WATER and LIFE Calendar 2014

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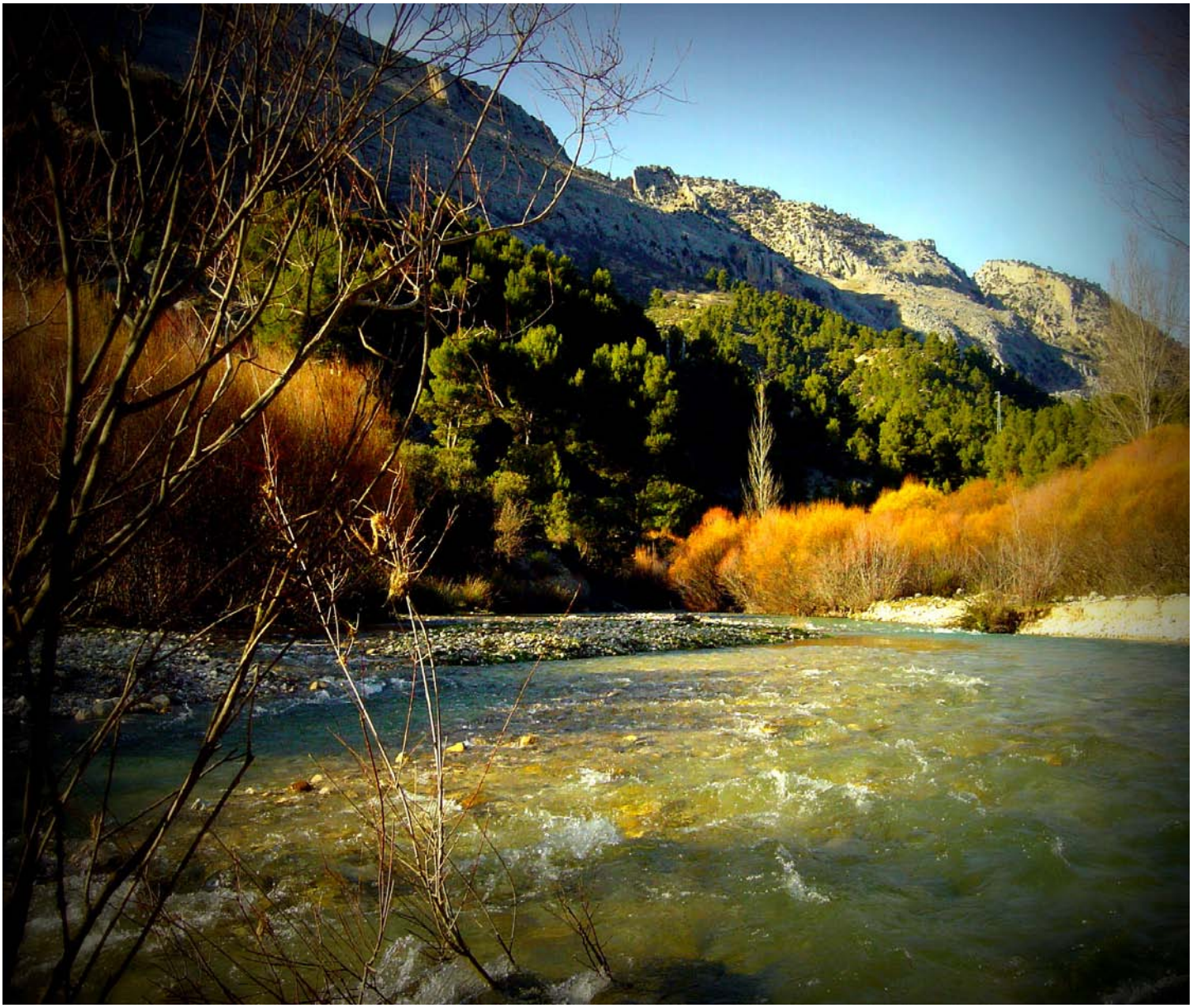
WATER and LIFE

European Life Long Learning Grundtvig Project 2011 - 2013



River Castril, province of Granada (Spain). The Castril river is one of the most beautiful rivers in the north of the province of Granada (Spain). In the upper course of the river there is few human activity and therefore the ecological status is very good. Its water is very clean and cold. Several kilometers downstream, the river is regulated by the Portillo Dam, which is used for water supply, irrigation and production of hydroelectric energy"

January 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

La Bolera Reservoir, river Guadalentin, province of Jaen, (Spain). In the south of Spain the weather changes a lot during the year. During the end of the spring and in summer, the agriculture needs a lot of water but the weather is very dry. Afterwards, during winter and the beginning of spring it is more rainy, sometimes with snow. For these reason we need reservoirs to keep water in the wet season for using it during the dry season. Nowadays this reservoir is used not only for irrigation and water supply, but also for ecological purposes and fishing.

February 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
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23	24	25	26	27	28	

As many Mediiterranean islands, Crete lays on the way of the migration paths of birds. As a result a significant variety of bird species can be found in the island. The estuaries of Moronis river in Souda bay (Chania, Crete) form a protected wetland, where several aquatic birds find shelter and food, mostly during the winter months. In the photo, two Little Egrets looking for food in the river delta.

March 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Alhambra, the complete form of which was Calat Alhambra, is a palace and fortress complex located in Granada, Andalusia, Spain. It was originally constructed as a fortress in 889, and was converted into a royal palace in 1333 by Yusuf I, Sultan of Granada. Today the Alhambra is one of the most visited UNESCO World Heritage Sites in the world. The park around the buildings has a multitude of nightingales and is usually filled with the sound of running water from several fountains and cascades. These are supplied through a conduit 8 km long, which is connected with the Darro at the monastery of Jesus del Valle, above Granada.

April 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

Corsica: Tolla dam - Hydroelectricity and water supply for Ajaccio and its region (South of Corsica). Builded on the Prunelli river in 1960 by EDF, the Tolla dam which contains 31 Mm3 is used for water supply, irrigation and production of hydroelectric energy.

May 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Sierra Nevada and olive trees, (province of Granada, Spain). Sierra Nevada has the highest mountain of the Iberian Penninsula, (Mulhacen, 3.478,6 meters above sea level). Its name "sierra Nevada" (snowy mountains), is quite logical, because from October to july, it has snow, what is not normal, taking into account its latitude, (37 degrees north). In the flood plain the agriculture is very rich, with very good olive trees.

June 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

On average more than 70% of water globally is used for agriculture, while 40% of world food production comes from the 18% of irrigated agricultural land. Increasing water use efficiency, by adopting localized irrigation systems, innovative irrigation techniques and use of low quality waters (saline, reclaimed, drainage), is the only way to satisfy the increasing demand.

July 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

The Munich water supply takes place from the mountain area Mangfall in the Alps. The fresh and clean water is collected as groundwater in about 20 caves, which are artificial made 100 years ago. The caves have a length of about 200 meters into the mountain. The water is directly served by gravitation without any cleaning or adding of chemicals to the city of Munich, which is about 70 km away.

August 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Canales reservoir, river Genil, province of Granada, Spain. The city of Granada drinks water from Sierra Nevada which is regulated at the Canales Reservoir. This reservoir is generated by the Canales Dam, the highest embankment dam in Spain. The water level in the reservoir changes with time, therefore, in order to select the water of best quality, an intake tower has been built, as shown in the picture.

September 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

A typical example in which water availability resulted in touristic and agricultural development, is the Falassarna plateau in Crete. However, overexploitation of water resources is threatening sustainability, with main problems being the increased salinity of the ground water and the reduced availability of good quality water for both sectors.

October 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
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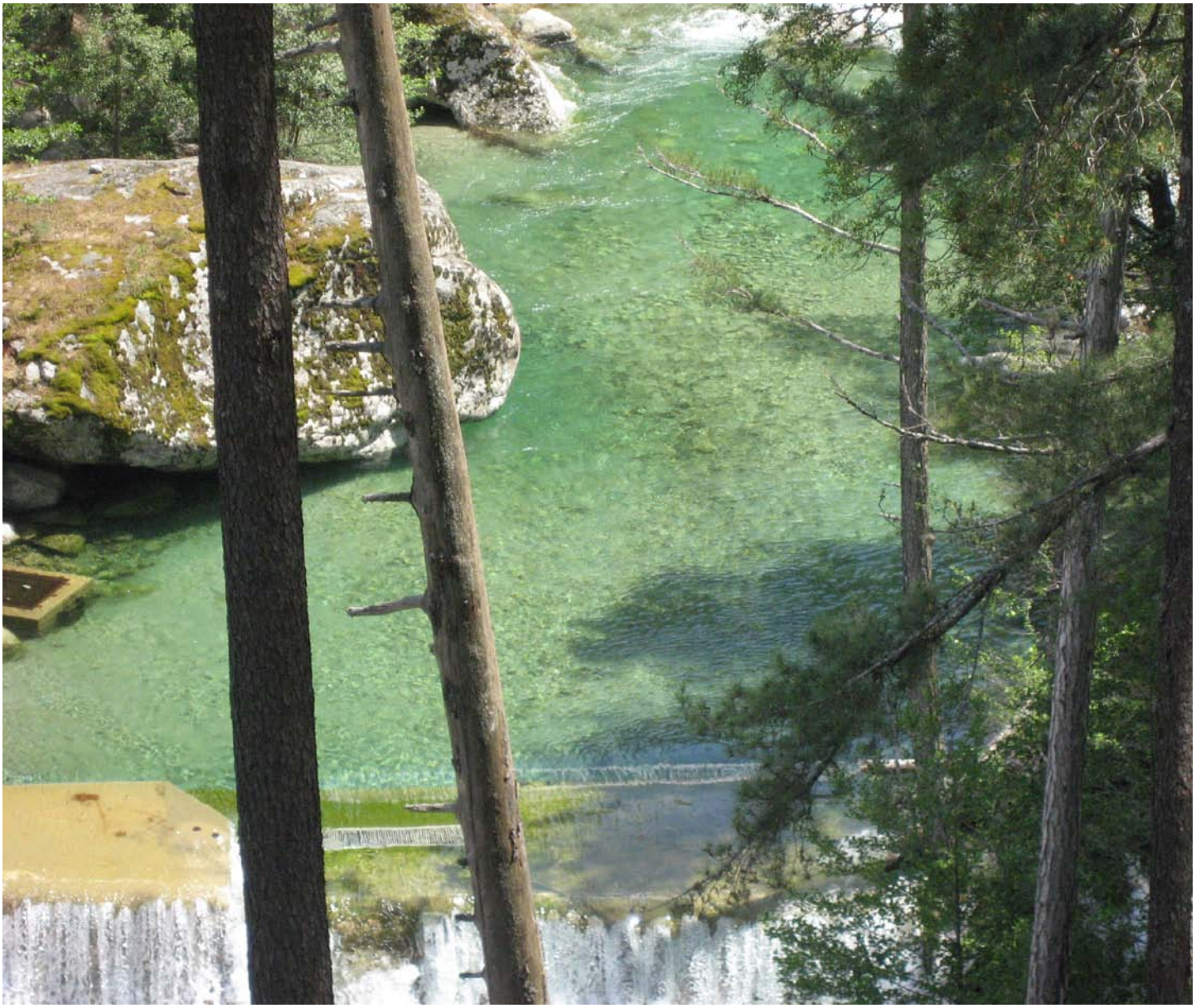
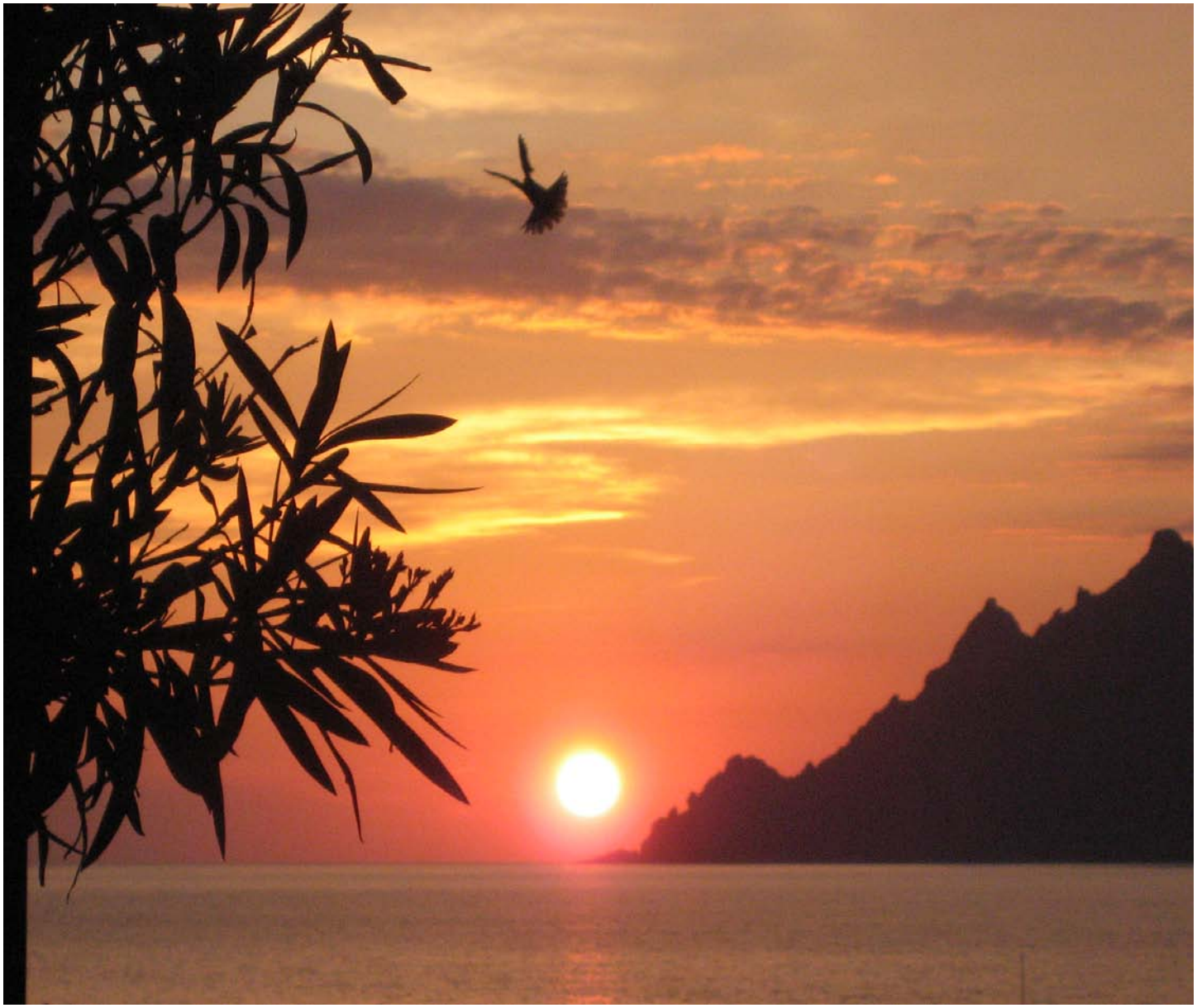


Corsica: Restonica Valley - Water supply for Corti (North of Corsica) - Unesco classified site.
The Restonica river rises in Lake Melo at an altitude of 1,711m in the Rotondo massif, one of the island's highest.
Corti city with about 7000 inhabitants and 4000 students (University of Corsica Pasquale Paoli) is supplied with drinking water from Restonica.

