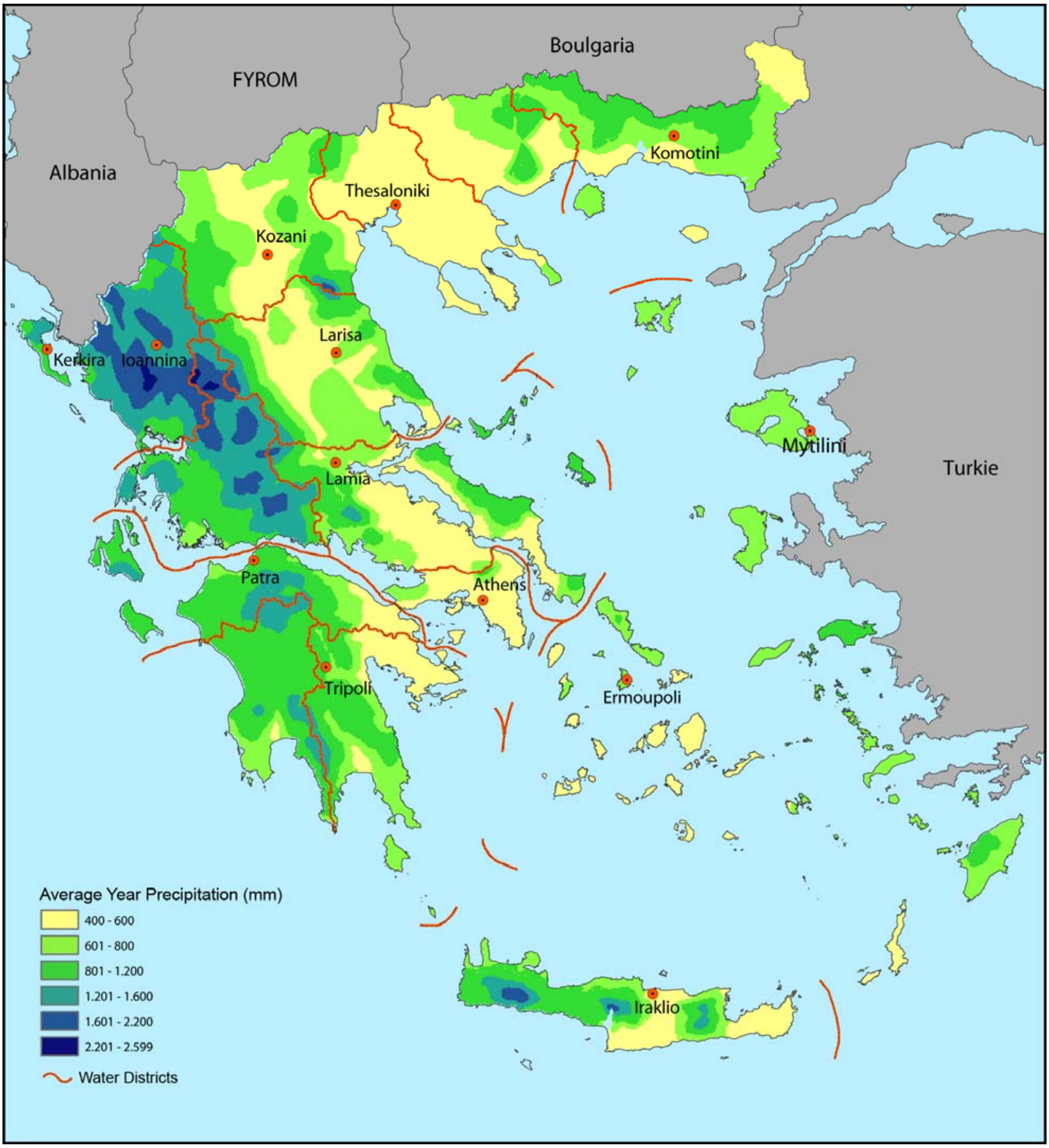

Figure 2: Average Annual Precipitation (mm) in Greece

The average relative humidity varies between 60 and 70%. However, the values are much lower during summer. Sunlight is considerably high comparatively to other European countries. The average annual sunlight varies between 2300-3100 hours. Higher values are noticed in Aegean and Crete while the lowest values occur in the mainland of north Greece. The percentage of fair weather days is between 20-50%. Winds in Greece are in general strong, mostly north and secondarily south, although the formation of winds depends on the local terrain. Windless days are most common in mainland and less in the islands.

The rainfall in Greece is variable in space, increasing from the South to the North, due to the change of climatic conditions varying from dryer and warmer to humid and cooler conditions because of the increase in latitude, and also increasing from the east to west due to the separation of the country to two different climatic unities, brought by the Pindos range and its extension to Peloponessos and Crete. The natural water resources of Greece are made up of the internal water resources (resulting from the precipitation) and the external water resources as shown on Table 2 below. Greece has some 381 wetlands of total area 201.267 Hectares (2.012 km^2) out of which 11 are Ramsar sites, with a surface area of 107400 Hectares (1.074 km^2). The present water resource uses are shown on Table 1.

Table 1: Present water use by sector

Sector	**Amount of water (m^3)**
Agriculture	7540,0 (84,49%)
Domestic	1150.0 (12.89%)
Industry	154.0 (1.72%)
Electric Power Cooling	80.0 (0.90%)
Total	**8924.0 (100%)**

3 Water Resources: Status and Future Trends

3.1 Water Recourses in Greece

In describing the water resources of Greece, the key element seems to be the uneven distribution, both in time and space, of precipitation, activities and population. Western Greece is by far richer in water creating a water ‘crescent’ from the north to the south than the eastern part of the country, where the majority of population is concentrated. Some additional constraints may be imposed by the continuing increase of water demand as well as by environmental considerations.

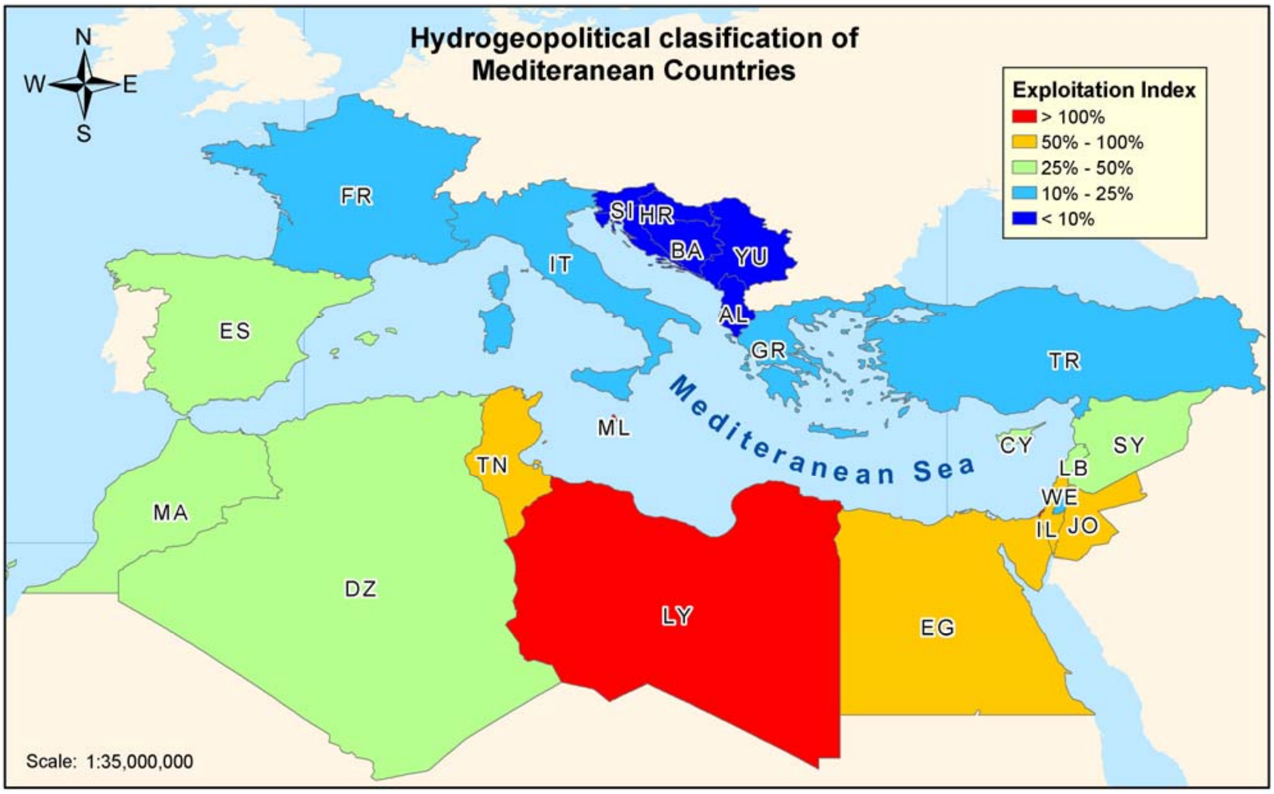

Figure 3: Hydrogeopolitical classification of Mediterranean Countries – Exploitation Index (Source Aquastat).

Greece makes use of only a 10-25% (See figure 2) of its water recourses. However, this is an average value and the truth is that although most of the continental country faces no problem, Greek islands and especially the Aegean islands that belong to the 14th (See figure 5) water sector are confronted with a serious drought problem.

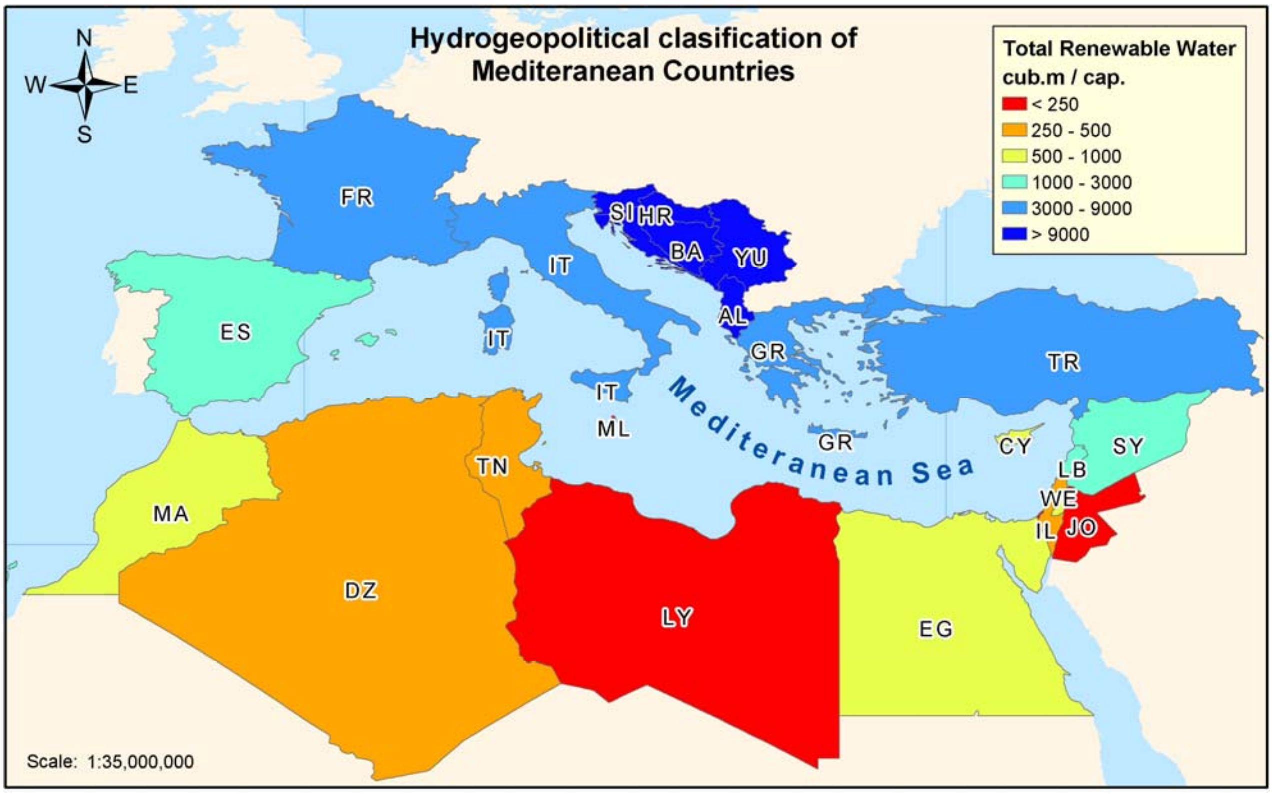

Figure 4: Hydrogeopolitical classification of Mediteranean Countries – Total renewable water (Source Aquastat).

The total water resources potential of Greece has different estimates throughout the literature. The OECD report (1983) presents a total flow into the Mediterranean sea of 49.1 x 10^9 m^3/yr of which only 4.3 x 10^9 m^3/yr are abstracted for use. However, the report states that among the OECD Mediterranean countries, Greece has the highest ratios of potential water resources per capita of 5934 m^3/yr, and one of the lowest in relative abstraction of 470 m^3/yr/inh. Grenon and Batisse (1989) estimate the total water resources of Greece at about 58.6 x 10^9 m^3/yr, of which 7.0 x $10^9 m^3$/yr is allocated with a net consumption of 3.65 x 10^9 m^3/yr. Data from the Greek Ministry of Agriculture (MA), estimate a water resources total of about 65.32 x 109 m3/yr. However, the estimate of water resources from the Ministry of Industry, Energy and Technology (MIET) is about 69.0 x 109 m3/yr.