November 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						



Corsica: Sunset in Porto Gulf - Unesco classified site.

December 2014

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Water is vital for all kinds of life. Taking into account the population explosion and climate changes, this issue will be crucial in the future for most of the world. People should be aware of the water quality and resources and contribute to its sustainability not only in their small area but in a global scale; they must respect other people, their diversities and special needs.
During this project, learners under the guidance of their tutors, will do some simple researches. First, they will look into their own water consumption and bills, find any significant changes and try to find some explanation if any; they will discuss their findings, fill a questionnaire and send it to their partners. One of the partners will undertake to analyze the results and report to the partners during the next meeting. The partners will discuss the outcome,modify or accept it and publish it. The results will be disseminated in order to learn more from one another and to create the necessary public participation in an effort to raise awareness and wider understanding which will lead to the improvement of the attitude of people towards using water wisely as well as towards other relevant environmental, energy ,economy or social issues.

The same procedure will follow for the next steps and meetings:
- examine the quality of water, pollution sources and treatment of water.
- look into the regional situation, demands for domestic, industrial and agriculture use; projection in the future.
- notice any climate changes and how they will affect water availability and quality.
- find examples of new cultivations or irrigations for water saving.
- conclude to some practical measures or incentives to be introduced in a small scale in the areas of the partners by local authorities and institutions.

1	OCT 2011	A calendar and some posters will be produced, in which you see the main topics of the project. The first report for domestic use of water is to be done. In all the following table points the web site of the project is continuously completed.
2	MAR 2012	Report on the quality of water.
3	JUL 2012	A short report-handbook on the regional situation and projection in the future is to be done by each participant.
4	NOV 2012	Report on changes in the water availability.
5	FEB 2013	Report on agricultural use and irrigation saving techniques.
6	MAY 2013	The final report on practical measures or incentives is to be introduced in a small scale in the areas of the partners by local authorities and institutions in the form of CD-ROM, report-handbook, leaflets and completing of the Water is Life-Portal.

CAROLVS·RO·IMP·SEMPER·AVG·HISPAN·REX·FVNDATOR·VNIVERSITATIS·GRANATENSIS

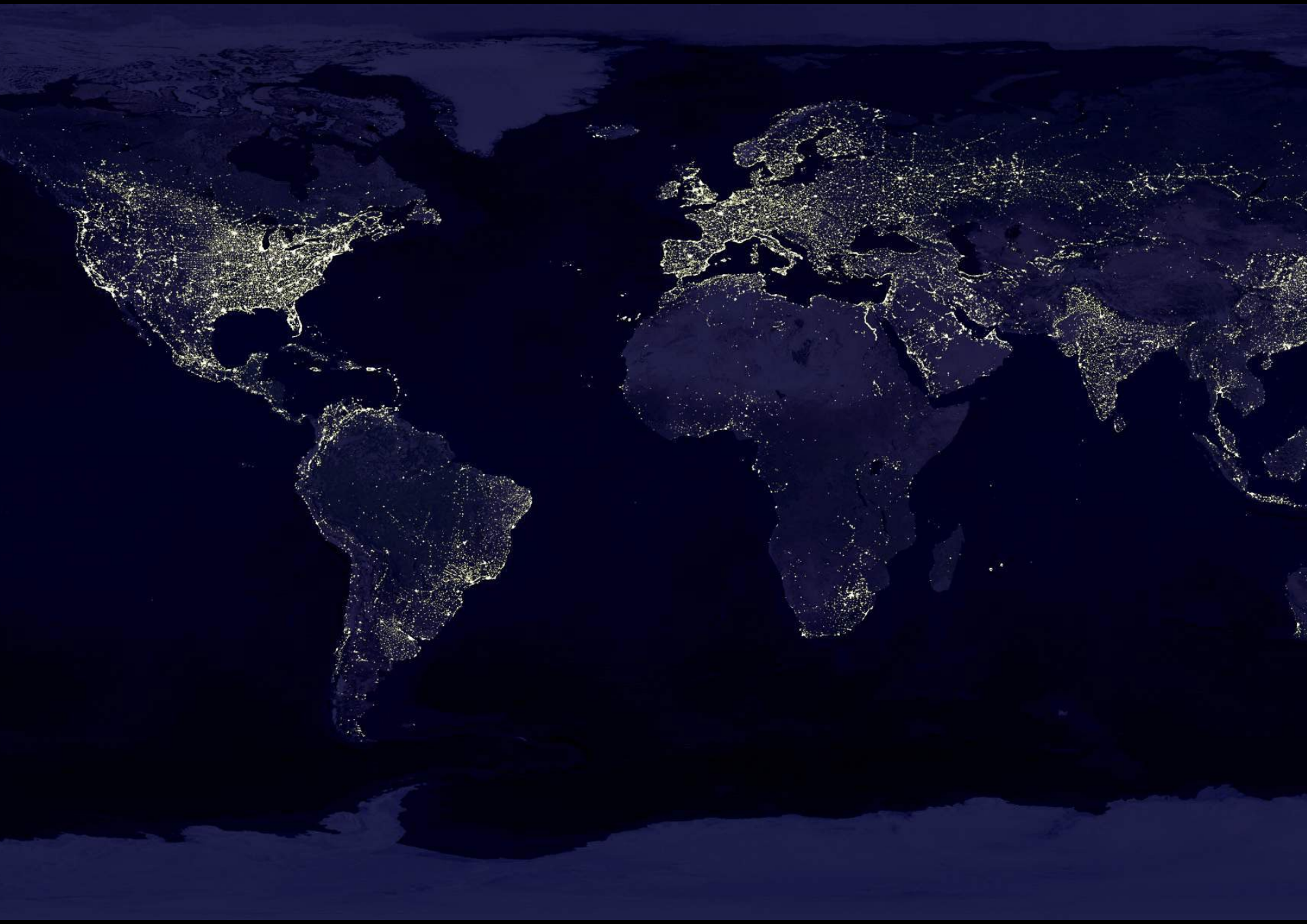
Universidad de Granada. (SPAIN)