According to MIET, from this total 10.3 x 109m3/yr are groundwater (7.35x109m3/yr karstic) and 58.7 x 109m3/yr are surface resources. The MA states that 62.868 x 109m3/yr is the total for surface waters, while 2.452 x 109m3/yr is the measured (not the potential as in the MIET data) groundwater flow. Based on existing legislation, Greece is separated into 14 water sectors based on the major watersheds (MIET, 1980) (See figure 5). Detailed information about the various estimates of water resources for each sector is given in Table 2; nevertheless, it has to be noted that updated information is still pending.

Based on the above estimations of total water resources, Greece is ranked among the richest countries in per capita total renewable water resources (See figures 3 and 4). This is of course half the truth because the uneven distribution of the available water resources and the fact that the most of the economically developed areas are located in the dryer part of Greece raising very serious fresh water shortage problems. Aegean Islands facing the most serious problems due to the huge number of tourists visiting them every year, while they are the driest part of Greece and at the same time isolated with the surrounding sea area making water transportation extremely expensive.

Figure 5. Administrative division of Greece in 14 Water Districts.

Table 2: Estimation of the water resources potential of Greece in each water district, in 10^6 m^3/yr (Karavitis, 1998)

Water sector	Surface water		Ground water				Total	
			Karstic	Other	Total			
	MIET[a]	Ma[b]	MIET	MIET	MIET	Ma[c]	MIET	MA
(1) West Peloponnesus	3050	2720	550	150	700	80	3750	2800
(2) North Peloponnesus	2650	3201	800	100	900	100	3550	3301
(3) East Peloponnesus	1000	1859	850	100	950	114	1950	1973
(4) West Sterea Hellas	9750	11649	750	100	850	75	10600	11724
(5) Epirus	8500	8591	200	50	250	59	8750	8650
(6) Attica	200	219	150	50	200	2	400	221
(7) East Sterea Hellas	1900	1816	750	300	1050	83	2950	1899
(8) Thesalia	3250	3253	550	800	1350	590	4600	3843
(9) West Macedonia	4100	4320	800	50	850	417	4950	4737
(10) Central Macedonia	6900	7186	150	550	700	344	7600	7530
(11) East Macedonia	4200	4419	300	250	550	252	4750	4671
(12) Thrace	10900	10991	100	300	400	180	11300	11171
(13) Crete	1300	1564	1200	100	1300	95	2600	1659
(14) Aegean Islands	1000	1080	200	50	250	61	1250	1141
Total	58700	62868	7350	2950	10300	2452	69000	65320

[a] The Ministry of Industry, Energy and Technology (MIET), 1987.
[b] The Ministry of Agriculture (MA), 1980.
[c] The data are measured groundwater flow.

The most striking element of water resources management in Greece seems to be the division of management responsibilities among a large number of entities. Such entities include the Ministry of the Interior (MI), the Ministry of Environment, Physical Planning and Public Works (MEPPW), the Ministry of Health and Well Fare, Care and Social Insurance (MHCSI), the Ministry of Culture (MC), the Ministry of Foreign Affair (FM), the MA, the MIET, the Public Company of Electricity (PCE) and a few other smaller agencies. Such fragmentation, as well as overlapping of similar responsibilities, seems to hinder any comprehensive water resources planning and management efforts. In addition, it may compound existing bureaucratic tendencies by creating delays in planning and implementation, and dispersing resources.

The estimates for the total water use are again conflicting. The MIET states that 5.04x109m3/yr is consumed, while the MA gives an estimate of 4.8 x 109 m3/yr. However, there is a consensus in the literature about the various users (CPER, 1989; Karavitis, 1992; OECD, 1983). Thus, it is estimated that agriculture accounts for about 80-84%, domestic users for about 13-15%, and power as well as industry account for about 2.5-4%. Some estimates on past, present and future water use in Greece are presented in Table3.

Table 3: Past, present and future water use in Greece in 10^6 m^3 (source: Greek Parliament minutes, 1990)

Type of water	1985			1990			2000		
	Domestic	Irrigation	Industry	Domestic	Irrigation	Industry	Domestic	Irrigation	Industry
Surface	510	3265	40	830	4150	50	1200	5780	160
Groundwater	240	1335	50	320	1515	60	390	1820	70
TOTAL	**750**	**4600**	**90**	**1150**	**5665**	**110**	**1590**	**7600**	**230**
Percent (%)	**13.8**	**84.6**	**1.8**	**16.6**	**81.8**	**1.6**	**16.9**	**80.7**	**2.4**

The greatest rivers in Greece are located in the northern regions of Macedonia and Thrace. Greek territories form the lower parts of the watersheds. The upper and greater parts of the watersheds fall into the neighbouring countries. Nevertheless, the management of these common water resources needs to be implemented by the principles of international cooperation, and is still pending.

The water quality can be generally described as satisfactory (Karavitis, 1992). However, pollution exists in some places due to the high use of fertilizers and pesticides, as well as municipal and industrial effluent. Problems might escalate as the rate of exploitation increases.

The coastal waters of Greece are primarily devoted to tourism. The quality of such waters is generally considered excellent, but high pollution exists in some areas (Athens and Thessalonica metropolitan regions); due to the dumping of untreated domestic and industrial wastewater. Legislation for the protection of the environment is incremental. There are not any clear-cut standards for the quality of water (surface, groundwater), neither any water exploitation rates to be enforced unitarily for the whole country. On the contrary, there are only some laws for certain locales with a variety of standards. European Union legislation has also to be implemented by all member states, and thus may create additional constraints. Summarizing, the existing water law seems inadequate to cover the ramifications and consequences of the present and future problems (CPER, 1989; Karavitis, 1992) but the compulsory harmonization of all the European countries with the new EU directives dealing with water resources may improve the relative legislation.

In few words, the main characteristic of water recourses in Greece is the uneven distribution of water resources vs. population and activities.

3.2 Water supply and wastewater systems

In Greece these elements have been treated incrementally without the necessary planning. During the last decades the increasing demand for a supply of good quality water as the living standards have been progressively rising, has led to an overexploitation of the traditional water supply and occasionally to a crisis situation (CPER, 1990). The concentration of the urban population in limited areas (Athens, Thessalonica), as well as the doubling or even tripling of the population in the tourist regions during the ‘peak’ summer season, have accentuated the problem.

3.3 Future Perspectives

The average values indicate that Greece is a country with generally affluent water recourses. However, this is a rather rough estimation since a careful study reveals the contrast concerning the supply and demand values in 14 water sectors. A thorough study of these values depicts the deficiency of water recourses in some of the sectors and mainly in the Aegean Islands. (Table 4 and Figure 4).

Table 4: Demand and supply (in hm^3) per water sector nowadays

Sector Number	Water Sector	Supply	Demand	Notes
1	West Peloponnesus	73	55	Surplus
2	North Peloponnesus	122	104	Surplus
3	East Peloponnesus	56	67	Deficit
4	West Sterea Hellas	415	82	Surplus
5	Epirus	193	33	Surplus
6	Attica	56	54	Marginally Surplus (1)
7	East Sterea Hellas	128	187	Deficit (2)
8	Thesalia	210	335	Deficit
9	West Macedonia	159	136	Surplus
10	Central Macedonia	137	130	Marginally Surplus
11	East Macedonia	354	132	Surplus
12	Thrace	424	253	Surplus
13	Crete	130	133	Marginally Deficit (3)
14	Aegean Islands	7	25	Deficit
Total		**2464**	**1726**	
(1) Water resources are mainly transferred from adjacent sectors				
(2) The irrigated areas have been overestimated and thus the water sector has marginally sufficient water resources although it is characterized as intensely deficit				
(3) The demand is supplied mainly from springs and drills				

Surplus: The supply exceeds the 110% of the demand
Marginally Surplus: The supply varies between 100% and 110% of the demand.
Marginally Deficit: The supply varies between 90% and 100% of the demand.
Deficit: The supply falls short of 90% of the demand.

Consequently, desalination can be proven an important alternative for the Aegean Islands which face the greatest water shortages and other solutions are very limited. Further more renewable energy development in the same region is of great importance because the power supply system is also autonomous and is mainly based on liquid fuels. More data for this region are presented as follows.

3.3.1 South Aegean Islands

The water sector of Aegean Islands is comprised by the prefectures of Kyklades, Dodekanisa, Lesbos, Samos and Xios. Its total area is 9,104 km^2. The main characteristic of the sector is the dismemberment of the total area in many smaller autonomous unities, the Islands. This peculiarity, imposes the sectors' approach by each island in particular, the total area of which is considered as an individual hydrologic - hydrogeologic unit.

The terrain in the water district of the Aegean Islands is mainly mountainous or semi-mountainous and a few times flat. The average elevation is 160m. Due to the small size of the islands, there do not evolve remarkable hydrologic basins in them. The drainage of waters that come from rainfalls materializes through small littoral currents, usually in a radial layout. Moreover, the limited precipitation in most of the islands joint with the geological configuration, do not allow the development of a dense hydrologic network.

The Aegean Islands water sector presents significant climatic variations, due to the geographic location, the size and the distance of the islands from the mainland. On the whole, the climate in the islands is mild Mediterranean. The average temperature varies between 16.9 to 19.9 degrees C. The greatest amount of precipitation appears in the northeastern islands whereas the smallest amount appears in Cyclades (See figure 2).

In table 5 the water balance of the islands with more than 300 inhabitants is presented.

Table 5: Water resources potential per prefecture and per island

Islands	Area km^2	Precipitation mm	Total Precipitation hm^3	Actual Evapo-transpiration hm^3	Area percentage of water permeable formation	Aquifer type	Underground Potential* hm^3	Surface Runoff hm^3
Perfecture of Kyklades								
Folegandros	32	379	12.1	8.88	50%	K	1.5	1.62
Paros	195	379	73.9	57.76	50%	K	7.9	8.34
Antiparos	35	379	13.3	9.77	30%	K	1.0	2.43
Milos	151	379	57.2	42.33	40%	M	2.4	12.47
Kimolos	36	379	13.6	10.06	90%	M	1.3	2.24
Sifnos	73	379	27.7	20.50	60%	K	4.2	3.00
Serifos	73	379	27.7	20.50	10%	I	0.1	7.10
Siros	84	379	31.8	23.53	25%	M	0.8	7.47
Kithnos	99	349	34.5	27.25	10%	I	0.1	7.15
Kea	131	349	45.7	36.10	10%	I	0.1	9.50
Andros	380	349	132.6	104.75	25%	M	2.8	25.05
Tinos	194	349	67.7	53.48	20%	M	1.1	13.12
Mykonos	85	379	32.2	23.83	20%	I	0.25	8.12
Naxos	428	379	162.2	120.03	50%	K	20.45	21.72
Amorgos	121	379	45.9	33.89	70%	K	8.1	3.81
Anafi	38	379	14.4	10.66	20%	I	0.1	3.64
Thira	76	379	28.8	21.31	60%	M	1.8	5.69
Ios	108	379	40.9	30.27	15%	I	0.24	10.39
Sikinos	41	379	15.5	11.47	50%	M	0.8	3.23
Total			877.7	666.37			55.04	156.09
Perfecture of Kyklades								
Patmos	34	603	20.5	12.71	15%	I	0.2	7.59
Leros	53	818	43.4	21.22	30%	M	2.6	19.48
Kalimnos	111	818	90.8	44.50	90%	K	40.4	5.90
Kos	290	818	237.2	116.23	60%	M	29.0	91.97
Nisiros	41	818	33.5	16.41	5%	I	0.1	16.99
Simi	58	818	47.4	23.23	100%	K	23.4	0.77
Tilos	63	818	51.5	25.23	80%	K	20.4	5.87
Xalki	28	818	22.9	11.22	100%	K	11.3	0.38
Rodos	1 398	818	1 143.6	560.36	60%	M	140	443.24
Karpathos	301	818	246.2	120.64	40%	M	20.1	105.46
Kasos	66	818	54	26.46	80%	K	21.4	6.14
Astipalaia	97	818	79.3	38.86	40%	K	15.7	25.74

Total			**2 070.4**	**1 017.07**			**324.6**	**729.53**
Perfecture of Samos								
Samos	476	603	287.0	177.94	70%	M	21.8	87.26
Ikaria	255	603	153.8	95.36	40%	I	1.3	57.14
Fournoi	30	603	18.1	11.22	100%	M	0.5	6.38
Total**			**458.9**	**284.52**			**23.6**	**150.78**
Perfecture of Lesbos								
Limnos	476	520	247.5	180.67	70%	I	7	59.83
Lesbos	1 630	603	982.9	609.40	40%	M	59.8	313.70
Agios Eystratios	43	520	22.4	16.28	100%	M	2.4	3.62
Total			**1 252.8**	**806.35**			**69.2**	**377.15**
Perfecture of Xios								
Xios	842	603	507.7	314.77	70%	M	54	138.93
Psara	40	603	24.1	14.94	10%	I	0.14	9.02
Total			**531.8**	**329.71**			**54.14**	**147.95**
Water Sector Total			**5 191.6**	**3 104.02**			**526.6**	**1 561.50**
				(60%)			(10%)	(30%)

*Referred to the theoretically existing underground potential, the exploitation of which is not possible. Only the amount of water which percolates in mixed karstic or granular aquifers is considered as underground potential. The small amount of water (rated at 3% of active precipitation) which percolates in the mantle decay of the impermeable formations is not considered as underground potential. In cases of islands where a karstic aquifer of large scale is developed, the referential underground potential (sometimes an important proportion), is the theoretical and the exploitation of only a part (about 30-40%) of which is feasible. The rest outflows underground towards to the sea, due to the sea contact perimetrically to the karstic aquifer. The surface runoff exploitation proportion is much smaller.

**The prefecture total number results only from the islands with more than 300 inhabitants. In the island there are many other small islands which are not included in the profound approach.

Aegean islands and mainly the Cyclades and the smaller islands of Dodecanese, are facing considerable water scarcity problems. To describe these situation are frequently used indices such as the Consumption Index, Exploitation Index and Population to Resources Ratio. In figure 6 is shown the consumption index of the south Aegean islands. The consumption index is defined as the ratio of total water demand to the total available water resources and represents a draft measure of the water shortage. Depending on the characteristics of the region, values of the consumption index over 80% indicate possible water shortage problems, and values over 130% indicate severe water stress conditions. In many cases the demand in these Islands is grater than the total stable water resources indicating that non-regional or non-conventional water resources are used (e.g., water transfer from other basins, desalination).

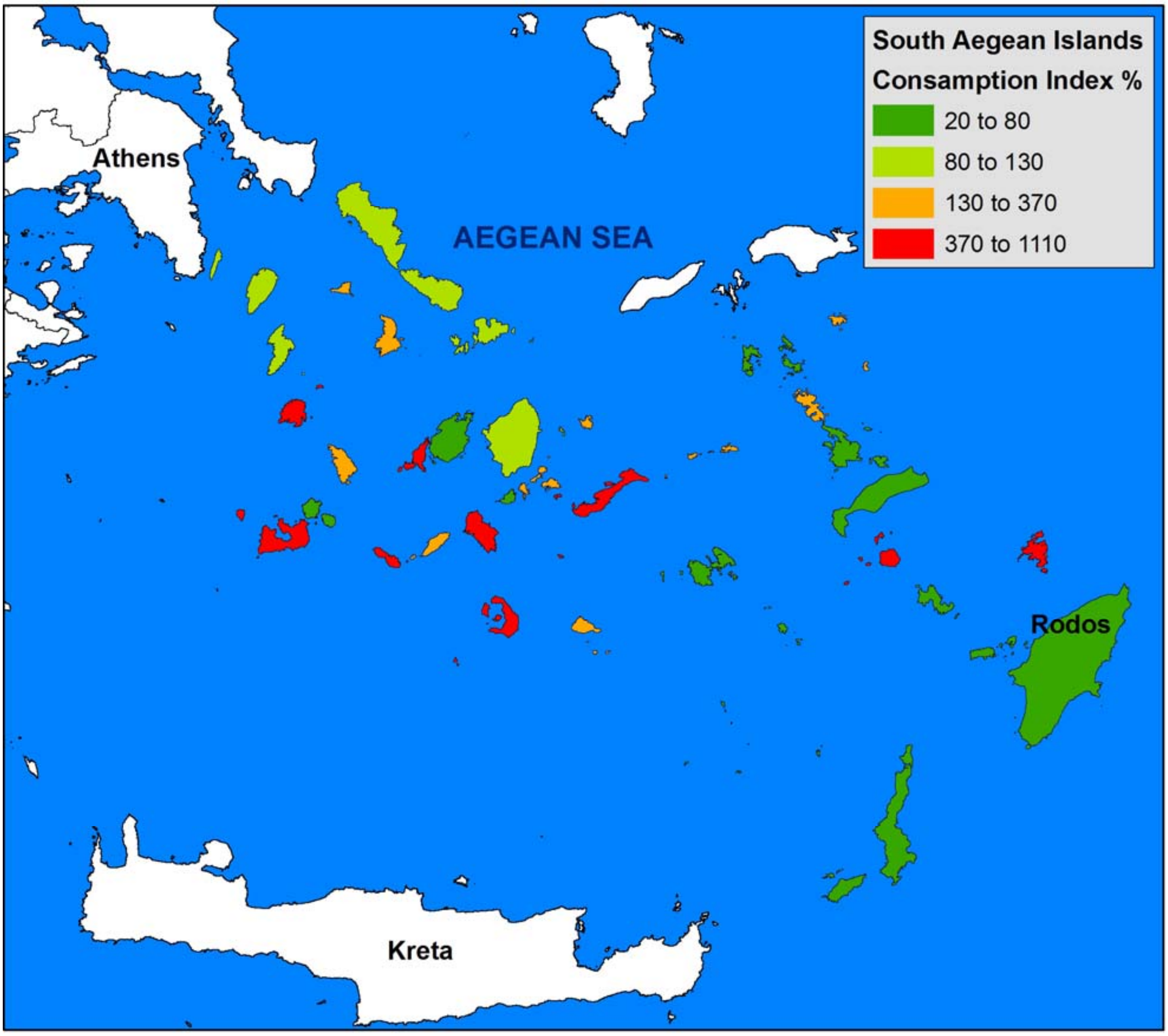

Figure 6: Consumption Index for the Aegean Islands (Voivontas et al., 1999)

In figure 7 the quantities of water transported in the south Aegean islands from 1997 to 2001 iareshown. In the case of the smaller islands the transported water is some times the main source of potable water. While water transportation is the only available solution for some of the islands its cost is very high and other solutions are also examined such as desalination. As an indication of the cost, the year 2001 the Ministry of Aegean and Islands Policy spend 1.900.000€ for the water supply of Cyclades and 2.900.000€ for the water supply of Dodecanese (Source Ministry of Aegean and Island Policy). This cost is even higher today.

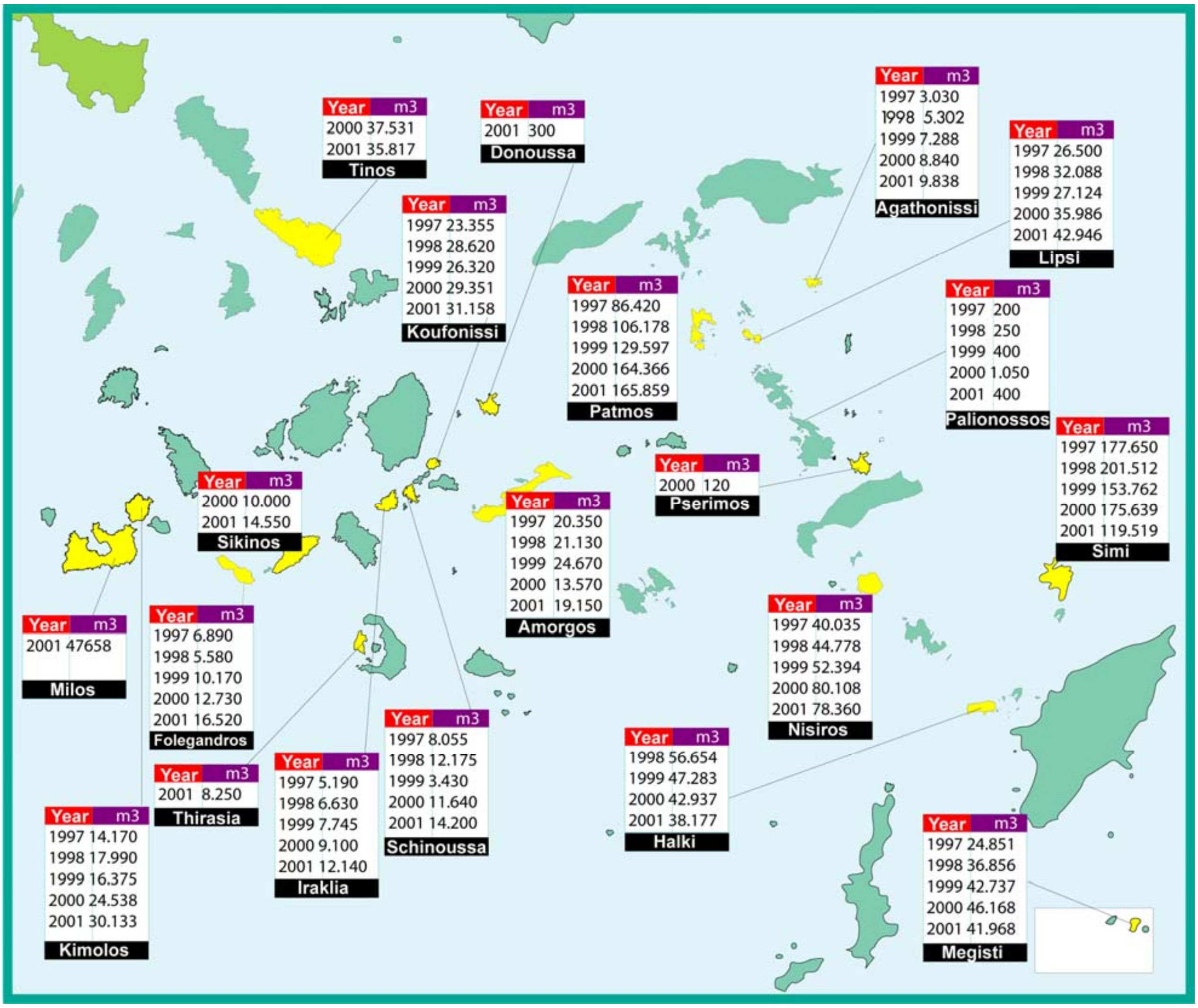

Figure 7: Quantities of fresh water transported in the South Aegean Islands from 1997 to 2001 (Source Ministry of Aegean and Island Policy).

Environmental Issues: The intense agriculture in the area is the main pollution source of the underground waters. Therefore, the implementation of the good agricultural practices is strongly recommended (Directive 91/676/EEC). On the other hand, the aquifers are subjected to intensive use which results in the water quality degradation due to the sea water intrusion.

Water Demand: The water resources of the particular water sector are used for agriculture, animal-breeding, water supply for drinking water, industries, energy production or other uses.

Concerning agriculture, the total number of cultivated area is 1.645.236.000 m2 while the number of the irrigated area is 204.500.000 m2. Nevertheless, only 39.500.000 m2 are irrigated from collective irrigation networks. The rest area’s water needs are covered with small local or private constructions like wells or boreholes extending the ground water quality degradation due to over-pumping. The future perspectives of the water sector comprise of an expanded research and construction of dams and reservoirs by the Ministry of Rural Development and Food in order to meet the needs of the sector in irrigation and drinking water.

The annual water needs for animal-breeding, amounts 6.8 hm3. Most of the water needed (5 hm3) is consumed for open breeding while only 1.8 hm3 are used for animal breeding in stables.

The Aegean islands water district has 456.712 permanent inhabitants. However, the needs for potable water increase significantly during the summer period when a huge number of tourists are accommodated.

The major industrial production in the sector comes from distilleries (Rhodes, Lesbos), tannage (Xios, Lesbos) and textile factories (Samos, Kyklades). The industrial water needs are covered by water supply networks or private drills.

In the water sector of the South Aegean Islands, there is not any hydroelectric power station. However, must be mentioned the existence of geothermic fields (Mylos, Nisiros) from which electrical energy could be produced. A lot of research has been accomplished the previous years towards this target. This water is rich in salts and therefore could not be used directly for irrigation or water supply, but it could cover a great part of the water needs after a desalination procedure.

4 Desalination

4.1 Local situation

Even if desalination is a very promising technology that can comprise a reliable solution for the fresh water shortage problem of the most arid Greek areas, it is fairly developed in Greece. Only the recent years were materialized several important desalination plants in the Greek islands, while up to now the only existent applications were mainly experimental or pilot installations. On the other hand, till the recent years, the preferable solution to cover the increased needs for fresh water due to the development of the tourism industry was the over exploitation of the ground water and the transportation of water with ships. The result of this policy was the serious degradation of the ground water quality due to the sea intrusion in the costal aquifers, and at the same time fresh water transportation was proven a very expensive practice.

The above reasons lead the authorities to search for other solutions in the form of integrated water management in a local scale incorporating all the appropriate solutions in order to decrease the water demand and to increase the available water resources. These solutions are the change of water pricing policy, the improvement of the distribution networks, the proper management of the ground water, the exploitation of the surface water etc.

In this framework desalination technologies were evaluated again and recognized as viable and reliable solution in the case of small, dry islands.