Water Problems and Solutions in Spain

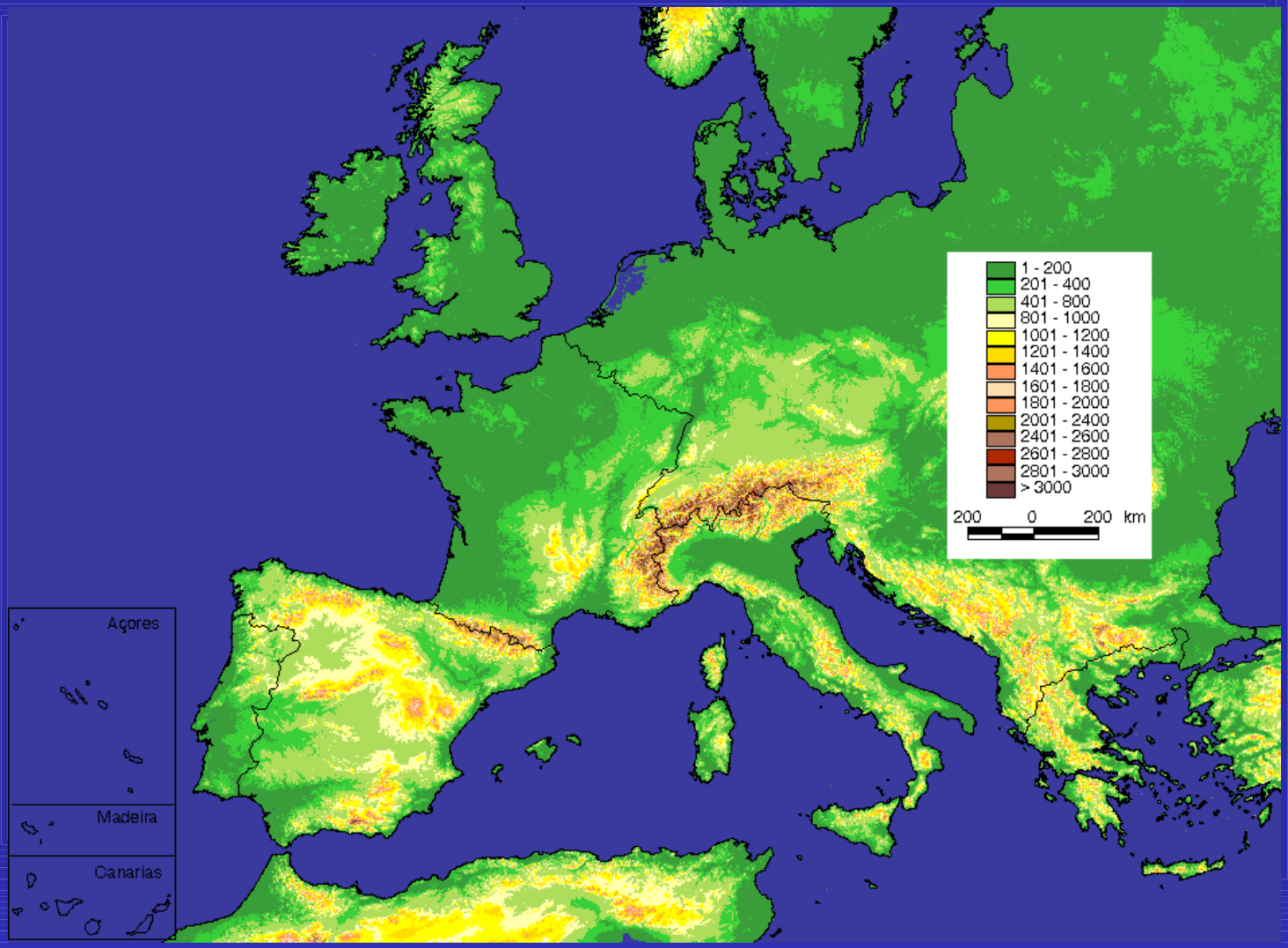
by

Professor J. Gonzalez-Lopez
and
Professor M.V. Martinez-Toledo

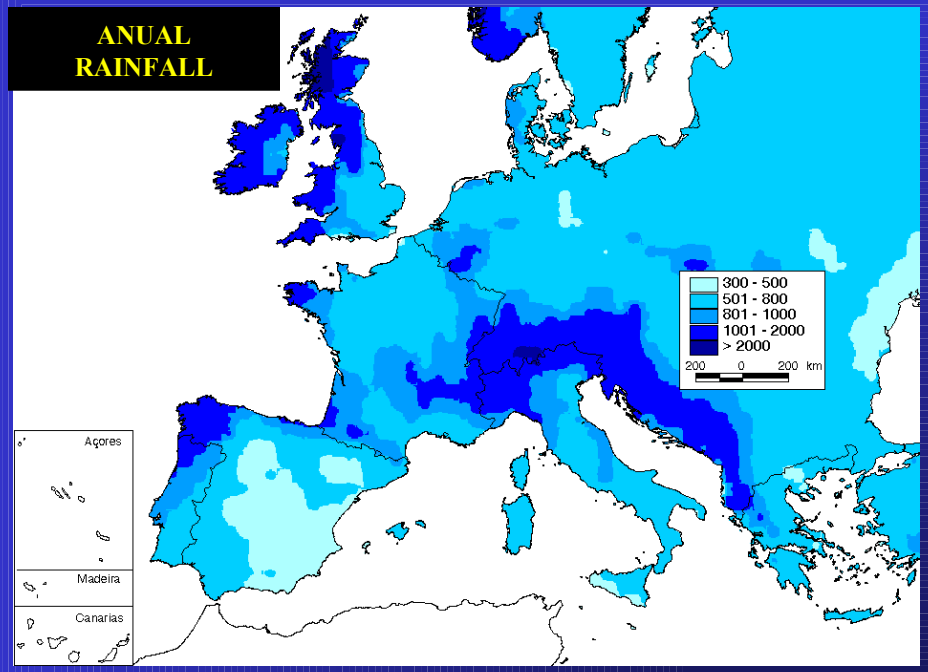
THE WORLD

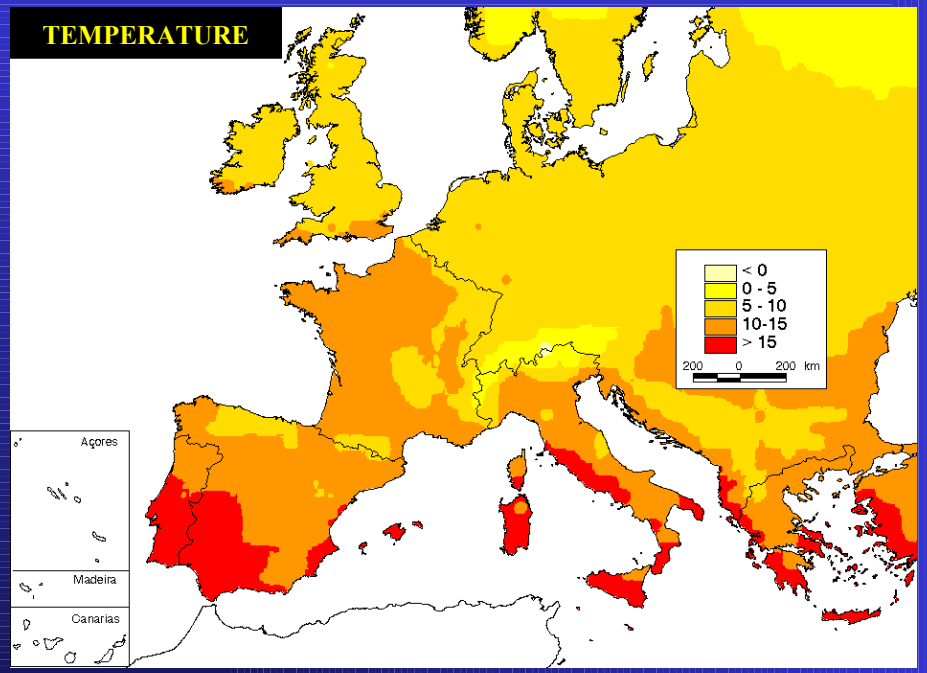


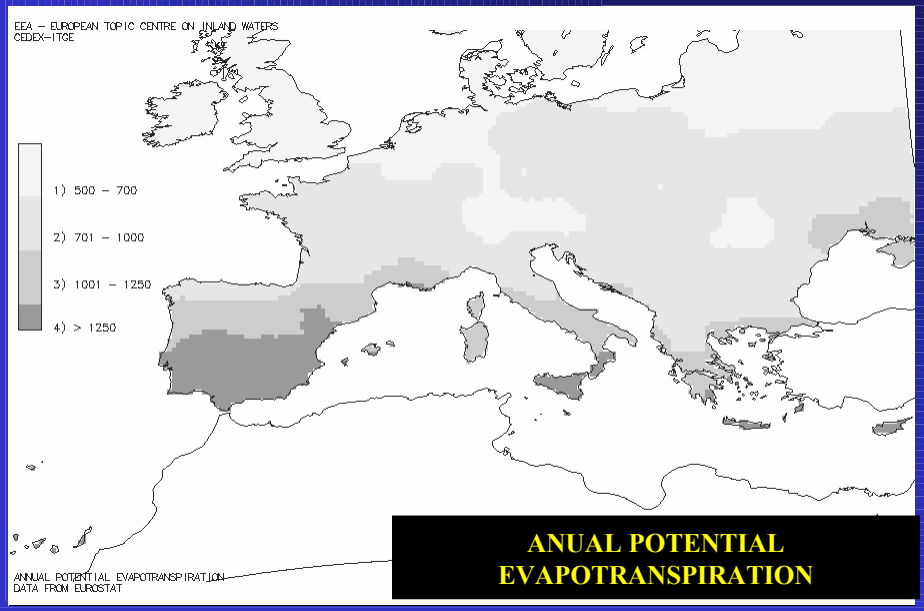
EUROPE

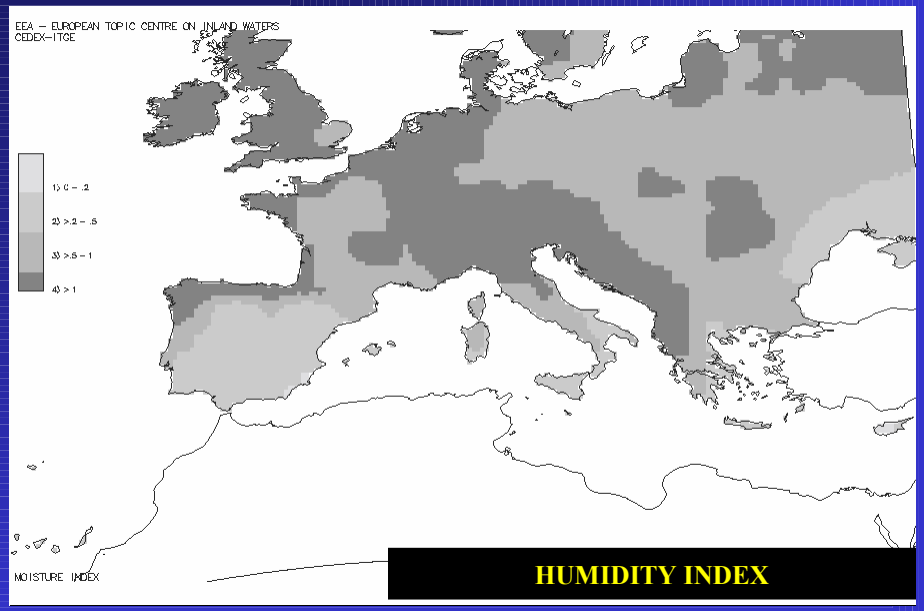


Modelo digital del terreno de Europa. Fuente: U.S. Geological Survey's EROS Data Center


ANUAL RAINFALL
300 - 500
501 - 800
801 - 1000
1001 - 2000
> 2000
200 0 200 km
Açores
Madeira
Canarias


TEMPERATURE
< 0
0 - 5
5 - 10
10-15
> 15
200 0 200 km
Açores
Madeira
Canarias


EEA – EUROPEAN TOPIC CENTRE ON INLAND WATERS
CEDEX–ITCE
1) 500 – 700
2) 701 – 1000
3) 1001 – 1250
4) > 1250
ANUAL POTENTIAL EVAPOTRANSPIRATION
DATA FROM EUROSTAT
ANUAL POTENTIAL EVAPOTRANSPIRATION


EEA – EUROPEAN TOPIC CENTRE ON INLAND WATERS
CEDEX–ITCE
1) 0 – .2
2) > .2 – .5
3) > .5 – 1
4) > 1
MOISTURE INDEX
HUMIDITY INDEX

SPAIN

Spanish Main Problems

SCARCITY

IRREGULAR DISTRIBUTION IN SPACE

IRREGULAR DISTRIBUTION IN TIME

EXTREMAL EVENTS: DROUGHTS & FLOODS

SCARCITY

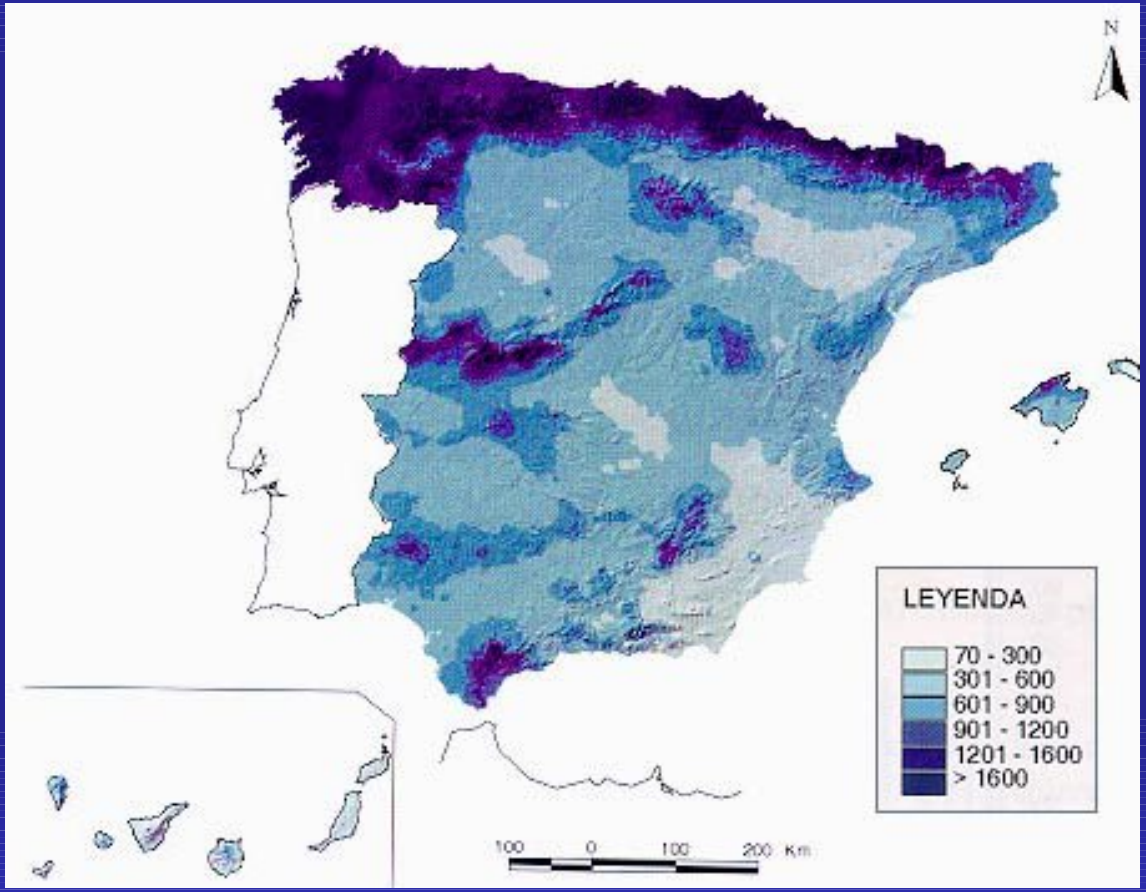
DIFFICULT DEVELOPMENT

AQUIFERS OVEREXPLOITATION

DESERTITATION

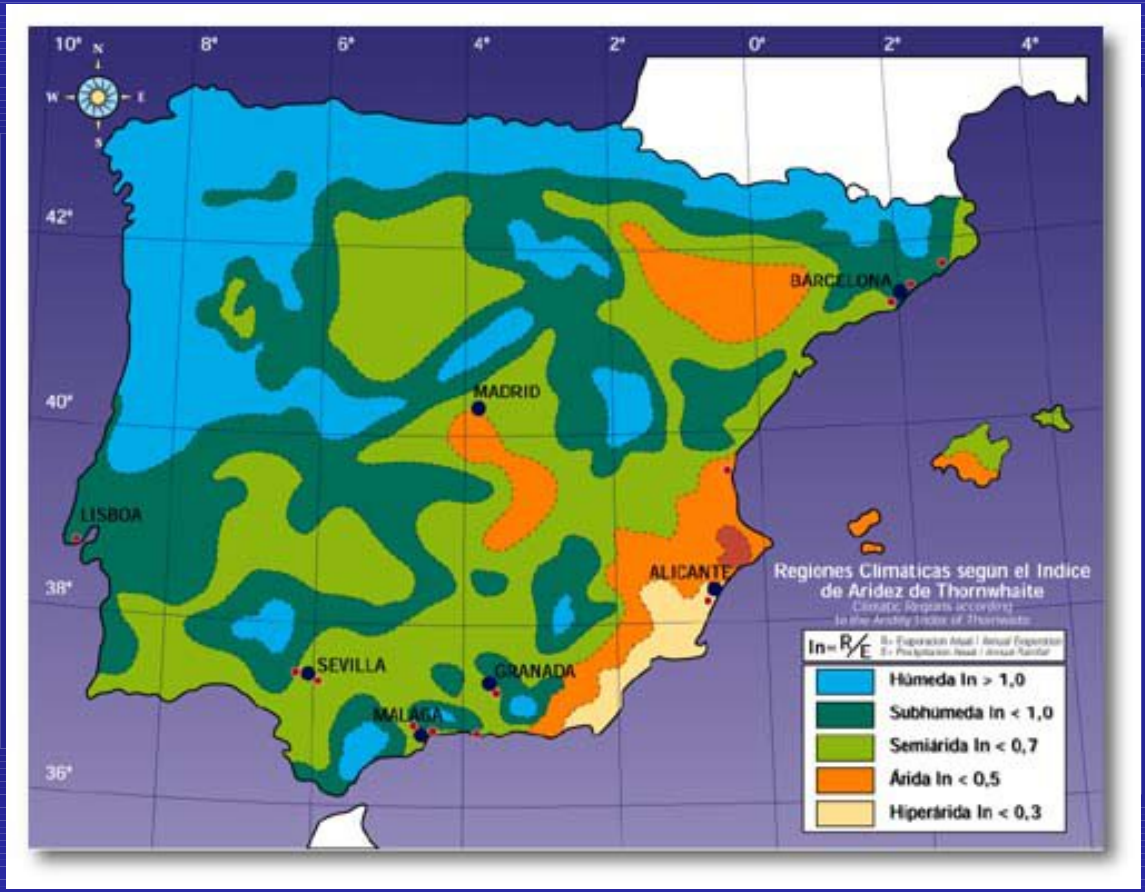
MANY OTHERS...