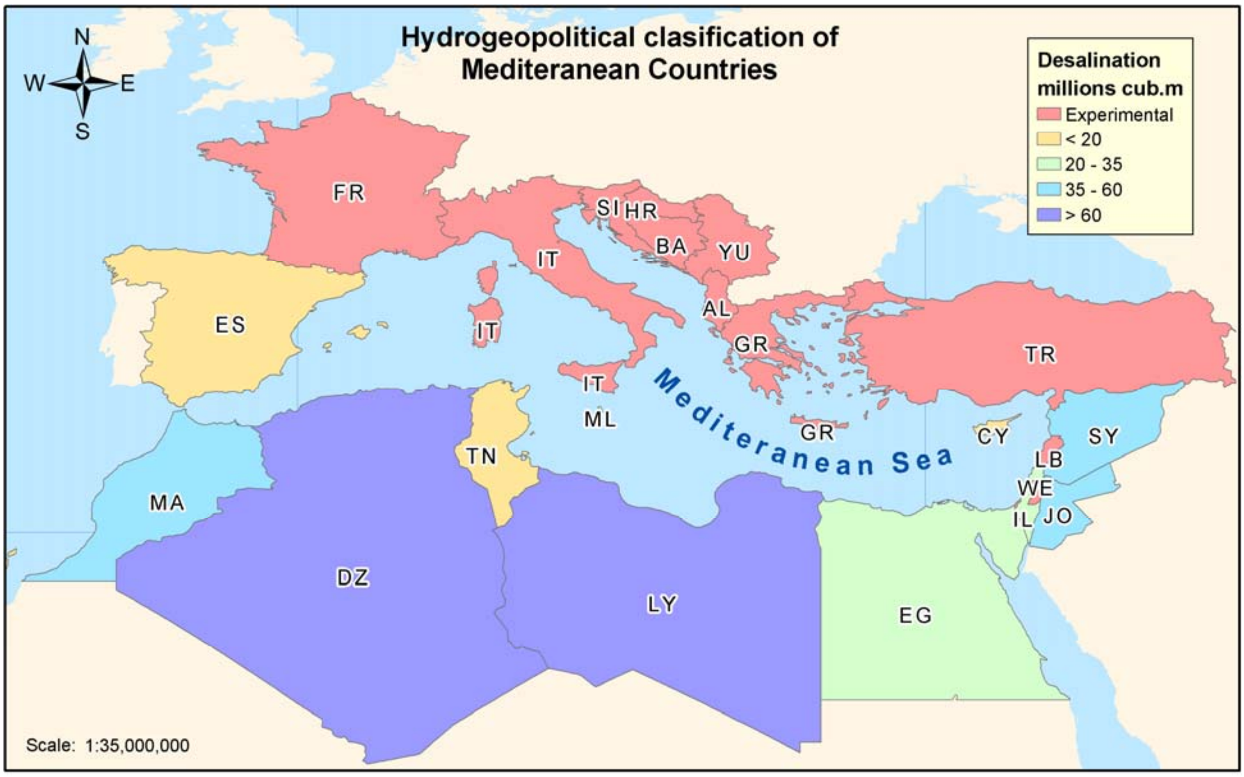

Figure 8: Hydrogeopolitical classification of Mediteranean Countries (Source Aquastat).

Some examples of desalination units installed in Cyclades and Dodecanese islands the previous years are presented in table 6.

Table 6: Desalination units installed in Cyclades and Dodecanese

Island	Site	Water capacity (m^3/day)	Year of installation
Cyclades			
Syros	Ano Syros	120	1993
		250	2000
		500	2002
	Ermoupoli	800	1992
		800	1997
		250 (2 units)	2001
		800 (4 units)	2002
	Poseidonia	750 (3 units)	2002
Ios	Mylopotas	1000	2001
Mykonos	Korfos	1200 (2 units)	1989
		2250 (3 units)	2001
Paros	Naousa	1200	2002
Sifnos	Kamares	500	2001
Tinos	Tinos	500	2001
Santorini	Oia	380	1995
Dodecanese			
Megisti	Megisti	50	1990
Nisiros	Nisiros	300	1991
		350	2002

Source: Ministry of the Aegean
Note: A 100m³/day plant is under construction in Schinousa

There were also installed numerous private desalination units, which cover the fresh water needs of hotels, small settlements or even houses. A successful example is the installation of three private desalination units at the Porto Karas Hotel, which is located in the peninsula of Halkidhiki, with a total capacity of 1.800 m3/day, which entirely covering the fresh water needs of the hotel complex and its activities.

Autonomous desalination units based on renewable energy sources concern only experimental or pilot installations. In figure 8 is shown that desalination technology even if it is a very important solution for specific cases, for the whole country it represents a very small amount of the consumed water.

4.2 Role in the water supply system and future perspectives

The role of desalination units in the water supply system of Greece is very limited and it mainly concerns medium size units installed in small Aegean islands with increased tourism. There are of course some examples like the small island of Oinouses, where a big desalination unit was recently installed aiming to cover most of the fresh water needs of the island. In the future desalination units will play an important role in the fresh water supply of dry isolated areas of Greece like the Greek islands.

As an example can be referred the provision in the water resources management plan of the prefecture of Cyclades, for the creation of desalinations units in the islands of Mykonos (2.000 m^3/day), Syros (3.000 m^3/day) and Folegandros (300 m^3/day).
Production of fresh water using desalination technologies driven by renewable energy sources (RES) is also a viable solution to the water scarcity at remote areas without access to the electricity grid.

In Greece almost all inhabited places are connected to the grid, but desalination units driven by RES, such as those driven by solar and wind energy, can offer environmental friendly production of fresh water in regions with severe water problems, like the south Aegean islands, which at the same time have large renewable energy resources potential while their electric grids are small and autonomous, and electricity production is mainly based on expensive and polluting liquid fuels (heavy fuel oil and diesel). ADU-RES penetration will be also supported by the subsidence existing for the production of energy from renewable sources.

Systems based on renewable energy can most of the time sell their surplus energy production to the Power Company and use the grid as backup since there is a special legislation promoting this kind of operation. In contrast the penetration of renewable energy to the power system of small isolated islands it is defined to be at maximum 15% to 30% to avoid stability problems at the network. So for the future, if the energy production from RES overtop this threshold, the desalination units based on RES will be forced to operate as autonomous systems.

5 Environmental perspective

5.1 Current state - most relevant problems.

Water resources management is a high priority for Greece because water demands cannot often be covered by local water resources. On the other hand water quality degradation due to human activities is further limiting the available water resources. The main problems in Greece are located in coastal areas particularly where associated with limited water resources as in many islands.

The main Greek rivers have good quality because the bigger cities in Greece and the industrial activities are sited near the sea and most of the effluents are flowing directly to the sea. Therefore there were, during the last decades, serious pollution problems of the sea near the big cities like Athens and Thessaloniki, but they were dramatically decreased with the systematic use of waste water treatment plants. There is still a big effort to apply appropriate waste water treatment in every significant town or industrial activity.

Exceptions to the good quality of the inland water are the big rivers at the north coming from the neighbouring countries but the problem is still under control with the help of international agreements for these rivers.So the two more serious threats for the inland water quality in Greece are the pollution coming from diffused sources like agricultural activities and the related pollution with agrochemicals, and the sea intrusion to the costal aquifers that causes salinization of the ground water and thus serious degradation of the water quality.

The problem of water pollution with agrochemicals like nitrates, pesticides etc is mainly sited in areas of intensive irrigated agriculture. There is also evidence that agrochemicals are seriously influencing the lakes water quality mainly by causing eutrophication. In contrast, the problem of ground water salinization mainly exists in dry coastal areas with developed agriculture or tourism like the Aegean islands and the east cost of the mainland, and is related with overexploitation of fresh water sources and over pumping of the ground water. In figure 9 are shown areas facing ground water salinization problems. The problem of sea intrusion is getting more serious in areas with special hydro-geological conditions. In such cases sea intrusion can even occur in wet areas like the west coast and the Ionian Islands.

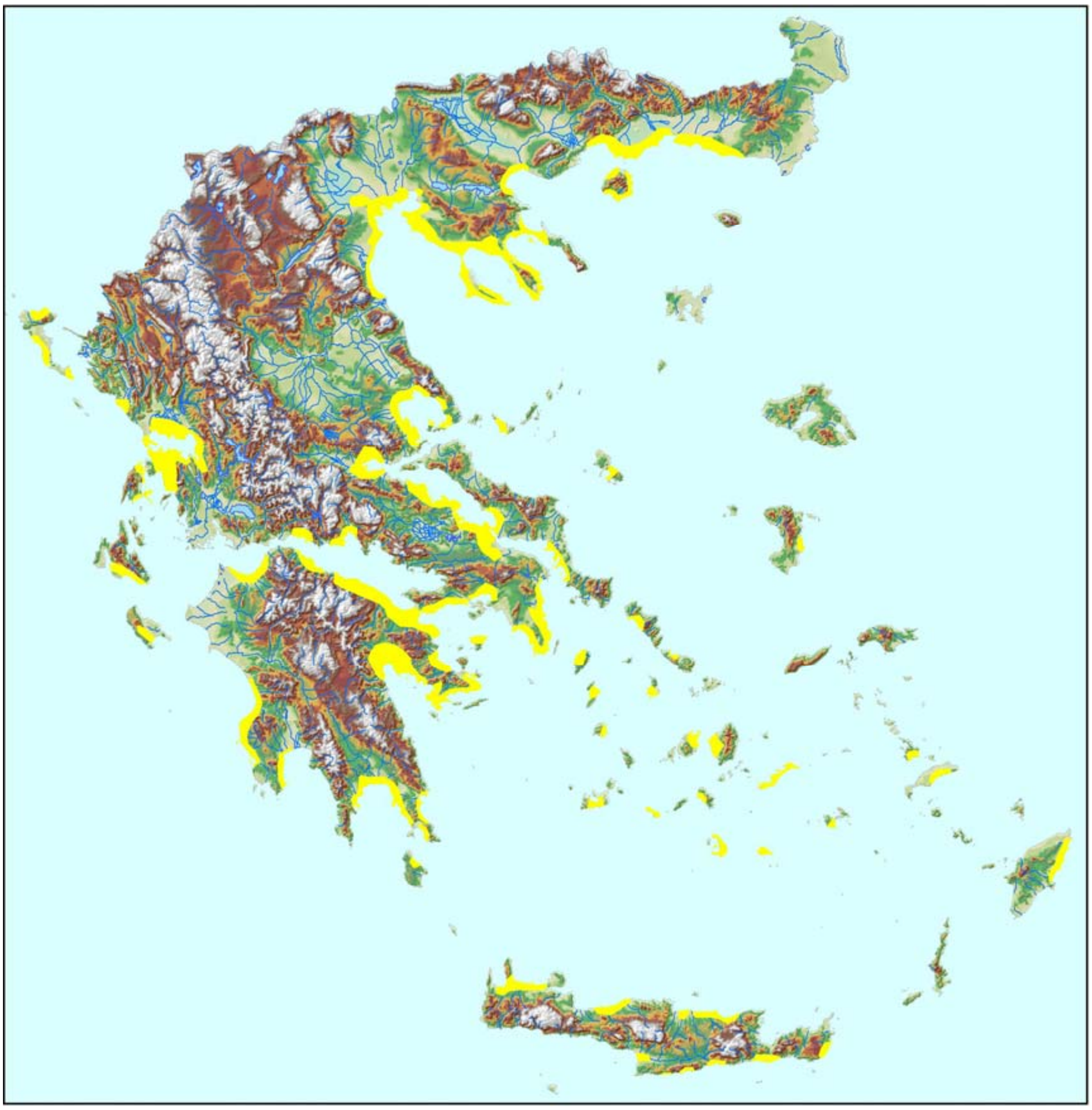

Figure 9: Coastal areas in Greece facing problems of aquifers salinization. (source: G.Soulios).

5.2 Current and planned solutions

It was already mentioned that one of the major problems concerning water resources is the pollution of surface and underground water due to pollution from wide spread nutrients, pesticides and other farm inputs. Nowadays, there are made some attempts to control the amounts of these substances entering the aquifers. However, it is rather difficult and time consuming to monitor and determine the movement of such ingredients. The most efficient solution is to take up the appropriate measures in order to adopt good agricultural practices, which will reduce to minimum the pollution charge from the above elements.

Biological treatment of wastes is the only sustainable solution, concerning the domestic waste water management. In Greece exists nowadays special legislation, foreseeing the building of biological treatment plants in every settlement with population over 3000 inhabitants and the treatment of all the waste water coming from any kind of activities like industrial tourism etc. At the same time there are several pilot applications using the treated waste water for irrigation.

In contrast the above legislation is very difficult to follow and in several cases even the public sector ignore the lows because there is lack of financial resources to apply the appropriate waste treatment methods.

Salinization is firstly confronted with rational ground water use. For this reason very careful water resources management is needed in the coastal areas including the use of alternative fresh water sources like treated waste water and desalinated water. Artificial recharge of the aquifers using treated waste water or sources of water that are not used during the winter, is a promising technique, used nowadays only in a pilot scale in Greece. Here must be also noticed that the desalination of brackish water coming from salinized aquifers must be avoided because it will lead to additional increment of the pumped water and consequently, further worsening of the salinization problem.

6 Energy sources

6.1 General overview of the energy supply

Public Power Corporation (PPC) is the dominant corporation in the energy sector in Greece. PPC was established in 1950 with main purpose the production and transmission of electric power and actually continues that role under Directive 96/92 regarding the deregulation of the electricity market and the relevant national enactment being Law 2773/1999 *"Liberalization of the Electricity Market-Regulation of energy policy issues and other provisions"* (Government Gazette A 286). The main energy sources for the country are the 34 major thermal and hydroelectric power stations and 3 wind parks which are connected to the mainland's power grid, plus the 58 independent power stations located on Crete and Rhodes and throughout the Greek islands (33 thermal, 2 hydroelectric, 18 wind parks, and 5 photovoltaic parks) (See Figure 10). All mentioned above form the basis for all of the country's economic activity together with the use of petroleum and natural gas.

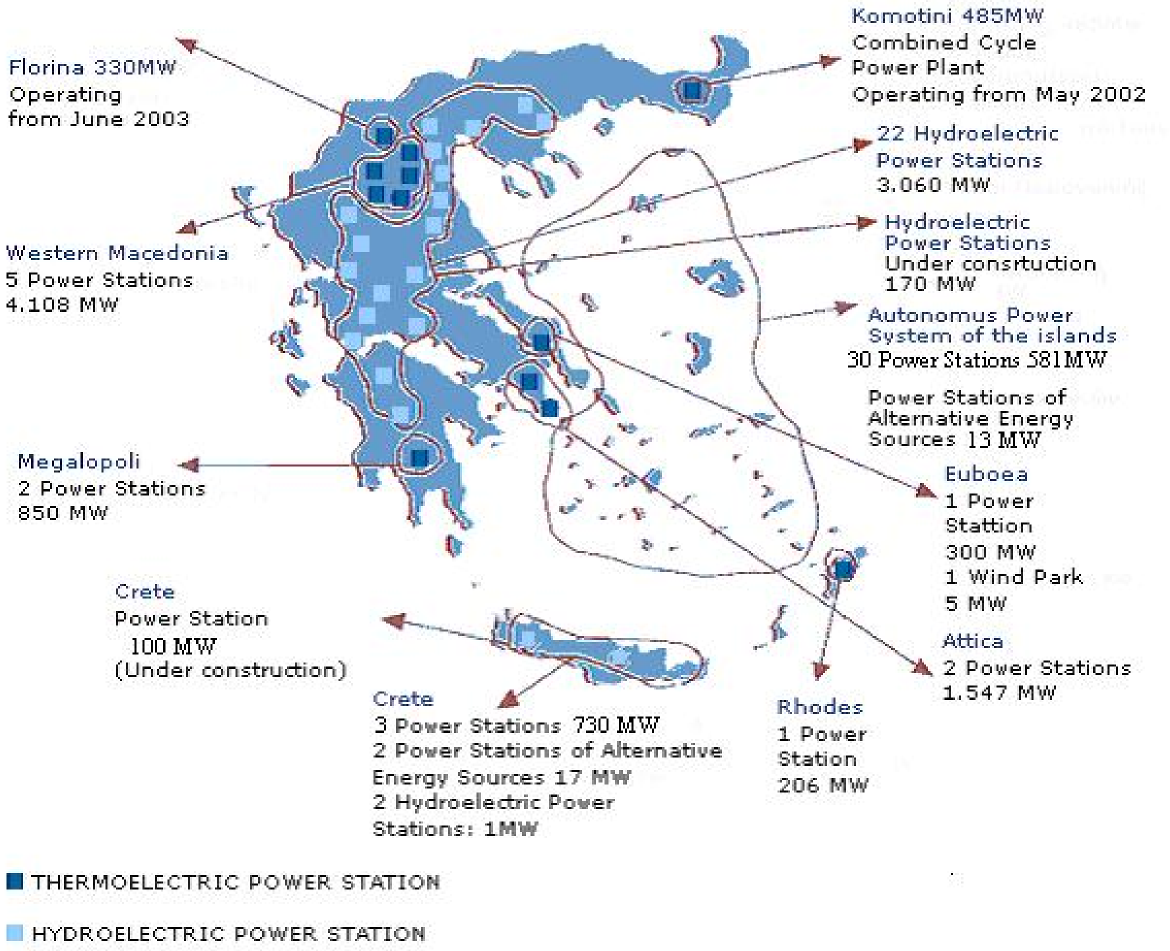

Figure 10: Power stations in Greece (Source PPC)

The exploitation of lignite fields has a key role in the electricity sector. Lignite is found in great abundance in Greece's subsoil (See Figure 11). In terms of lignite production, the country is second in the European Union and sixth worldwide. On the basis of Greece's total deposits and anticipated future rate of consumption, it is estimated that the domestic supply of lignite is enough to last for more than 50 years. To date, a total of 1.3 billion tons of lignite have already been mined, while exploitable reserves total approximately 3.2 billion tons. In 2003, a total of 68.1 million tons were mined, a record since the beginning of the mines' operation. Today, PPC's 8 lignite power stations comprise 44% of the country's total installed capacity and produce nearly 64% of the country's electrical energy.

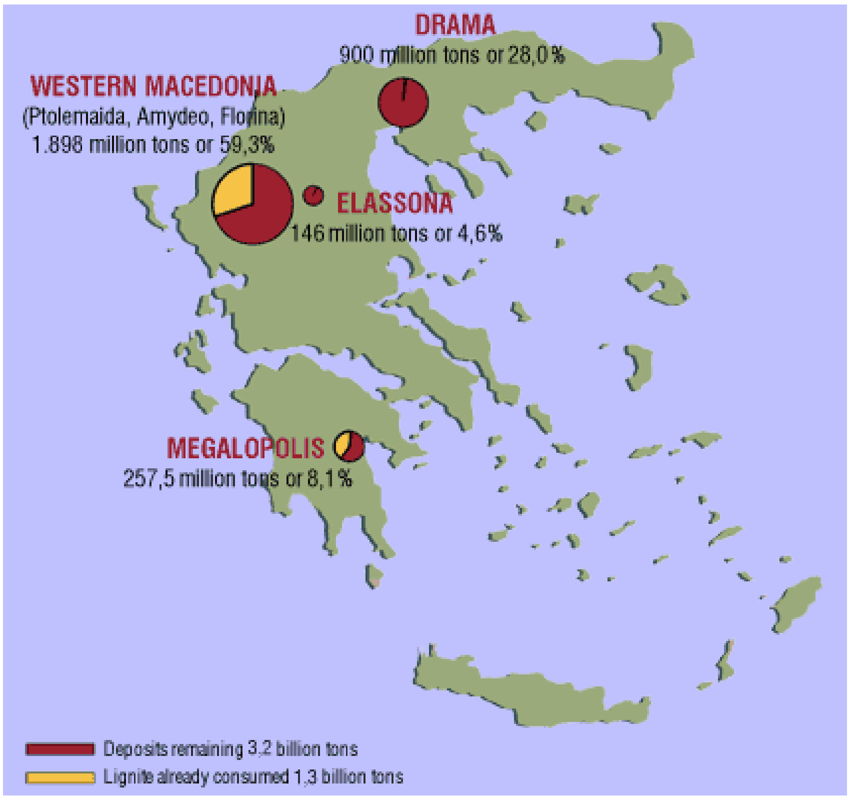

Figure 11: Lignite's exploitation in Greece (source: PPC)

During the past few years the PPC, apart from the construction of new thermal (lignite, petroleum and natural gas) and hydroelectric power stations, has also turned towards the utilization of alternative forms of energy (wind, sun and geothermal).

The electricity transmission system on mainland Greece is owned by PPC, which transmits electricity throughout the country via high voltage lines. The operation of the transmission system is a responsibility of HTSO. PPC's Transmission Business Unit is responsible for the day to day physical operation, maintenance and development of the interconnected transmission system, according to instructions HTSO's. Electricity generated by PPC power stations or by independent generators - and, in the case of imported electricity, from the points of interconnection with neighboring electricity systems- is transported to large industrial consumers and to the distribution network, which then distributes electricity throughout the interconnected system.

There is an extensive transmission system in Greece, which covers the needs even of the most distant areas of the country. In particular, the mainland is covered by a sole network which is connected with the adjacent countries.

International connection secures the safety of national energy systems and their mutual support in cases of emergencies. Furthermore, it allows the commercial operation of the national energy systems, since their interconnection enables electric energy imports and exports. The transmission system is interconnected with the neighboring transmission systems of Albanian, FYROM, Bulgaria and, through a 400 kV direct-current submarine cable, with Italy's transmission system, while two international interconnections (Turkey, FYROM) are currently underway.

On the other hand, the Greek islands have either an autonomous transmission system or they are connected by two or three and own a common transmission system. The cost of the produced electric power is higher in the islands because the production is depended on diesel and also because of the small size of the networks that making difficult and expensive to balance the pick loads.

6.2 The electricity market in Greece

The demand for electric energy in Greece during the past few years has exhibited a far greater rate of growth than the average increase in Europe. The increase in the rate of demand is likely to continue, as the per capita consumption of electricity in Greece is considerably lower than the European mean average, and domestic charges by PPC S.A. are the lowest in Europe.

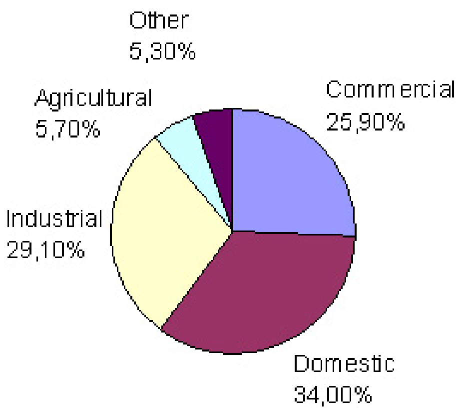

Figure 12: Composition of Greek electricity consumption for the year 2003 (Source: PPC)

In the charts below the increasing trends of consumption in the Greek market, as well as a comparison between domestic charges in Greece and the E.U. can be seen.

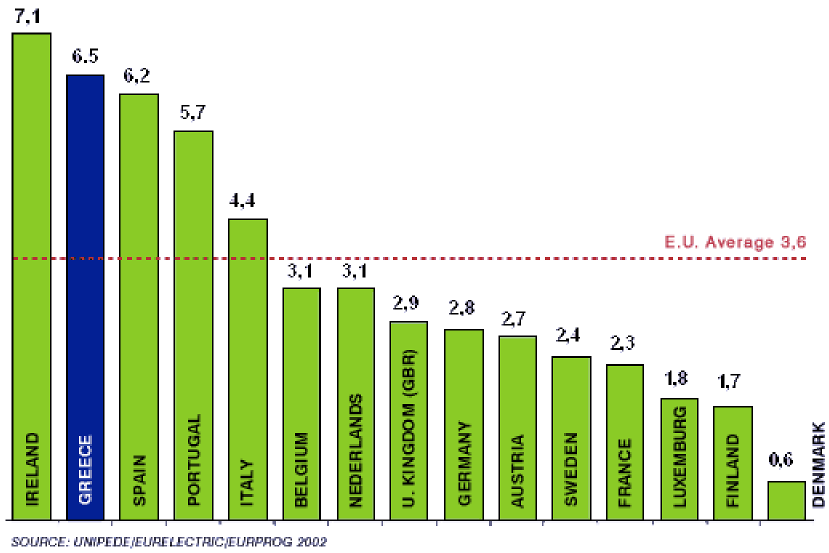

Figure 13. Annual percentage of increase in European energy consumption. (Source PPC)

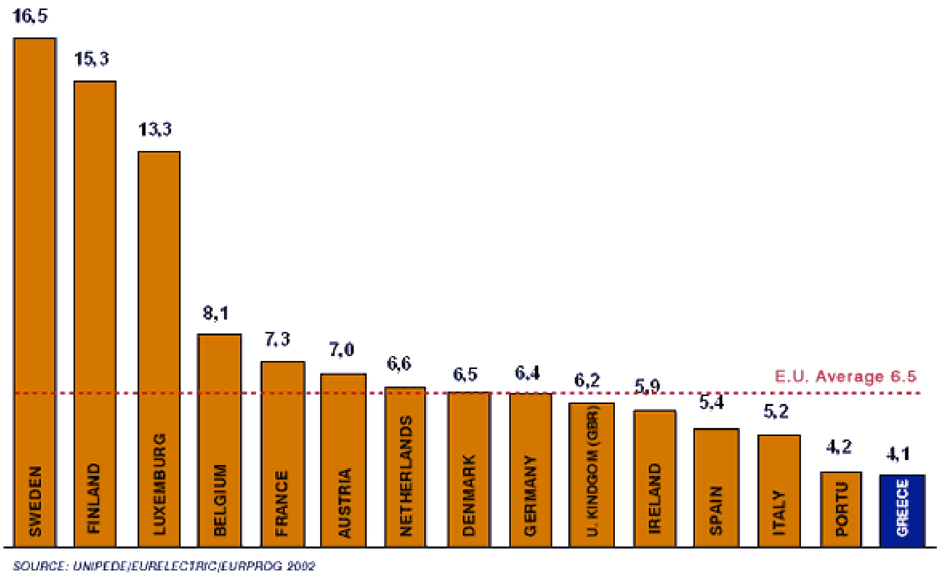

Figure 14: Comparison of E.U. domestic electricity prices, by country. (Source PPC)

The deregulation of Greece's energy market (February 2001) allowed the granting of power generation licenses to many other companies and private bodies. Also, the operation of the interconnected system is being carried out by an independent authority named Hellenic Transmission System Operator (HTSO). Similarly, the overall control of the Greek Power System (Power Generation, Transportation, and Distribution) has been taken up by RAE (Regulating Authority for Energy). PPC S.A. carries out the duty of the operator of the network in the non-interconnected island clusters with main objectives the operation, exploitation, maintenance and development of the network in a sufficient, secure, economically efficient and reliable manner.