IRREGULAR DISTRIBUTION IN SPACE



ANUAL AVERAGE RAINFALL (mm)

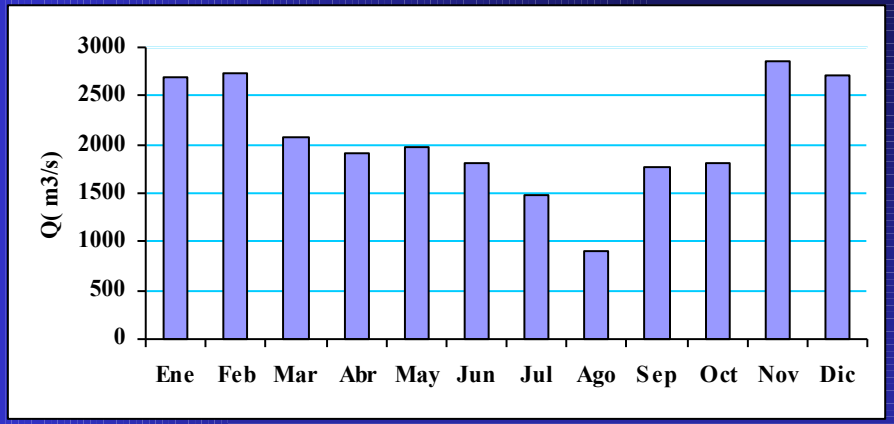
IRREGULAR DISTRIBUTION IN SPACE



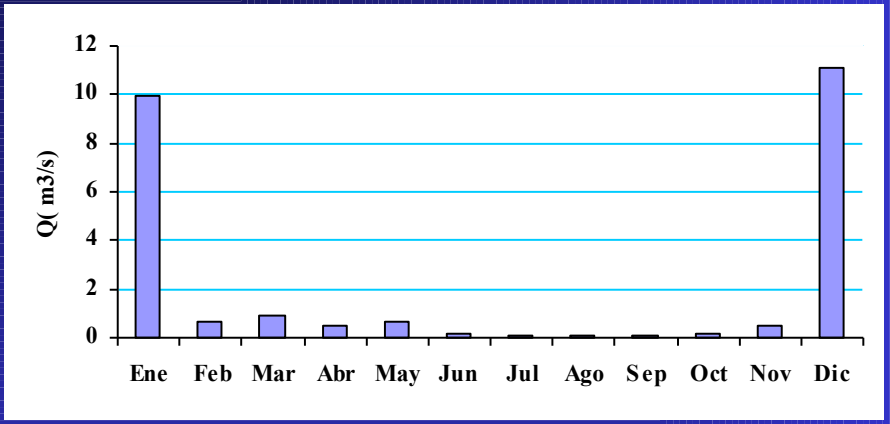
AVERAGE ARIDITY INDEX

IRREGULAR DISTRIBUTION IN TIME

ANUAL RAINFALL DISTRIBUTION IN SPAIN



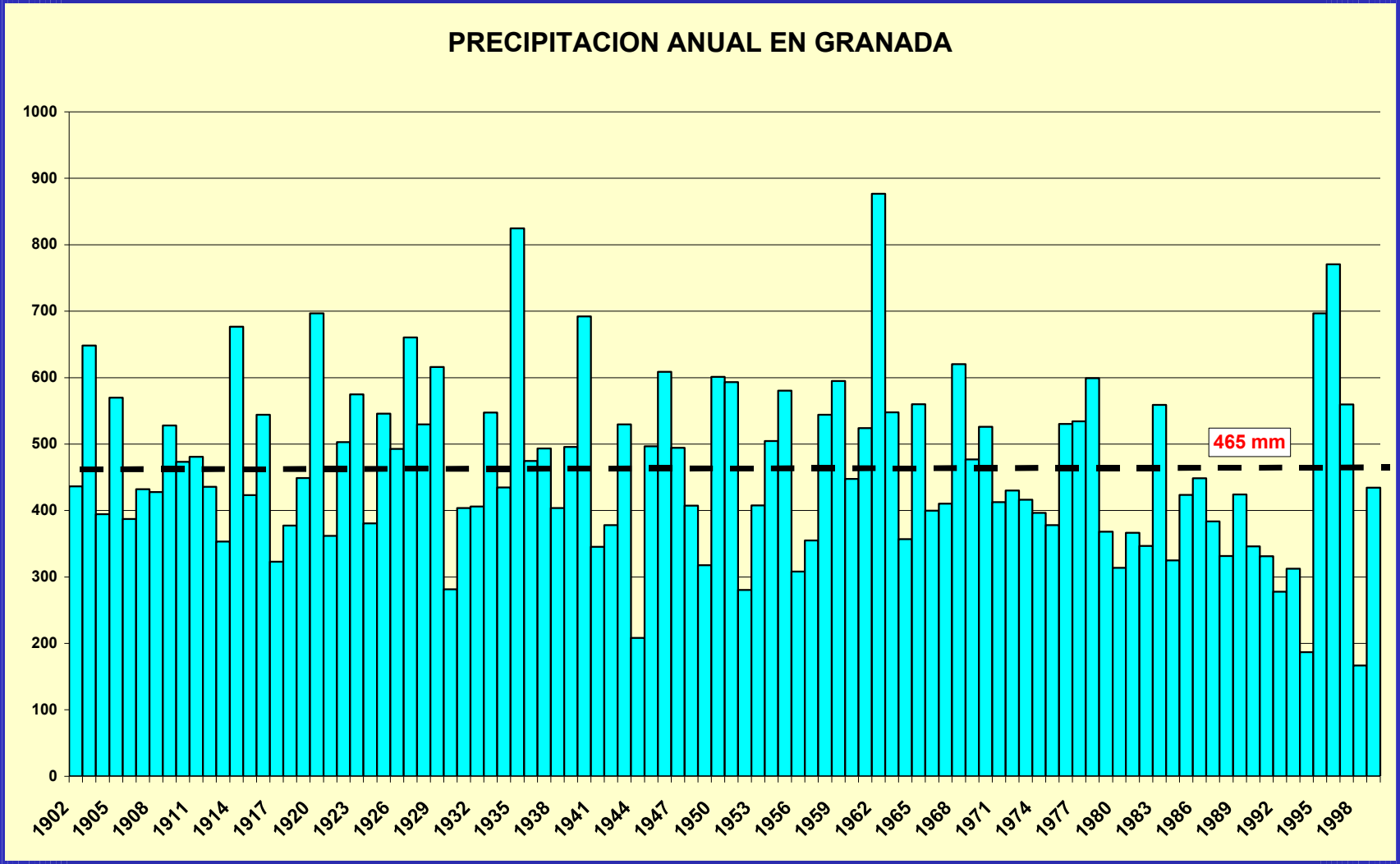
River **Ródano,** Beaucaire (Francia) 1990-97 except year 91



River Guadiaro, San Pablo de Buceite (España).1990-96

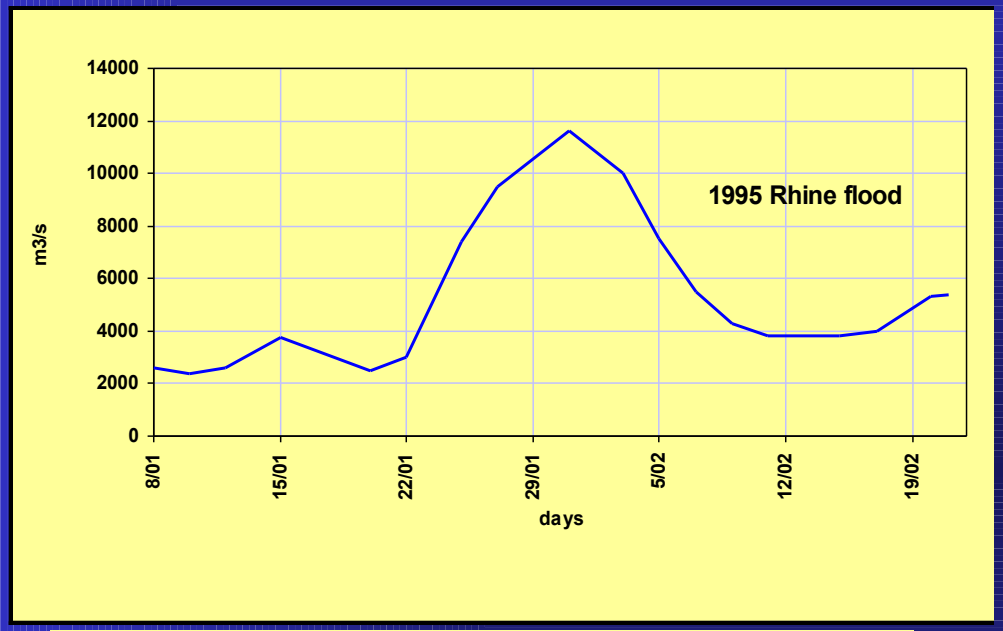
Fuete: CEDEX

IRREGULAR DISTRIBUTION IN TIME

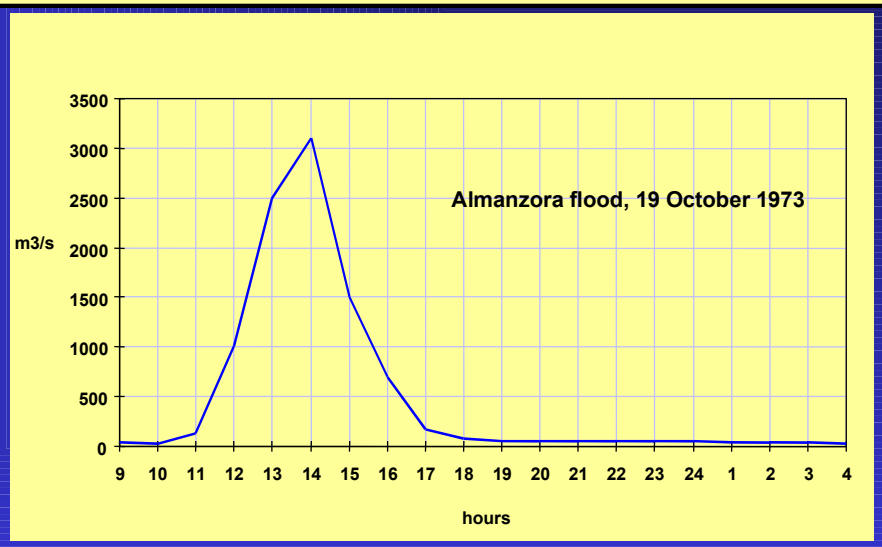


INTERANUAL VARIATION

EXTREMAL EVENTS: DROUGHTS & FLOODS



Hidrograma de la avenida de 1995 en el Rhin. Fuente: German Ministry for the Environment, 1996.



Hidrograma del río Almanzora en Almería, España durante la avenida del 19 de Octubre de 1973. Fuente: MIMAM, 1998

Fuete: CEDEX

EXTREMAL EVENTS: DROUGHTS & FLOODS

DROUGHTS

Aracena Dam, (Huelva), 1995

FLOODS

Tous Dam Break, (1982). 550mm/24h, Qin max=10,000m3/s Qout max=15,000m3/s, 8 deaths.

What can we do with this problem?

A.- Leave such a “horrible” country and move to a more comfortable land

B.- Stay and enjoy our “paradise” but “fighting against the Gods”

C.- Just drink some WINE, have a “SIESTA” and wait for a better weather

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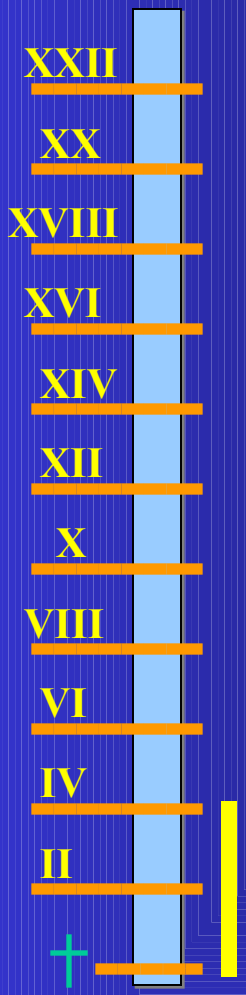
Spanish Hydraulic Works through the HISTORY

Roman Empire



- Water supply, industry, irrigation and navigation
- Small dams but with regulation capacity
- Examples:

- ***Toledo: Alcantarilla (17) + 40 km***
- ***Mérida: Proserpina (19) & Cornalvo (24) + 10km***
- ***Cádiz: 75 km***
- ***Granada: Barcinas + 10km***
- ***Itálica: 37 km***
- ***Córdoba: 15 km***
- ***Segovia: 12 km***
- ***Tarragona.***
- ***Ponferrada: 100 km***