6.3 Role of the renewable sources

Nowadays, there is a strong vividness among national and foreign private corporations targeted in the market of the renewable sources. Many new corporations invest in the construction of wind parks. Some wind parks already exist in Serres (17MW) and in some Greek islands (Lesbos (9MW), Kefalonia (3.6MW)). Greece possesses a significant Renewable Energy Sources potential. The development of Renewable Energy Sources and rational use of energy has been set a national priority.

A national legislative framework that seeks to promote Renewable Energy Sources and rational use of energy includes:

- Law 1559/1985 "Regulation of matters of alternative forms of energy and specific matters of power production from conventional fuels and other provisions" (Government Gazette A 185) under which PPC installed 24 MW while local government organizations only 3 MW and the private sector did not participate.
- Law 2244/1994 *"Regulation of power generation issues from renewable energy sources and conventional fuels and other provisions"* (Government Gazette A 168) which incorporates institutional regulations for co-generation and the establishment of a dynamic traffic policy for RES electricity production. The Law established fixed sale rates of renewable energy at a level substantially equal to 90% of the medium-voltage and made it obligatory for PPC to buy that energy.
- The development Law 1892/92 which foresees the subsidization of industrial activities relative to energy saving and the subsidization of industries and companies for the production of electricity through the exploitation of indigenous RES.
- Recent Law 2941/2001 *"Simplification of procedures for establishing companies, licensing Renewable Energy Sources plants, regulation of matters of the company GREEK SHIPYARDS S.A. and other provisions"* (Government Gazette A 201), not only filled some gaps of the legislative fabric but also attempted to deal the licensing process.

The Greek energy demand is summarized in the table below:

Table 7: Greek Energy Demand (Source Greek Ministry of Energy)

Source	Year 1999 (Mtoe)	Percentage (%)
Lignite	8.91	36.4
Coal	0.73	3.0
Hydro	1.67	6.8
Natural Gas	2.65	10.8
Crude oil	10.54	43.0
Total Primary Energy	24.5	100

6.4 Experiences on autonomous systems

Autonomous systems have been developed in a limited scale because, as it was mentioned above, the electric grid covers almost the entire area of the country. Some examples of specific pilot applications are referred below.

The Centre of Renewable Energy Sources materialized the **MIDES** programme (Milos Geothermal Energy Driving ORC Turbo generator and Seawater Desalination Plant). Milos is a municipality of approximately 5.000 inhabitants and a total amoumt of about 80.000 tourists visiting the island during the summer months. The water demand and the number of tourists increase annually, while the Island depends on the mineral exploration and the increasing tourism. On the other hand, water wells supply a bad quality (due to salinity) and insufficient quantity of water. The main objective of this innovative demonstration project was to provide the Milos community with sufficient quantity of clear drinking water in a cost and energy efficient way avoiding environmental impacts. This objective was achieved by combining the technologies of ORC electricity generation, ME distillation and absorption chilling. The project led to an improvement of the local economy, life quality, and emission reduction.

Moreover, the development and application of a software tool for designing hybrid renewable energy systems was accomplished in order to cover the electricity and water needs of the Merssini village on Donoussa Island in the Aegean Sea of Greece (Manolakos *et al*., 2001). The Merssini village is occupied by 20 year round residents while the population is doubled during the summer period. The village is non-electrified and faces a problematic scarcity of fresh water. Therefore, a simulation programme has been developed and applied for optimising the system size. The programme consists of routines which simulate the operation of all the available technologies such as wind generator, photovoltaics, batteries and a micro hydraulic plant which form the energy storage as well as a reverse osmosis desalination plant. The electricity produced by the wind and the photovoltaic generators is driven to the different energy sinks through an intelligent energy management centre. The sea water is pumped from sea level to the desalination cartridges at a pressure of about 70 bars. The brine is used to drive a turbine in order to recover part of the energy used by the high-pressure pump. Electricity is supplied to a pump to lift the fresh water from the desalination plant to the upper reservoir. The fresh water reservoir has the capacity to fully satisfy year-round, the needs of the village for drinking, washing, etc. and also to irrigate small pieces of land for the local production of high value vegetables. Any power surplus is consigned to the innovative storage system (consisting of both micro-hydraulic and battery systems mentioned earlier) of the PV-Hydro. This storage is used in order to partially replace the batteries which have several disadvantages, particularly limited life duration (up to several years depending on the maintenance) and the toxic wastes that their use implies.

6.5 Future perspectives

In the framework of future planning of the Energy Sources in Greece, a turn in the Renewable Energy Sources and natural gas must be noted, which could result in the cutback of the lignite use. The use of nuclear energy is not feasible in Greece due to the strong citizens’ opposition.

In relation to desalination technologies, it must be also noticed that the main target regions for desalination in Greece are the small islands, areas which have a significant deficit in fresh water.

At the same time these islands, are most of the times, not connected to the electricity transmission system of the mainland but they have autonomous power supply systems, including also renewable energy power sources like wind farms. In other words the development of desalination as an alternative source of fresh water is greatly depended on the existence of secure but cheap energy supply sources while the small grids of these areas cannot afford the significant loads of the desalination units, or the very high cost of the extra energy production which is mainly based on diesel generators.

7 The Institutional Framework for Water Management

7.1 The Water Law

Since December 2003, a new legislative and institutional framework has been put into force in the country. It consists of Law 3199/9-12-2003 (OJG 280A/2003) on “water protection and the sustainable management of the water resources” with which the EU Water Framework Directive (WFD) (2000/60/EC) is transposed into the national legislation. This new framework Law foresees a radical reorientation of the respective administrative capacities in Greece and introduces an innovative and holistic approach concerning water management that recognizes explicitly the ecological function of water. It also lays emphasis on the management of water on the basis of river basins as well as on the water pricing so that it reflects its full costs. In more detail, the main objectives of the new Law include: the long-term protection of water resources, the prevention of deterioration and the protection and restoration/remediation of degraded water resources and wetlands, the reduction and, in cases, the phase out of harmful and polluting discharges, the reduction of groundwater pollution and the prevention of its further deterioration as well as the mitigation of the effects of floods and droughts. The 3199/03 Law also incorporates the ‘polluter pays principle’ and the objective of maintaining or reaching a ‘good ecological status’ for all water resources through the control of pollution by use of thresholds levels and standards. It also introduces innovative approaches concerning the protection of water quantity and the transnational cooperation for the protection of transboundary water courses and lakes.

The new legislation for the protection and the sustainable management of the water resources in Greece provides a detailed identification of 14 River Basin Districts (RBDs) according to the administrative units of the country, the competent authorities and their respective responsibilities in water management in Greece. In this context, Regional Water Directories and Councils will be established within each River Basin District / Water Region (RBDs) and they will have the responsibility for organising and coordinating water policy activities (including water pricing) and specific Water Programmes and Action Plans with specific measures for each RBD. They will be in charge for implementing the WFD in the RBDs of the country and they will be supervised by the National Water Agency, a governmental authority with the overall responsibility for establishing water policy. In the new legislation there is also consideration about the most effective options for setting up legal coordination mechanisms relating to the designation and management of the River Basins that cross the Water Region borders. The appointment of the new authorities will be legally binding once it is integrated into the new legislation.

The 3199/03 Law also integrates the public participation requirements of the WFD. The active involvement of the interested parties is ensured by their representation at the National and Regional Water Councils that will be developed as a part of the new administrative framework. In order to complete the transposition of the WFD, besides this new law, further instruments, Presidential Decrees and Joint Ministerial Decisions are under preparation, for the incorporation of the technical provisions of the Directive.

Before this new law on water was put into force, the legislative framework of the country on this issue included Law 1739/1987 on Water Resources Management, establishing the institutional framework for the management of water resources in Greece and the Environmental Protection Law 1650/1986 for the protection of surface and groundwater quality, including control of effluent discharges. The 1987 Law also provided for the design and implementation of water resources policies as a prerequisite for development that would enhance the results of production processes, balance the various competitive uses for water and contribute to the renewal-replenishment of water resources as well as to the protection of the environment through participatory processes.

Despite the innovative and integrated approach introduced by this Law, its complexity made its full implementation in practice quite difficult.

The existing Legal Framework for water resources management in Greece, apart from the above mentioned new Law 3199/9-12-2003, also includes Joint Ministerial Decisions (JMD) such as JMD 46399/1352/1986 and JMD A5/288/1986 for the harmonization of the Greek legislation with EU Directives 75/440, 76/659, 76/160 and Directives 78/659, 79/869 and 80/778 respectively, as well as JMD18186/271/1988 for measures and restrictions for the Protection of the Aquatic Environment: Determination of Limit Values for Dangerous Substances in wastewater. It also includes Council of Ministers' Decisions (CMD) such as CMD 144/1987 for the Protection of the Aquatic Environment from Pollution caused by Dangerous Substances. Moreover, concerning drinking water quality, the Sanitary Regulatory Decision A5/288/86 (Official Gazette of the Government - OJG 53B, 379B) about "Drinking Water Quality" (which refers to the qualitative characteristics of drinking water, to the frequency of sampling and the obligations of the responsible persons), in harmonization with Directive 80/778/EEC, was valid until December 25th 2003,when the new JMD Y2/2600/01 (OJG 892/B/11/11-7-01), in harmonization with EU Directive 98/83 for the quality of water for human consumption came into force.

Management of protected areas including wetlands, was defined in 1999 (Law 2742/99) through the establishment of administrative units (Management Bodies) and the competence of NATURA 2000 Committee, whereas in 2002, through Law 3044/02, 25 Management Bodies were established, additionally to the existing two ones. Management of the most important protected wetland sites in Greece, designated as Ramsar wetlands of international importance, is attained through the establishment of these Bodies (which are financially supported, for the time being, from the state), that will collaborate with the respective regional services to be established according to Law 3199/03, with the mandate to develop and implement regional water management plans.

Concerning the protection of the quality of water resources and of vulnerable zones, in years 2001 and 2002 the existing legislative framework was complemented by various JMDs determining protection measures for vulnerable water resources as well as threshold levels for polluting substances from various anthropogenic sources, according to relative EU Directives.

Finally, in 2003, a new Forest Act (3208/03) was adopted, concerning the protection and management of forest resources with emphasis on the protection of forests and their hydrological role.

7.1.1 Qualitative standards

The directives concerning several uses of water as well as the protection of water are of great interest. The Directives are sited as follows:

A. **Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States**

This Directive concerns the quality requirements which surface fresh water used or intended for use in the abstraction of drinking water must meet after application of appropriate treatment. Ground water, brackish water and water intended to replenish water-bearing beds shall not be subject to this Directive.

Harmonization of national legislation implemented in 1986 with the 46399/1352/86 Ministerial Decision. Based on the Ministerial Decision and in accordance with the Council Directive, surface water is subdivided in the three following categories concerning the definition of the standard methods of treatment for transforming surface water into drinking water:

Category A1: Simple physical treatment and disinfection, e. g. rapid filtration and disinfection.

Category A2: Normal physical treatment, chemical treatment and disinfection, e.g. pre-chlorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination).

Category A3: Intensive physical and chemical treatment, extended treatment and disinfection e.g. chlorination to break-point, coagulation, flocculation, decantation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination).

The numerical values and the list of parameters given in the table in Annex II of the Council Directive, defining the physical, chemical and microbiological characteristics of surface water are presented in ANNEX I of this document.

The Council Directive 79/869/EEC of 9 October 1979 concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water in the Member States, is a completion of the Directive 75/440/EEC.

B. **Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community**

With regard to 76/464/EEC Directive, the appropriate steps are taken to eliminate pollution of the waters (inland surface water, territorial waters, internal coastal waters, ground water) by the dangerous substances classified in to lists.

List I contains certain individual substances which belong to the following families and groups of substances, selected mainly on the basis of their toxicity, persistence and bioaccumulation, with the exception of those which are biologically harmless or which are rapidly converted into substances which are biologically harmless:

1. organohalogen compounds and substances which may form such compounds in the aquatic environment,
2. organophosphorus compounds,
3. organotin compounds,
4. substances in respect of which it has been proved that they possess carcinogenic properties in or via the aquatic environment,
5. mercury and its compounds,
6. cadmium and its compounds,
7. persistent mineral oils and hydrocarbons of petroleum origin,
8. persistent synthetic substances which may float, remain in suspension or sink and which may interfere with any use of the waters.