Germanic Tribes

XXII
XX
XVIII
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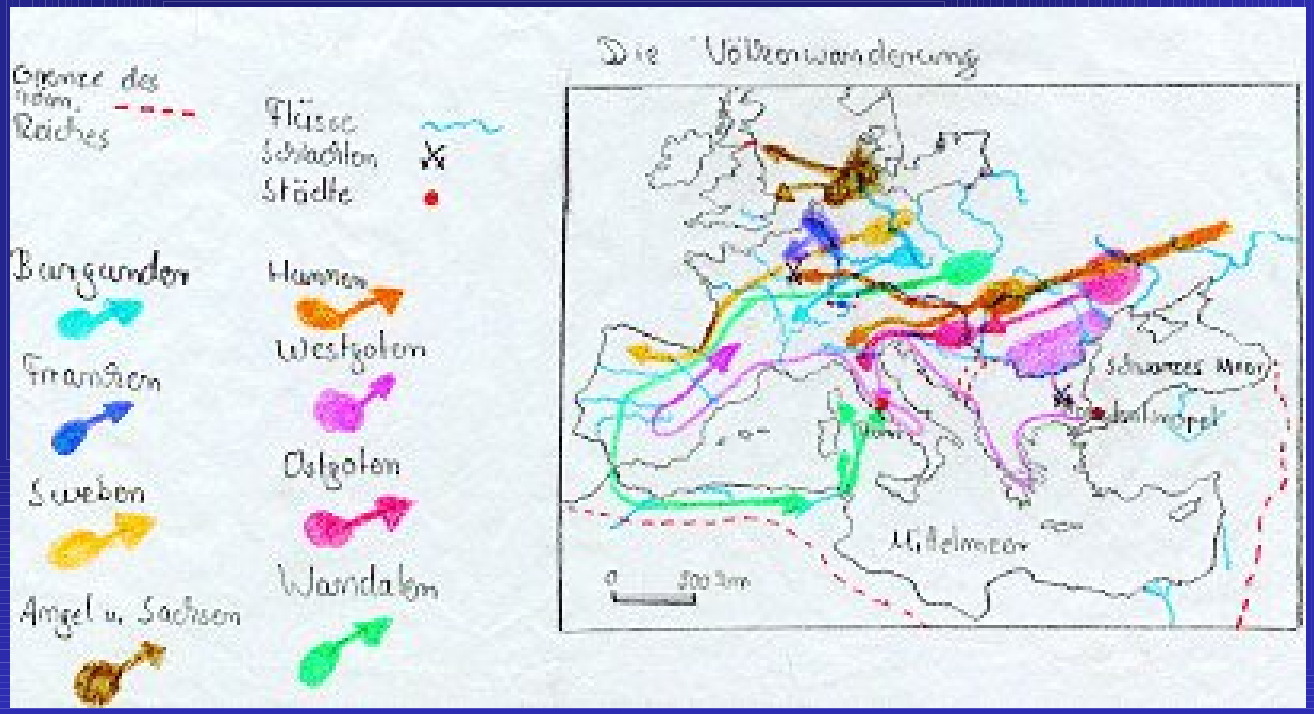
II

- more pasture than agriculture
- not new hydraulics works
- hydraulic development stopped



Arabs & Christians

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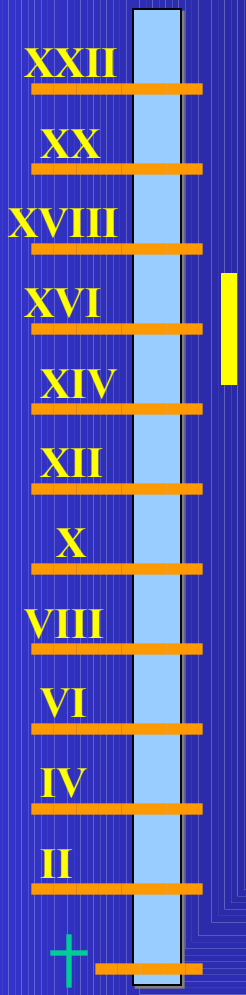
II

- water as a valuable natural resource
- agriculture (great development) and gardens
- water distribution more than water regulation
- use of Roman structures
- origin of the traditional Spanish irrigation systems

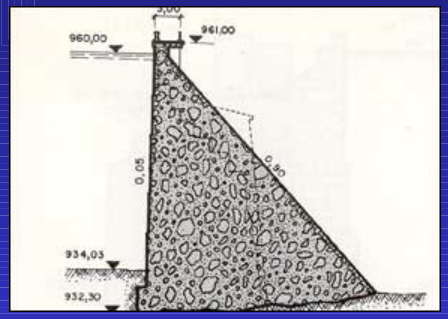
- ***Granada: Alhambra and Generalife***
- ***Zaragoza: Almonacid Dam (30)***
- ***Albacete: Almansa Dam (15-21)***

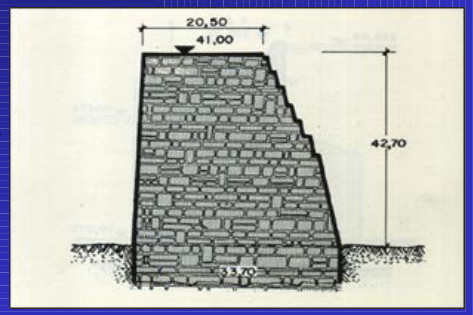
Habsburg´s Dynasty



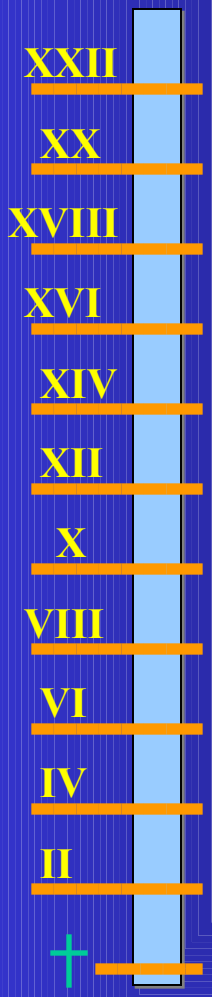
- new Hydraulic Works in Levante and Ebro´s Area
- use of rivers for navigation purposes
- hundreds of new projects

- *„Canal Imperial de Aragón“*
- *Huesca: Arguis Dam (1687, 23m)*
- *Castilla Channel (beginning)*
- *Alicante: Tibi Dam (1580, 46m)*
- *Transfers to Murcia (project)*



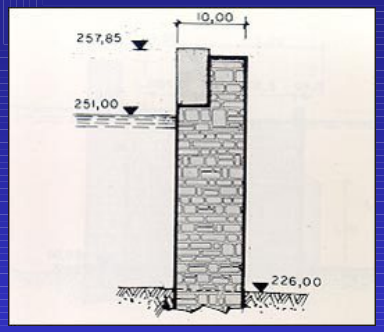


BORBONES´ DINASTY



- navigation channels as first objective all across the country
- still using Roman structures (repaired) and new ones
- lots of large dams

- ***Madrid: Gasco Dam (1787, 91m but destroyed with only 50m)***
- ***Alicante: Relleu Dam (1653,32m)***
- ***Murcia: Puentes Dam (1785,50m)***
- ***Zaragoza: Mezalocha Dam (1719, 45m)***
- ***Castilla Channel (cont.)***



S. XIX

XXII
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- great development after Independence War
- trains substitute navigation channels
- 1799: Cuerpo de Ingenieros de Caminos, Canales y Puertos and ist "Technical Highest School"
- 1864 first "global" planification
- 1866: first Law of Water
- 1870. Law of channels and reservoirs

- ***Madrid: El Villar Dam (1873, 50m)***
- ***Murcia:Valdeinfierno Dam (1785-1806,49m)***

S. XX

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VIII
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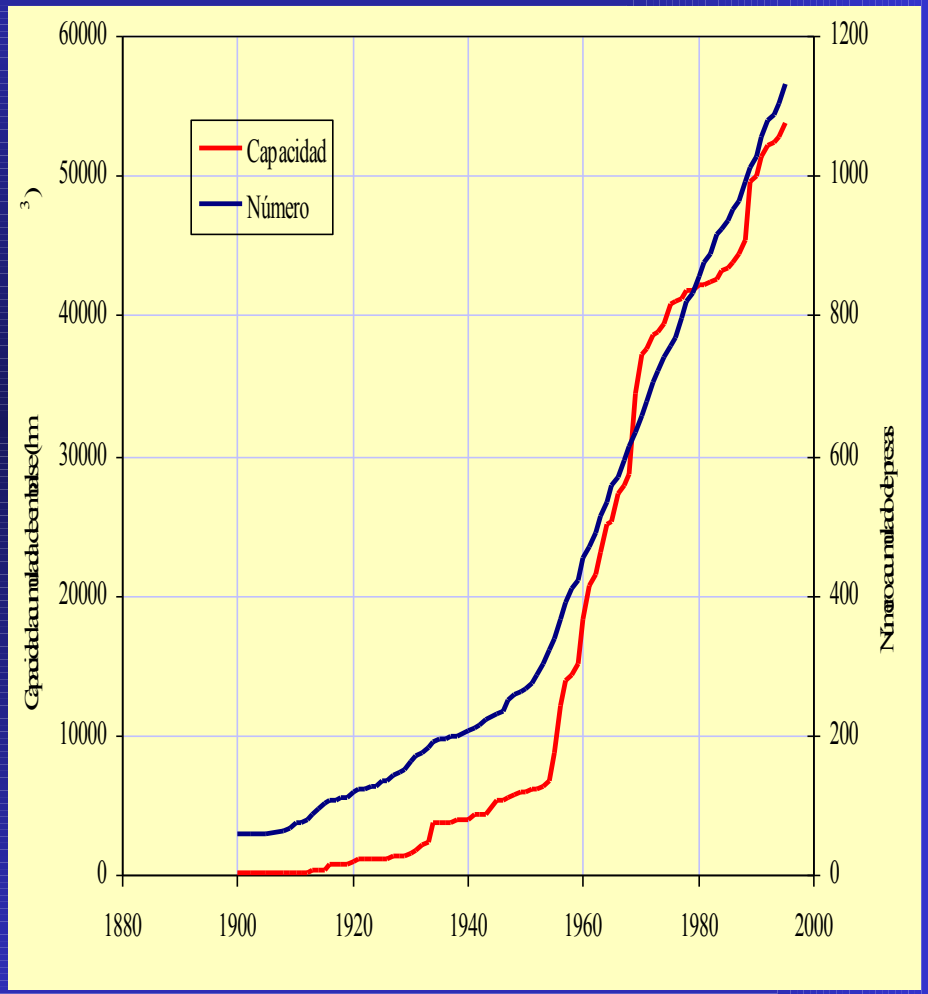
IV
II

- 1902 General Plan of Irrigation Channels and Reservoirs (205 new hydraulics works but without a general organisation)
- 1926 creation of the "Hydrografic Confederations"
- 1936-1939 Civil War
- 1933 and 1940 National Plans of Hydraulic Works
- 1967-1978 Transfer Tajo-Segura
- 1985 Present Law of Water
- Enormous development



... And, what do we have TODAY?

WATER RESOURCES

DAMS

GROUNDWATER EXPLOITATION

WATER RE-USE

DESALINIZATION

TRANSFERS

WATER RESOURCES

DAMS

GROUNDWATER EXPLOITATION

WATER RE-USE

DESALINIZATION

TRANSFERS

MORE THAN 1,200 LARGE DAMS IN SPAIN

WATER RESOURCES

DAMS

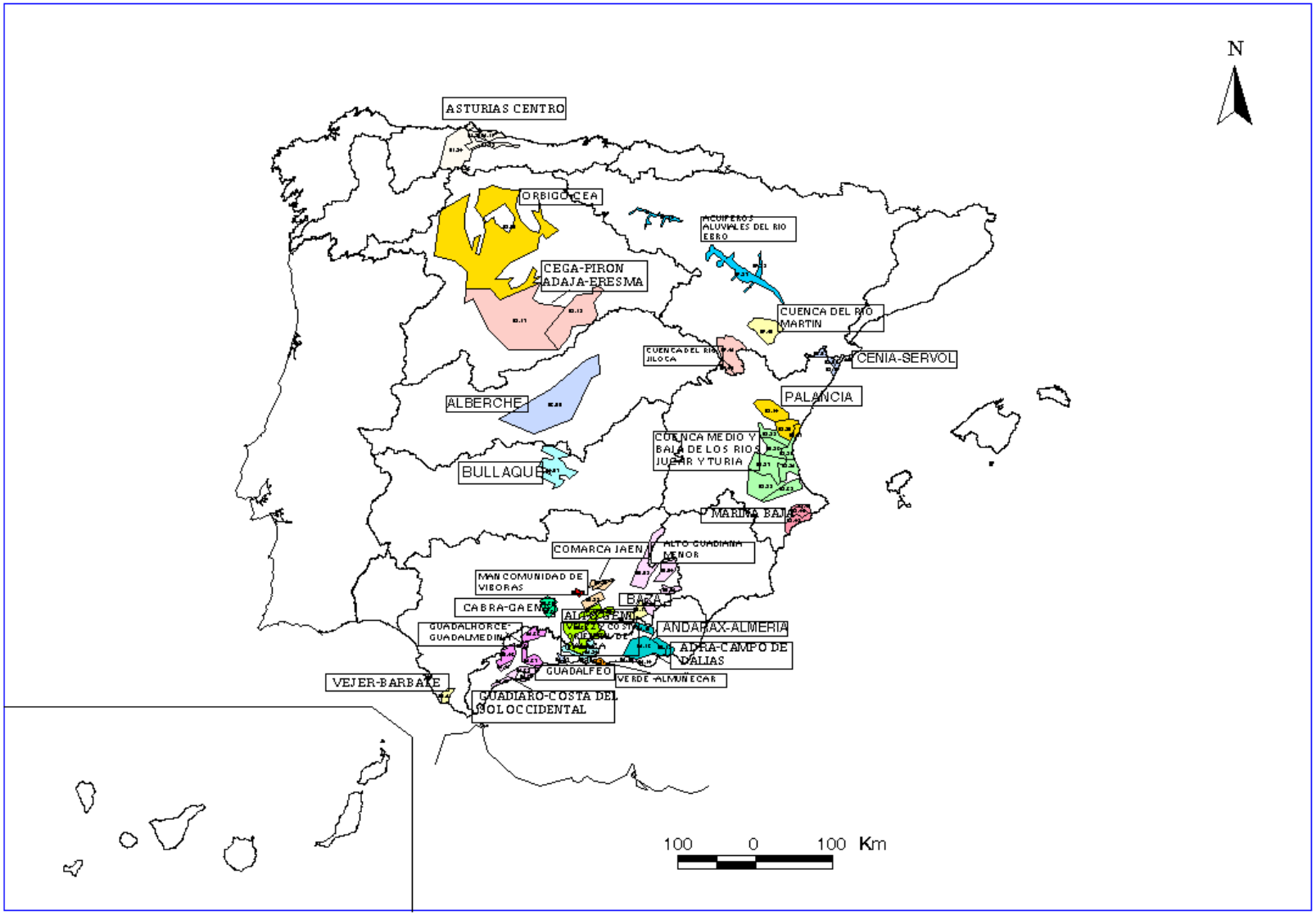
GROUNDWATER EXPLOITATION

WATER RE-USE

DESALINIZATION

TRANSFERS

AQUIFERS-RESERVOIRS SYSTEMS



Fuete: CEDEX

WATER RESOURCES

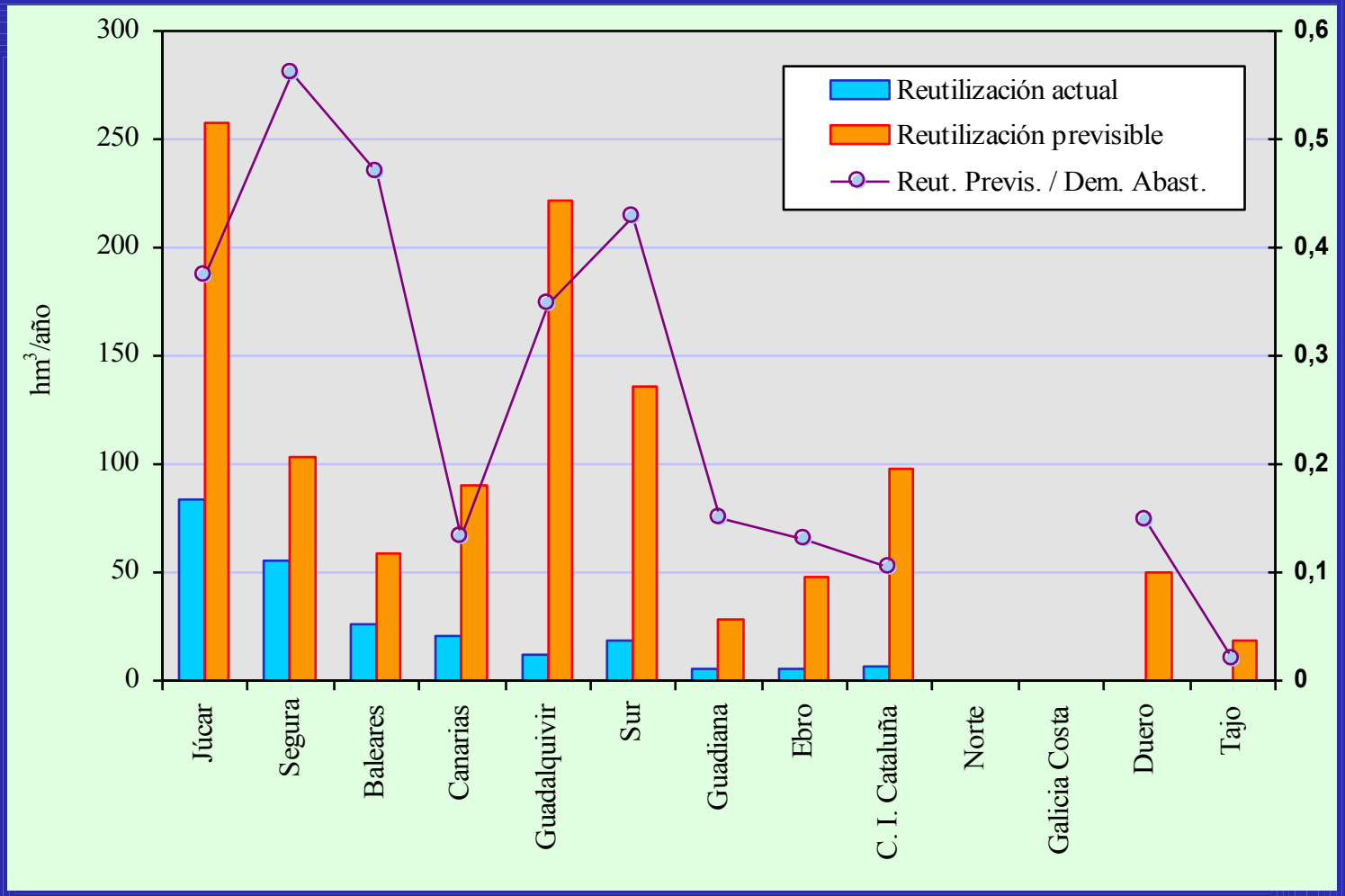
DAMS

GROUNDWATER EXPLOITATION

WATER RE-USE

DESALINIZATION

TRANSFERS



Volúmen total de reutilización previsible en España (2º horizonte de los Planes Hidrológicos de cuenca): 1.100 Hm3/año : (CEDEX)

Fuete: CEDEX

WATER RESOURCES

DAMS

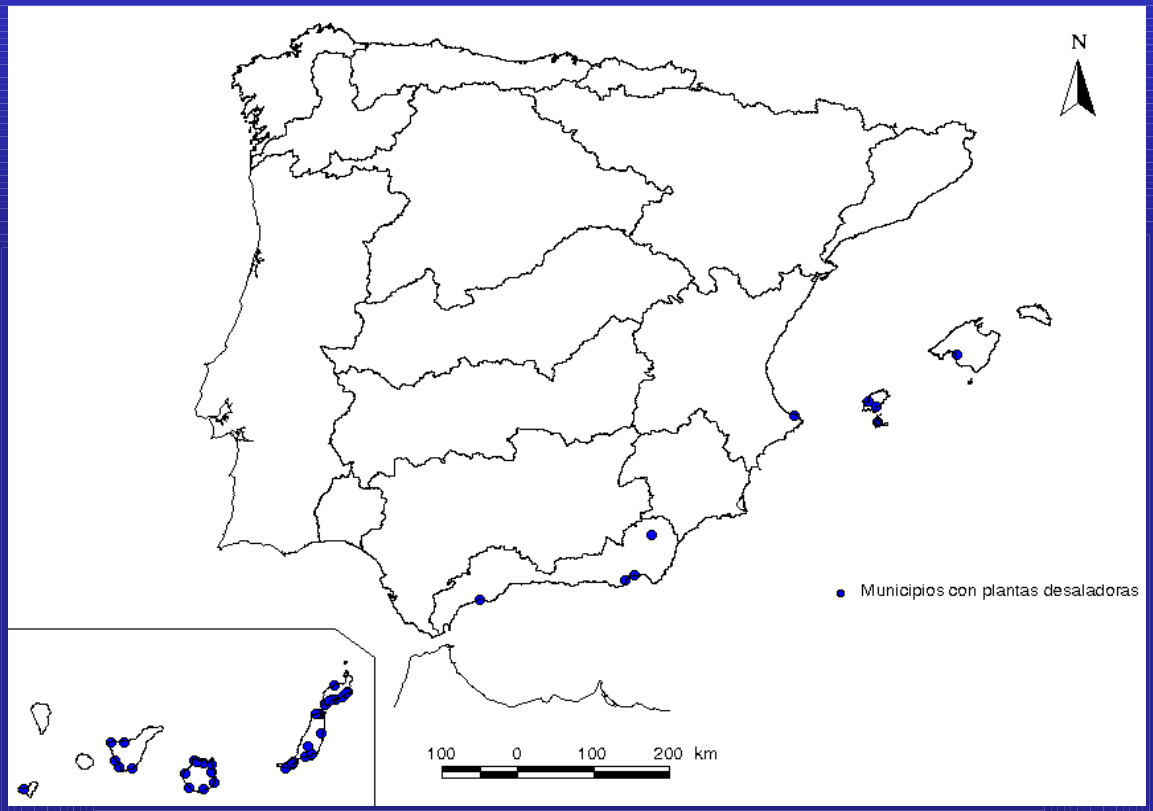
GROUNDWATER EXPLOITATION

WATER RE-USE

DESALINIZATION

TRANSFERS

DESALINIZATION INSTALLATIONS



Mapa de municipios con instalaciones de desalación para abastecimiento urbano

Agua de mar	Uso urbano	89 hm^3/año
	Uso agrícola	5 hm^3/año
Agua salobre	Uso urbano y turístico	29 hm^3/año
	Uso industrial	40 hm^3/año
	Uso agrícola	58 hm^3/año

Distribución por usos de las aguas desaladas marinas y salobres. Total: unos 220 Hm3/año