List II contains certain individual substances and categories of substances belonging to the families and groups of substances listed below:

1. Metalloids and metals and their compounds
2. Biocides and their derivatives not appearing in List I.
3. Substances which have a deleterious effect on the taste and/or smell of the products for human consumption derived from the aquatic environment, and compounds liable to give rise to such substances in water.
4. Toxic or persistent organic compounds of silicon, and substances which may give rise to such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances.
5. Inorganic compounds of phosphorus and elemental phosphorus.
6. Non persistent mineral oils and hydrocarbons of petroleum origin.

7. Cyanides, fluorides.

8. Substances which have an adverse effect on the oxygen balance, particularly: ammonia, nitrites.

Harmonization of national legislation implemented in 1988 with the 18186/271/88 Joint Ministerial Decision.

C. **Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment**

The Directive determines the minimum technical infrastructure in sanitation networks and waste water processing installations depending on the population and on the final receiver of the processed waste waters. The final receiver could be characterized as sensitive or less sensitive.

A water body must be identified as a sensitive area if it falls into one of the following groups:

(a) natural freshwater lakes, other freshwater bodies, estuaries and coastal waters which are found to be eutrophic or which in the near future may become eutrophic if protective action is not taken.

The following elements might be taken into account when considering which nutrient should be reduced by further treatment:

(i) lakes and streams reaching lakes/reservoirs/closed bays which are found to have a poor water exchange, whereby accumulation may take place. In these areas, the removal of phosphorus should be included unless it can be demonstrated that the removal will have no effect on the level of eutrophication. Where discharges from large agglomerations are made, the removal of nitrogen may also be considered;

(ii) estuaries, bays and other coastal waters which are found to have a poor water exchange, or which receive large quantities of nutrients. Discharges from small agglomerations are usually of minor importance in those areas, but for large agglomerations, the removal of phosphorus and/or nitrogen should be included unless it can be demonstrated that the removal will have no effect on the level of eutrophication;

(b) surface freshwaters intended for the abstraction of drinking water which could contain more than the concentration of nitrate laid down under the relevant provisions of Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States.

On the other hand, a marine water body or area can be identified as a less sensitive area if the discharge of waste water does not adversely affect the environment as a result of morphology, hydrology or specific hydraulic conditions which exist in that area.

D. **Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources**

The 91/676/EEC Council Directive has the objective of reducing water pollution caused or induced by nitrates from agricultural sources and - preventing further pollution. The Directive contains criteria for identifying waters affected by pollution and waters which could be affected by pollution and codes for good agricultural practice such as:

1. periods when the land application of fertilizer is inappropriate;
2. the land application of fertilizer to steeply sloping ground;
3. the land application of fertilizer to water-saturated, flooded, frozen or snow-covered ground;
4. the conditions for land application of fertilizer near water courses;

5. the capacity and construction of storage vessels for livestock manures, including measures to prevent water pollution by run-off and seepage into the groundwater and surface water of liquids containing livestock manures and effluents from stored plant materials such as silage;

6. procedures for the land application, including rate and uniformity of spreading, of both chemical fertilizer and livestock manure, that will maintain nutrient losses to water at an acceptable level.

Furthermore, the codes of good agricultural practices may include the following items:

7. land use management, including the use of crop rotation systems and the proportion of the land area devoted to permanent crops relative to annual tillage crops;

8. the maintenance of a minimum quantity of vegetation cover during (rainy) periods that will take up the nitrogen from the soil that could otherwise cause nitrate pollution of water;

9. the establishment of fertilizer plans on a farm-by-farm basis and the keeping of records on fertilizer use;

10. the prevention of water pollution from run-off and the downward water movement beyond the reach of crop roots in irrigation systems.

The harmonization of national legislation comes with 16190/1335/97 Joint Ministerial Decision.

E. **Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption**

The objective of this Directive is to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean. 'Water intended for human consumption` means:
(a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers;
(b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form.
This Directive does not apply to natural mineral waters and waters which are medicine products.
According to this Directive all Member States shall take all measures necessary to ensure that regular monitoring of the quality of water intended for human consumption is carried out, in order to check that the water available to consumers meets the requirements of this Directive and in particular the parametric values set to water intended for human consumption (Article 5 of the same Directive). Samples should be taken so that they are representative of the quality of the water consumed throughout the year. In addition, Member States shall take all measures necessary to ensure that, where disinfection forms part of the preparation or distribution of water intended for human consumption, the efficiency of the disinfection treatment applied is verified, and that any contamination from disinfection by-products is kept as low as possible without compromising the disinfection.
The harmonization of national legislation with 98/83/EC is published in 2001, and is valid since 25/12/2003, with Y2/2600/2001 Health Regulation.
In ANNEX II of this document, parts of the Council Directive 98/83/EC concerning the quality of water intended for human consumption are cited.

7.2 Other Relative Legislation

Apart from the basic Laws (1739/87 and 1650/86) there is a series of enactments and Joint Ministerial Decisions which concern the research, development, use and protection of water recourses. Suggestively, the most important legislation is cited below by section:

7.2.1 Water Supply

- Law 2744/1999 “for the reorganization of EYDAP” (the Athens Water Supply and Sewerage Company).
- Law 1069/1980 (Government Gazette A 191), “Constitution of water supply and drainage uniform Companies” (DEYA- Municipal Enterprise for the Water Supply and Drainage).
- Quality of drinking water
  - Joint Ministerial Decision A5/2280/1983 in harmonization with the Council Directive 80/778/EEC for “Drinking Water Quality”.
  - Health Regulation A5/288/1983 (Government Gazette A 720) for the “Protection of the water supply in the capital of Greece” and its modification with Joint Ministerial Decision A5/5180/1988.
  - Joint Ministerial Decision Y2/2600/2001 (Government Gazette B 892) in harmonization with Council Directive 98/83/EE for the “Quality of water for human consumption”.

7.2.2 Agricultural use

- Legislative Decree 608/1948 (Government Gazette A 97) concerning “the administration and management of the water used for irrigation”, which was complemented with the following judgments:
  - Law 1988/1952 (Government Gazette A 34), concerning the drills.
  - Royal Decree 2/1949
  - Legislative Decree 3784/1957
- Legislative Decree 3881/1958 (Government Gazette A 181) “concerning land improvement” which was complemented with the following judgments:
  - Legislative Decree 1218/1972
  - Legislative Decree 1277/1972
  - Law 414/1976
- Royal Decree 13.9.59 (Government Gazette A 243), “concerning Land Improvement Organizations”
- Presidential Decree 499/1975 (Government Gazette A 163), “concerning the police of irrigation waters and projects administrated by GOEB” (GOEB-Land Improvement general organizations)

7.2.3 Energy

- Law 2773/1999 and Presidential Decree 333/1999, concerning the establishment of Public Power Corporation.
- Presidential Decree 328/2000 (Government Gazette 268), concerning the establishment and foundation of Hellinic Transmission System Operator- HTSO.

7.2.4 Protection of water resources

- Health Regulation E1b 221/1965, concerning waste disposal and industrial wastes.
- Joint Ministerial Decision 46399/1352/1986, concerning the appropriate water quality for consumption, swimming, life in fresh water, measurement methods, sampling frequency and analysis of surface water intended for drinking. This JMD was established in harmonization with Council Directives 75/440/EEC, 76/180/EEC, 77/659/EEC, 77/659/EEC, 79/923/EEC and 79/869/EEC.
- Joint Ministerial Decision 69269/5387/1990, "Projects and activities classification in categories and environmental impact assessments content.
- Joint Ministerial Decision 18186/1988 (144/Government Gazette 197/1987, YS70/Government Gazette 90/1990), concerning the limiting values for dangerous substances in water and liquid wastes.
- Joint Ministerial Decision 26857/553/1988 (Government Gazette A 196), concerning the protection of underground water from dangerous substances disposal, in harmonization with the Council Directive 80/68/EEC.
- Legislative Decree 191/1974 (Government Gazette A 196), "Verification of the wetland protection treaty"
- Joint Ministerial Decision 5673/400/1997 (Government Gazette B 192), "Measures and conditions for civil wastes processing and disposal"

7.2.5 International waters

- Law 4334/65 (Government Gazette A 173/1963), concerning the verification of Greek -Turkish protocol for the decisive settlement of the differences concerning the accomplishment of hydraulic works for the arrangement of river Evros bed.
- Legislation Decree 4012/1959 (Government Gazette A 232), concerning the verification of the agreement between Greece and Yugoslavia on hydro-economy.
- Legislation Decree 4399/1964 (Government Gazette A 193), concerning the verification of the agreement between Greece and Bulgaria on the use of waters and rivers which cross the two countries.
- Law 2402/1996 (Government Gazette A 98), concerning the verification of the agreement between Greece and Bulgaria on the river Nestos waters.

8 The Water Policy

Although the legislation related to the water issues is very extended and modern, the actual situation is that the efforts made up to now to apply these laws were inadequate. A very good example is the way that one of the main general principles of the water framework directive referring that "the water pricing must reflect its full costs", is applied.
The charges for water use in Greece are generally lower than most of the European countries even if there are serious water scarcity problems. Further more in the examples following it is obvious that the water price is many times lower in areas with dramatic water scarcity problems and higher in areas with abundance of water resources. The prices are also different for irrigation than it is for drinking water. Water prices for irrigation are most of the times not related with quantity of water consumed but with the area irrigated. The fact that the charge is not based on the amount of the water used evokes an increase on water consumption. In many instances, boreholes are used for irrigation water or for water supply. Even if there is a straight legislation concerning the permissions for drilling or using boreholes in reality there is totally uncontrolled leading to over-pumping of the aquifers.
In the tables that follow, some characteristic price lists for drinking water in some districts of Greece are presented:

The water prices in Athens, the capital of Greece, are a good example of a pricing policy promoting the limiting of water consumption. Here must be noted that EYDAP, the company responsible for the water supply of the capital was privatized recently and it is a good example of the modern legislation that promotes the involvement of private companies in services traditionally provided by the government.

Table 9: Prices for drinking water for domestic use and for industries. (EYDAP-Athens)

Amount of water	Price
Domestic Use	
0-5 m^3	0,39 €/ m^3
5-20 m^3	0,61 € / m^3
20-27 m^3	1,75 € / m^3
27-35 m^3	2,45 € / m^3
Over 35 m^3	3,05 € / m^3
Industries	
Up to 1.000 m^3	0,77 €/ m^3
Over 1.000 m^3	0,90 €/ m^3

Two examples of the water pricing in two cities at the north-west part of the country that are very wet are following:

Table 10: Prices for drinking water in Kastoria

Amount of water	Price
0-14 m^3	0,58 €/ m^3
15-26 m^3	0,19 €/ m^3
27-32 m^3	0,21 €/ m^3
33-44 m^3	0,24 €/ m^3
Over 45 m^3	0,28 €/ m^3

Table 11: Prices for drinking water in Grevena

Amount of water	Price
0-50 m^3	0,34 €/ m^3
51-90 m^3	0,38 €/ m^3
Over 91 m^3	0,46 €/ m^3

The water pricing in a city at the central part of the country that is located in the mainland but in a relatively dry area is following:

Table 12: Prices for drinking water in Larisa

Amount of water	Price
0-50 m^3	0,43 €/ m^3
Over 50 m^3	0,52 €/ m^3

Two examples of the water pricing in two Ionian Islands (west Greece) that are relatively wet but facing some times water shortages due to their geomorphology is following:

Table 13: Prices for drinking and industrial water in Kefallonia

Amount of water	Price
Domestic Use	
0-20 m^3	0,40 €/ m^3
20-30 m^3	0,60 €/ m^3
30-45 m^3	1,00 €/ m^3
45-60 m^3	1,50 €/ m^3
Over 60 m^3	3,00 €/ m^3
Industrial Use	
0-50 m^3	0,60 €/ m^3
50-100 m^3	0,80 €/ m^3
Over 100 m^3	2,00 €/ m^3

Table 14: Prices for drinking water in Kerkyra

Amount of water	Price
0-15 m^3	13,84 € (min. consumption)
16-25 m^3	0,51 €/ m^3
26-50 m^3	0,57 €/ m^3
51-100 m^3	1,12 €/ m^3
101-500 m^3	1,18 €/ m^3
Over 501 m^3	1,14 €/ m^3

The water pricing in a dry Aegean island located in Cyclades and threatened with serious water shortages is following:

Table 15: Prices for drinking water in Paros

Amount of water	Price
0-5 m^3	free
6-30 m^3	0,42 €/ m^3
31-50 m^3	0,80 €/ m^3
51-70 m^3	1,00 €/ m^3
71-100 m^3	1,54 €/ m^3
101-150 m^3	1,91 €/ m^3
151-200 m^3	2,33 €/ m^3
201-400 m^3	2,81 €/ m^3
Over 401 m^3	5,30 €/ m^3

It is astonishing that prices vary significantly from place to place but they are not following the water availability.
In the table 16 and the figure 15 that follow, a brief list of the prices for 30 m^3 in some Greek cities are presented.

Except EYDAP in all the other cases referred the water supply is provided by municipal companies and the prices depend on the municipality. In most cases and especially in the dry areas, the water price is not following the water cost but it is subsided either from the municipality or the government. For this reason, future installations of desalination plants will not be able to be competitive and the only possibility is to offer the produced water through the municipal water supply companies under special agreements. These units can also be operated from the municipalities or in some cases can be totally private and selling the produced water to the municipal company.