Fuete: CEDEX

WATER RESOURCES

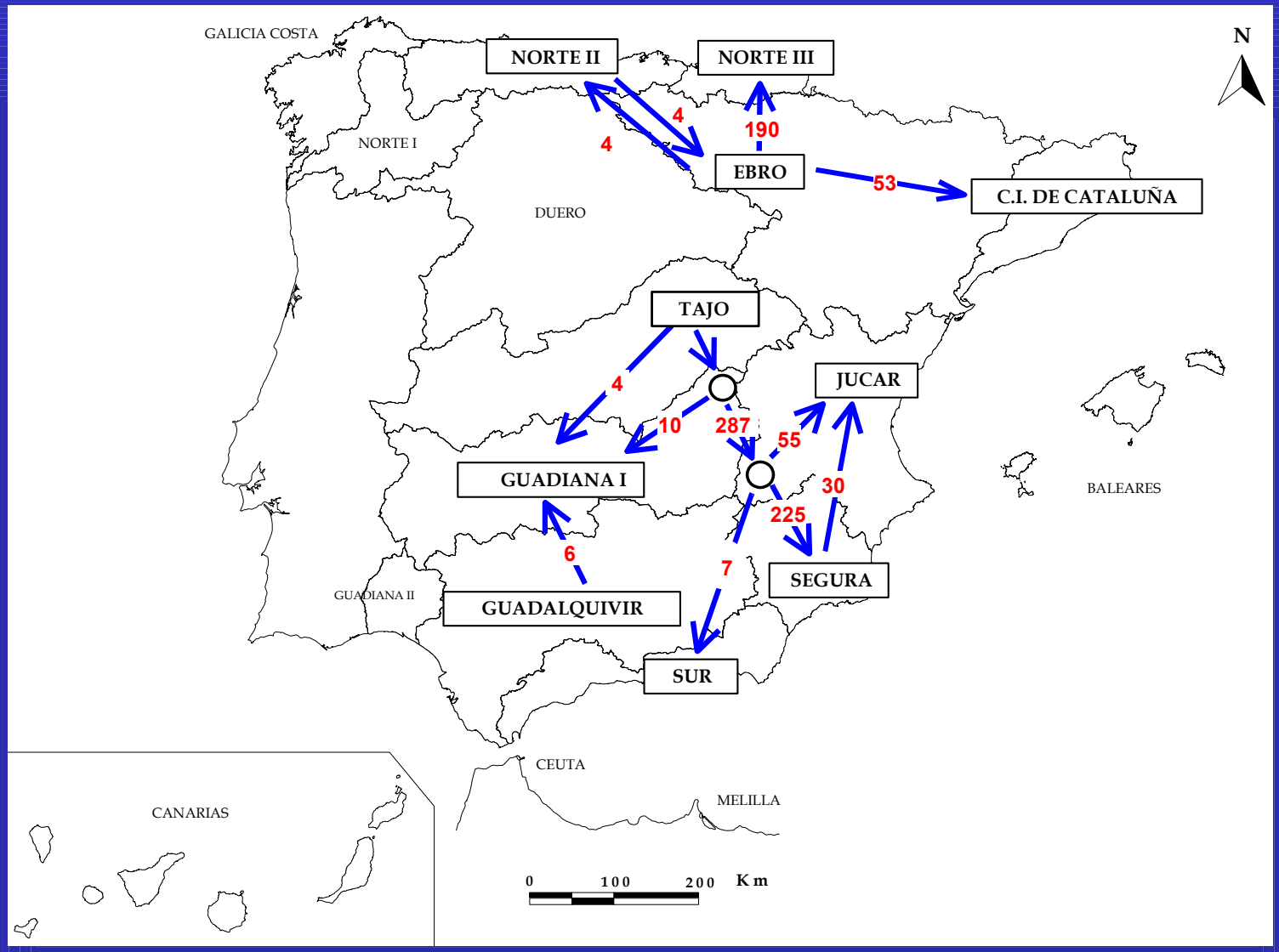
DAMS

GROUNDWATER EXPLOITATION

WATER RE-USE

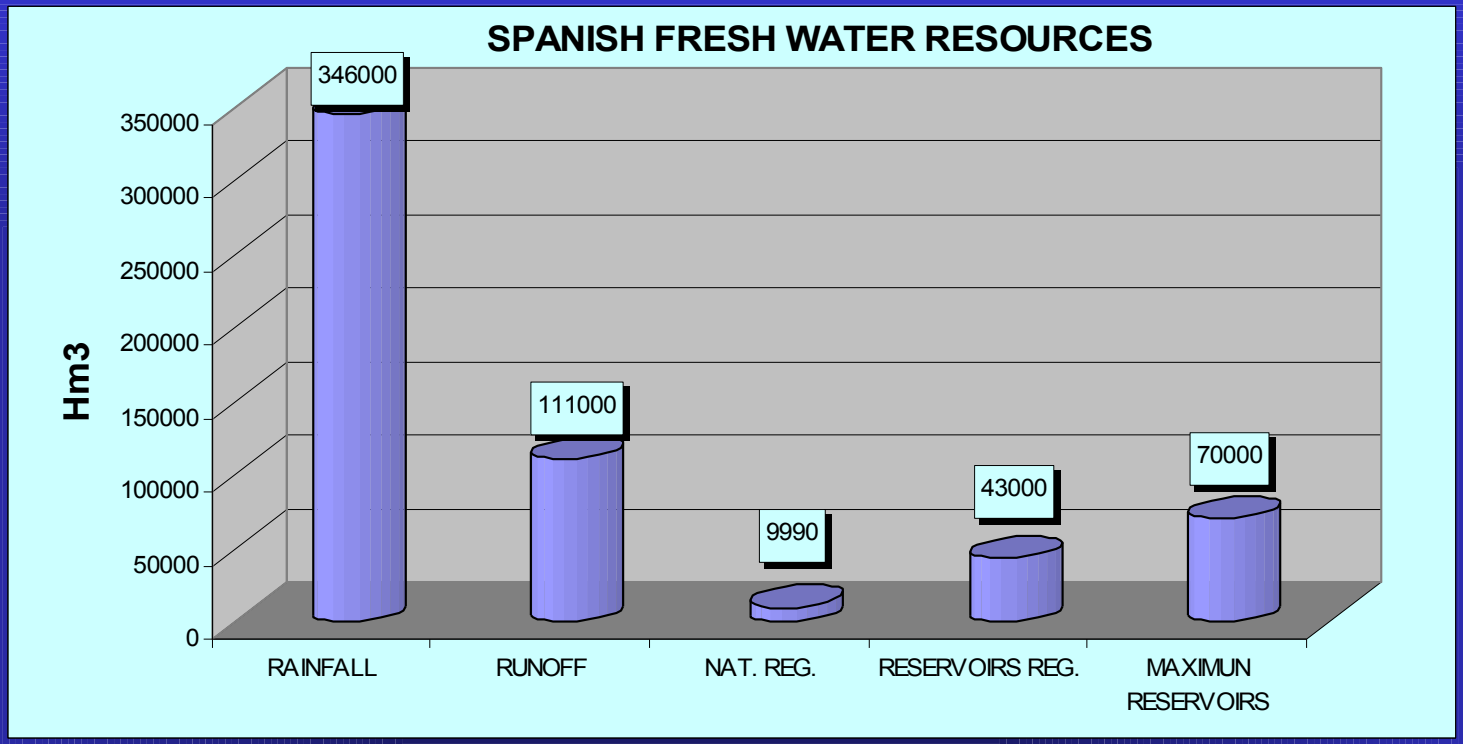
DESALINIZATION

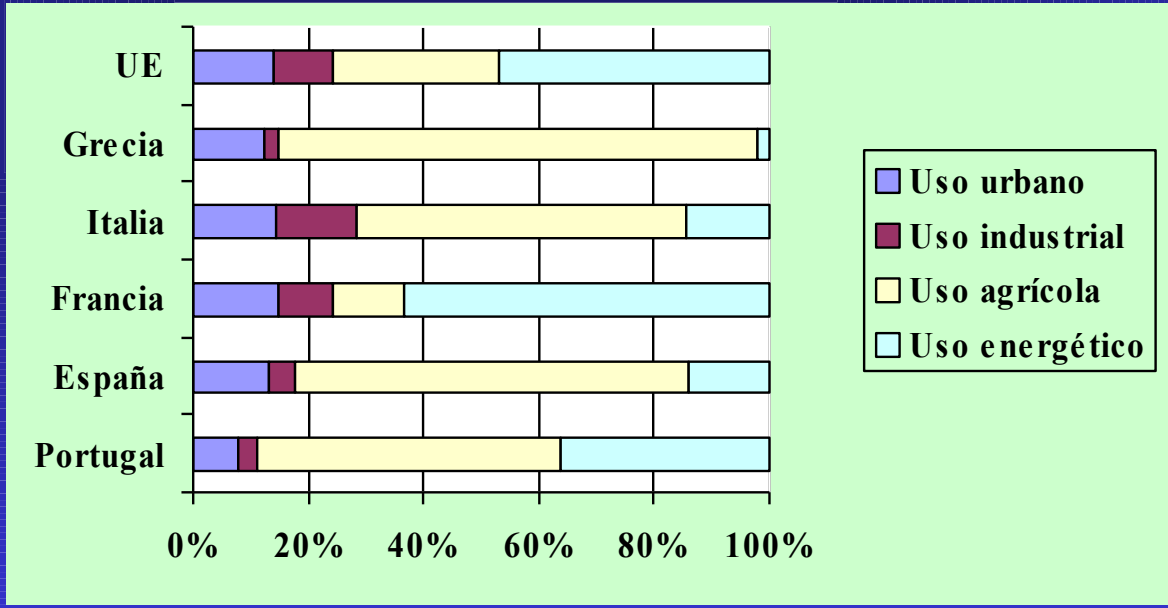
TRANSFERS



Main Current Tranfers in Spain (average anual values hm3)

Fuete: CEDEX


SPANISH FRESH WATER RESOURCES
Hm3
350000
300000
250000
200000
150000
100000
50000
0
346000
111000
9990
43000
70000
RAINFALL
RUNOFF
NAT. REG.
RESERVOIRS REG.
MAXIMUN RESERVOIRS


UE
Grecia
Italia
Francia
España
Portugal
0%
20%
40%
60%
80%
100%
Uso urbano
Uso industrial
Uso agrícola
Uso energético

Fuete: CEDEX

... Is the problem solved, or we have to keep on working TOMORROW?

IN THE NEXT DECADE WE HAVE TO DO...

PLAN HIDROLÓGICO NACIONAL

PLAN NACIONAL DE REGADÍOS

NEW LAW ABOUT FLOOD RISK PROTECTION

NEW REGULATIONS ABOUT DAM SAFETY

EUROPEAN ENVIRONTMENTAL POLICY

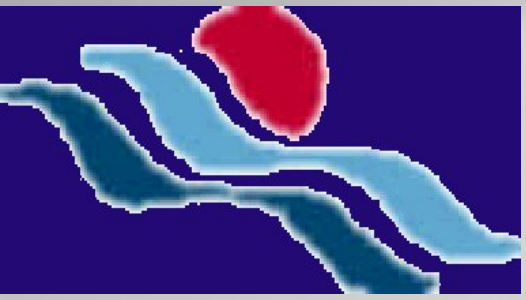
AUTONOMIC COMUNITIES´ HYDRAULIC WORKS

CONCLUSSIONS

Thank you for your attention

Monday, 1st of July to Friday, 5th of July
Schrobenhausen, Augburg, Wolnzach,
Germany

EVOLUTION OF BIOLOGICAL WASTEWATER TREATMENT: From Activated Sludge (AS) to Moving Bed Membrane Bioreactor (MB-MBR)



Microbiology and Environmental Technologies
(MITA)

University of Granada (UGR)

ugr

OUR RESEARCH GROUP

Working centres:

- ✓ Civil Engineering School
- ✓ Institute for Water Research
- ✓ Pharmaceutical Sciences Faculty

Departments:

- ✓ Civil Engineering
- ✓ Microbiology
- ✓ Structures and Hydraulic Engineering

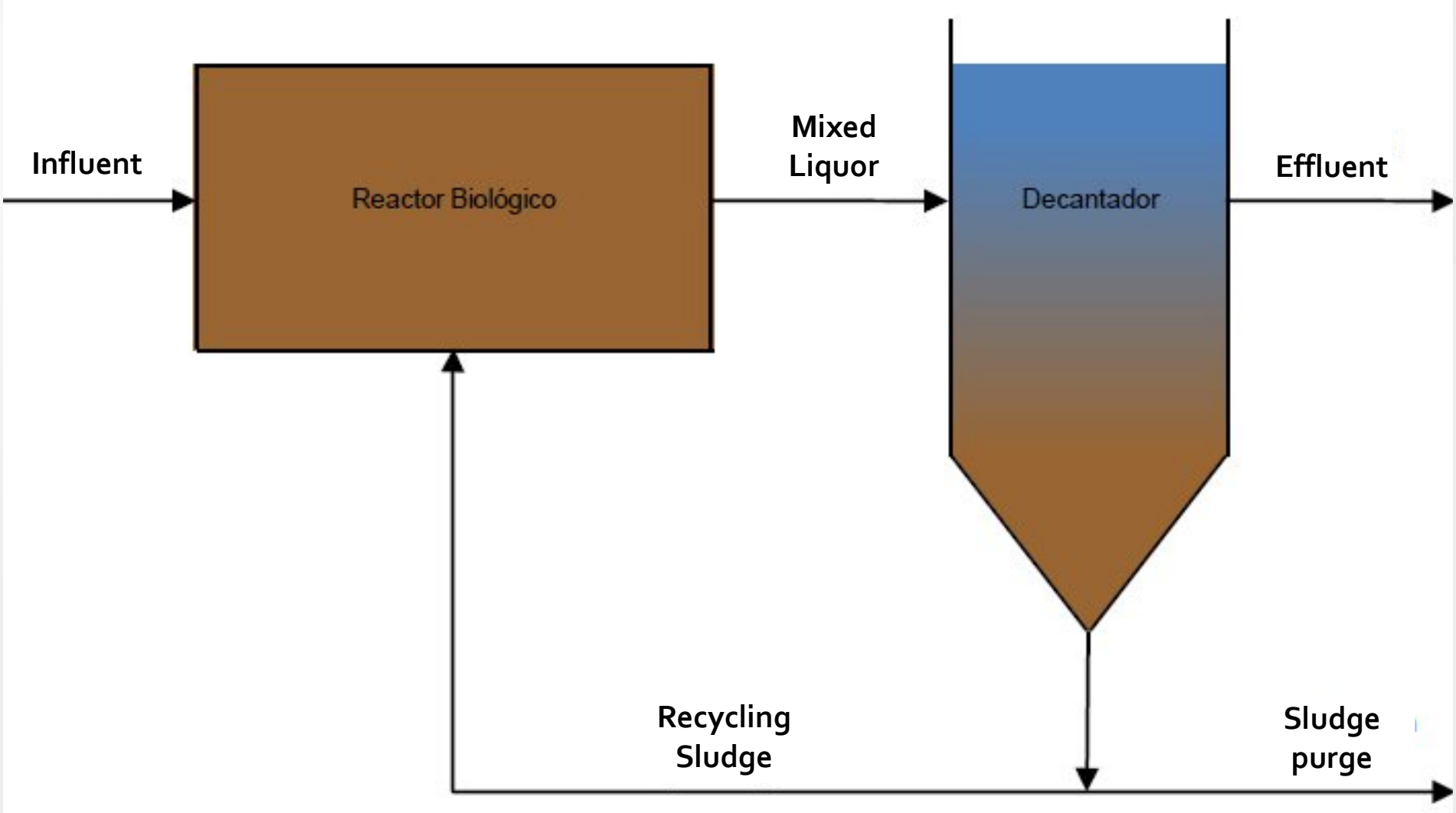
Research lines:

- ✓ Urban wastewater treatment
- ✓ Industrial wastewater treatment
- ✓ Wastewater reuse
- ✓ Soil bioremediation
- ✓ Soil pollutant removal