An other opportunity for installation of desalination plants is the case of big private investments on tourism in dry areas as for example big hotels that cannot be served from the municipal water supply network and they will have to secure their own water supply. Such an example was given in chapter 4.

Table 16: Comparison of prices for drinking water depending on the town

City	Price (of 30 m^3)
Ermoupoli	51,38 €
Rethimno	48,13 €
Leros	47,03 €
Halkida	44,37 €
Alexandroupoli	43,14 €
Kozani	41,21 €
Chios	40,06 €
Kos	36,98 €
Ioannina	36,64 €
Larisa	34,78 €
Argos	33,81 €
Florina	33,75 €
Kastoria	33,69 €
Agios Nikolaos	32,05 €
Chania	31,99 €

Ierapetra	31,69 €
Kalamata	31,31 €
Athens	30.70 €
Lamia	30,52 €
Trikala	29,18 €
Iraklio	25,93 €
Preveza	25,91 €
Agrinio	25,83 €
Drama	25,18 €
Serres	24,30 €
Thiva	23,96 €
Mykonos	23,31 €
Kerkyra	21.79 €
Patra	21,23 €
Petaloudes	19,14 €
Kalabaka	13,76 €
Kefallonia	12.00 €
Paros	10,80 €
Grevena	10.20 €

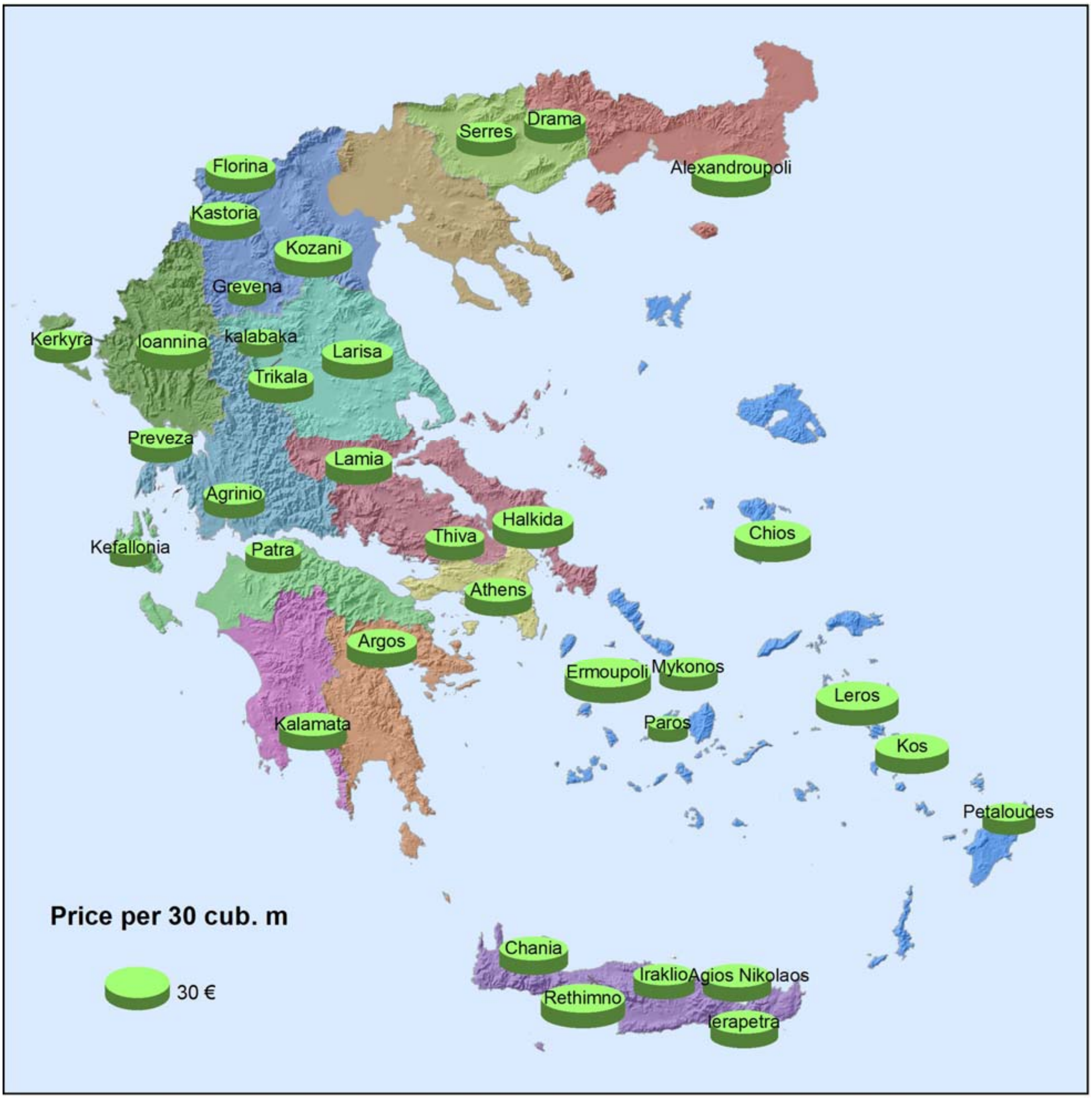

Figure 15: Comparison of prices for drinking water depending on the town.

9 Water Administrative Structure

9.1 Administrative set-up

The most striking element of water resources management in Greece seems to be the division of management responsibilities among a large number of entities. Such entities include the Ministry of the Interior (MI), the Ministry of Environment, Physical Planning and Public Works (MEPPW), the Ministry of Health and Well Fair, Care and Social Insurance (MHCSI), the Ministry of Culture (MC), the Ministry of Foreign Affairs (FM), the MA, the MIET, the Public Company of Electricity (PCE) and a few other smaller agencies. Such fragmentation, as well as overlapping of similar responsibilities, seems to hinder any comprehensive water resources planning and management efforts. In addition, it may compound existing bureaucratic tendencies by creating delays in planning and implementation, and dispersing resources.
Some of the main public agents among others which deal with water and their main responsibilities (research, development, use and protection) are listed below:

- Ministries:
    - of Foreign Affairs (cross-border water resources, international organizations)
    - of the Interior, Public Administration and Decentralization (water supply and drainage, watering projects)
    - of Development (water resources administrative agent, industry-bottling, energy- small hydroelectric plants, tourism, research, technology, commerce): Under this Ministry the Central Directorate for the Water Resources and Natural Resources is organized which is responsible for the Coordination of the Water Resources Management. The law also provides that the Ministry is responsible for the organization and execution of studies and research for the evaluation of the available water resources and for this reason Institutions and Organizations shall undertake this.
    - of Environment, Physical Planning and Public Works (research and construction of big water supply and drainage projects, responsible for the quality conditions of water recourses as part of the environment): This Ministry is in charge of the coordination of the implementation of the UN Framework for Climate Change Convention and of the Kyoto Protocol. In its structure it includes the Directorate of Environmental Planning, which includes the Departments for Water and Air Quality. Both Departments are deeply involved in the implementation of the National Plan for the reduction of Greenhouse gas emissions, in accordance with the Convention and the Kyoto Protocol.
    - of Rural Development and Food (agriculture – irrigation, forestry): This Ministry is responsible for the management of the water resources allocated to agriculture and for the use of the water at the farm level.
    - of Health and Welfare (quality of drinking water)
- Local administrations (regions, prefectures, OTA- Organizations of Local Administrations):
    - Regions (water recourses management in water sector level, small hydroelectric plants, water quality, water supply-drainage, agricultural uses, relative researches and projects)
    - Prefecture Administrations (restrictive measures, irrigation, industry, bottling, water supply and irrigation projects)
    - OTA - Organizations of Local Administrations (water supply, drainage)

- Organizations, Institutes, Research Centers:
  - o EMY- Hellenic National Meteorological Service (meteorological observations): This Service is responsible for the provision of meteorological services for the requirements of the civil aviation, the collection of meteorological data and information, the compilation of climatological statistics and monitoring of climatic variations and trends and the preparation of climatological studies and reports. It is also responsible for the provision of weather information and consultative services for applications in various fields such as agriculture, water resources, fisheries, and shipping industry, regional planning and development, tourism, architectural and civil engineering works, renewable energy resources, environmental studies etc.
  - o PPC – Public Power Corporation S.A. (hydroelectric energy)
  - o IGME – Greek Institute of Geology and Mineral Exploration
  - o EYDAP – Athens Water Supply and Sewerage Company
  - o National Observatory of Athens : The National Observatory of Athens forecast the 72-hours weather forecasts for the Eastern Mediterranean and Greece on a daily base.
  - o Hellenic Center for Marine Research (research of water recourses)
  - o NCSR "Demokritos" (research)
  - o N.AG.RE.F. – National Agricultural Research Foundation (agricultural research): N.AG.RE.F strives for constant improvement in competitiveness of Hellenic agricultural products in the international market. Moreover, it works to symmetrically upgrade the quality of life in the Greek countryside, with the aim of reversing migration and preventing the degradation of our unique environment.
  - o Institute of Forestry Research
- Univercities and TEI (research projects relative to water)

9.2 Establishment of desalination plants.

The complicated structure of the administration scheme responsible for the water management is also illustrated in the procedures needed to establish a desalination plant.

Until now there is not any standard administrative or legislative procedure for the establishment of a desalination plant. Therefore, the general procedure which is followed is this of licensing for water acquisition and use, together with the procedures applied for energy production, effluents management and other related aspects.

To begin with, a sitting permission is needed which presupposes two prior actions; the accomplishment of an environmental impact assessment and the cover of the environmental conditions for each district under study. It is also required the selected site to cover all the legal conditions including land proprietary rights, land use type zone etc.

After the first license issue, licenses relatively to the implementation of energy production plants and civil works are also mandatory, together with license for water acquisition from the sea or from the brackish water source and license for the effluents disposal. The appropriate services of the Ministry of Environment, Physical Planning and Public Works or their local branches are responsible for the license issues. As far as water resources are concerned, licenses from other institutions and ministries are also needed and primarily from Ministry of Rural Development and Food or Ministry of Marines for the water acquisition. Relatively to the energy plants, Ministry of Development and PPC are responsible for the licenses.

Here, it must be noted that for the construction of plants with public interest (e.g. water supply of municipalities) special procedures can be followed relaxing the prerequisites and even regulating land-allocation issues.

In the future, as the interest for ADURES units will be rising, special legislation will be probably instituted and motivation measures may be adopted as it happened with RES, helping the spreading of these technologies.

Another important issue that that interest when talking for ADURES is that according to legal restrictions, the maximum RES power that can be installed in an autonomous electrical system of an island cannot be more than 30% of the maximum power needs in the island. In case that the extra amount of energy produced by the RES is bigger than the electrical power which is allowed to be provided to the grid, then the unit must be autonomous. This may be a reason to construct an autonomous unit even in areas that are covered from the grid. Otherwise the RES are connected to the grid and the extra produced energy is sold to the PPC in order to improve the economic efficiency of the desalination unit.

Thus the most challenging market for desalination in Greece are either private installations to supply fresh water to large hotels or other tourism activities like marinas mainly in small islands or installations made to serve the municipal water supply companies existing in all small islands.

The possible schemes to finance and operate such units under the Greek conditions are the following:

Private installations to serve the increased needs in good quality fresh water of hotels, tourism facilities, industries or even single houses in small arid islands or in other remote arid areas.

- Cooperative private installations to serve small settlements of cottages in remote arid areas, which are organized more and more often in all over Greece
- Installations financed and operated completely from the municipal water supply companies.
- Installations financed by private funds or by both public and private funds. In this scheme which gets more and more common in many applications in Greece, private companies are financing the installation and take over the operation and maintenance responsibilities. Then they selling the previously agreed quantity of produced water in a specific price under contracted terms, to the municipal water supply companies.

Nonetheless, we ought to mention that in case of small private plants where the production is intended for private use (for example small hotels or houses), the license issue is easier and the main and sometimes sole issue is the fulfilment of the environmental conditions.

10 Conclusions

Greece is a country that to a great extent seems to have affluent water resources. Nevertheless, due to the spatial and temporal variability of the available water resources significant problems of fresh water shortages exist in some cases.

Such areas are most of the islands in the south Aegean Archipelagos which at the same time are isolated making water transportation from other sites very expensive. In the same areas tourism is developing very fast and the situation is becoming more and more difficult every year.

In these districts desalinization plants could be adopted to confront the problem. These desalination plants can be Autonomous or Grid Connected depending on the site conditions, but in every case renewable energy sources (RES) powered desalination systems have been extensively discussed as an innovative approach to desalinate water economically and in an environmentally friendly manner especially in the islands were electric power production is very expensive and the electricity networks are small and autonomous.

Nowadays, there are made some attempts towards desalinization plants but the number of desalinization plants is yet limited. Even more ADURES are used only as experimental or pilot installations. The importance of the desalination on the other hand is widely recognized by the authorities who up to now subsided water transportation in arid islands undertaking an enormous cost.

Thus, the potential of a rapid future development in this field is clear, aside from the tensive need for fresh water in the arid zones of Greece, the existence of a legislative and administrative framework could accelerate the development of desalinization plants in the country.

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