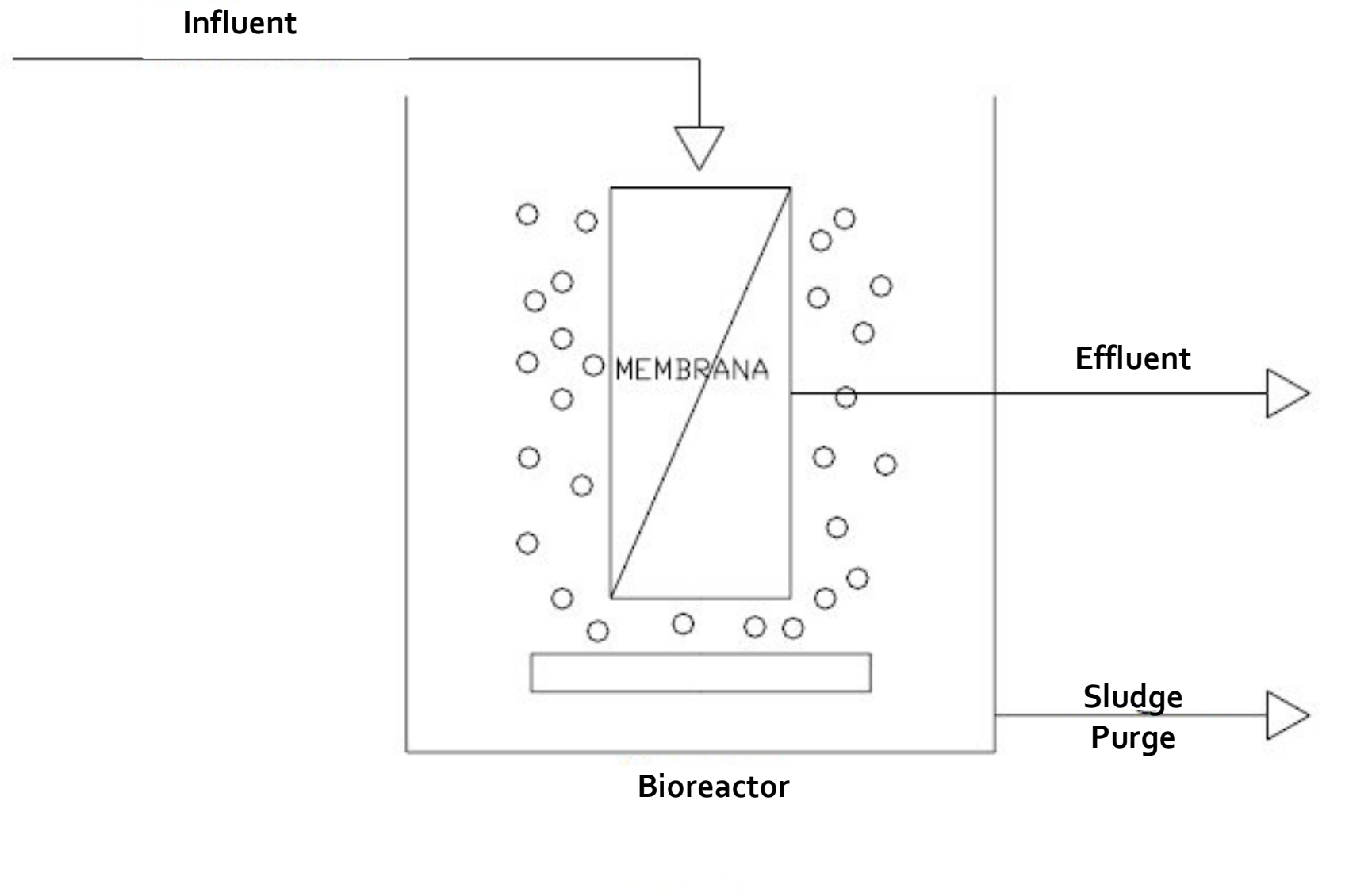
BIOLOGICAL WASTEWATER TREATMENT

- ✓Natural consumption of the organic matter.
- ✓Nutrients removal.
- ✓Microorganisms removal.

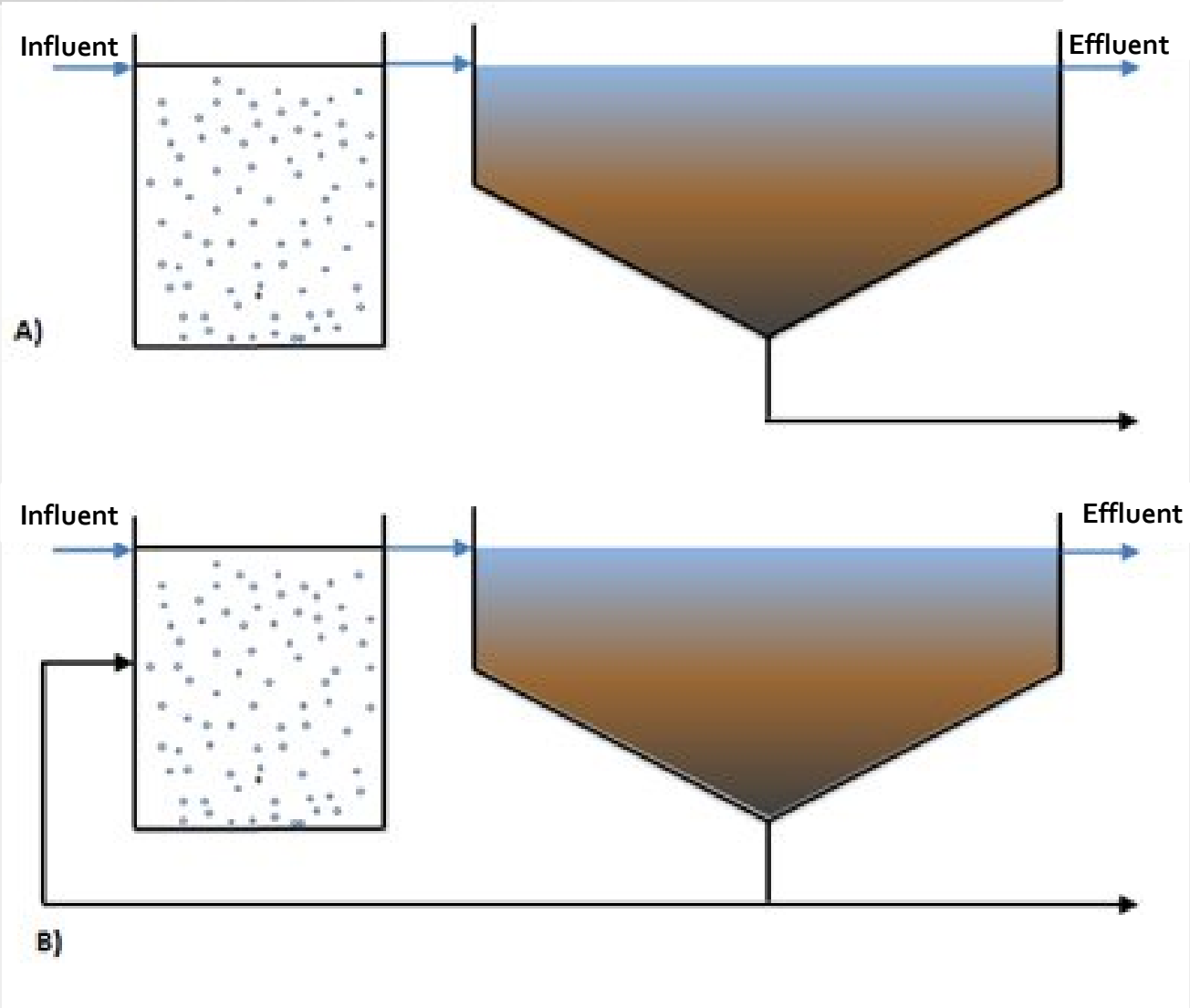
CONVENTIONAL ACTIVATED SLUDGE



MEMBRANE BIOREACTOR



MOVING BED BIOREACTOR

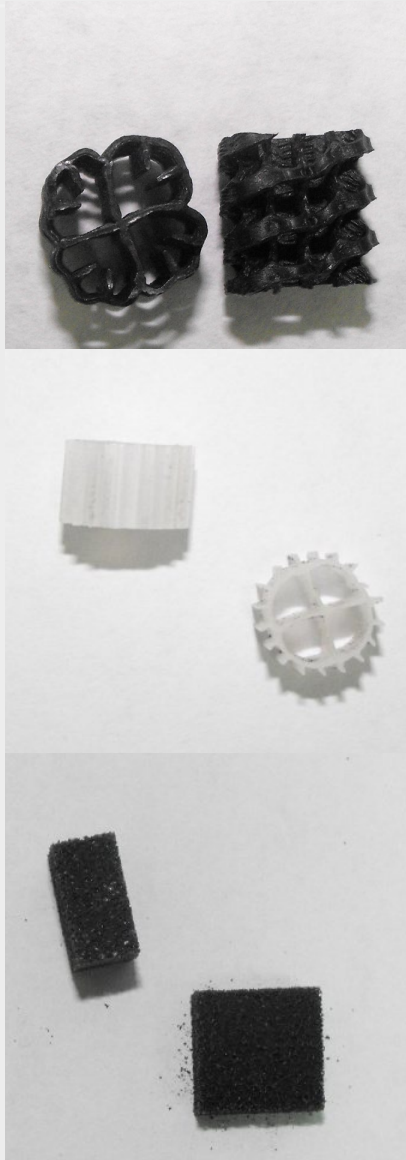


Moving bed bioreactor (A) with biofilm or (B) with hybrid biomass: biofilm and suspended solids

MOVING BED BIOREACTOR

Carrier

- ✓Protected area to cell growth.
- ✓Microorganisms and organic matter transfer.
- ✓Microorganisms and oxygen transfer.
- ✓Carrier density slightly lower than the water one to provide the bed motion.



MOVING BED BIOREACTOR

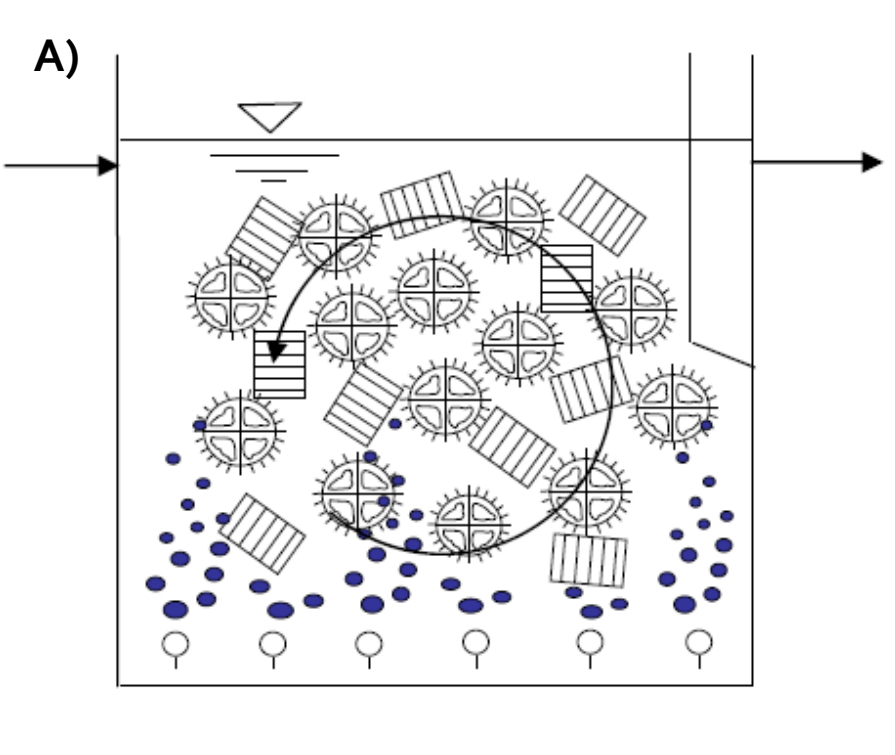
✓ A moving bed bioreactor must be in continuos motion to:

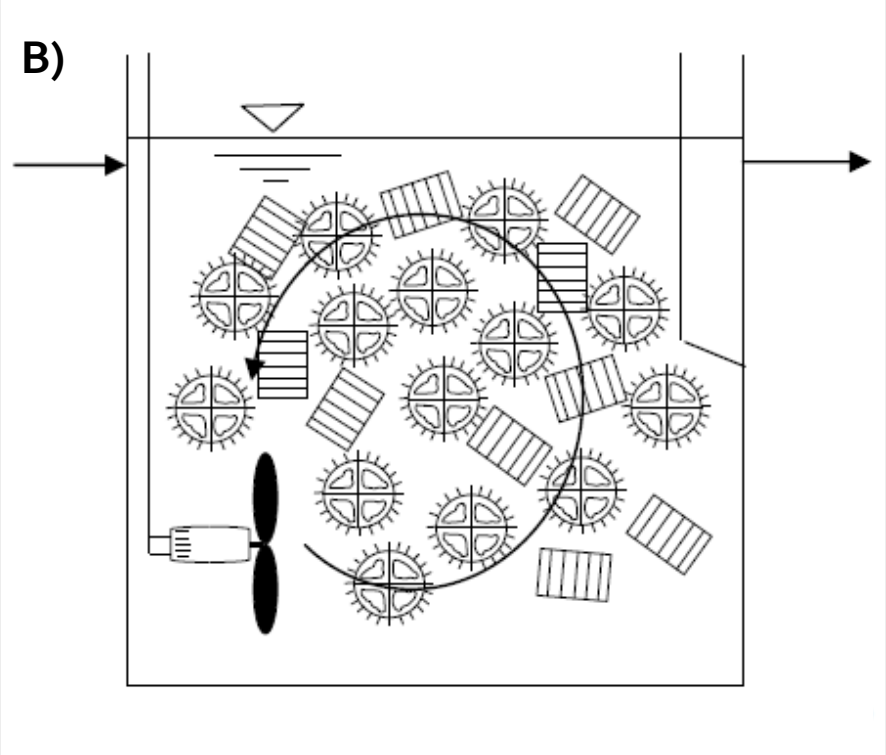
- Bed clogging.
- Contact between the organic matter and the microorganisms.

- **Pure Moving Bed** — VIDEO 1
- **Hybrid Moving Bed** — VIDEO 2

MOVING BED BIOREACTOR

- ✓ Aeration (aerobic bioreactor) or mechanical stirrer (anaerobic or anoxic bioreactor).





Moving Bed Bioreactor (A) aerobic conditions or (B) anoxic conditions

MOVING BED BIOREACTOR

Elements of the wastewater treatment plant

✓ Air diffuser.

MOVING BED BIOREACTOR

Elements of the wastewater treatment plant

✓Sieve arrangement.

MOVING BED BIOREACTOR

Elements of the wastewater treatment plant

MOVING BED BIOREACTOR

Advantages

✓ Simple alternative to uploaded conventional activated sludge plants.

VIDEO 3

✓ Advantages from the biofilm process.

✓ Increase the organic matter and nutrient removal rates.

✓ Efficiency depends on the filling ratio.

✓ Reduce the suspended solids concentration in the bioreactor.

✓ The sludge retention time increases.

✓ Biofilm is more resistant than the biological flocs regarding the variation of pH or organic loading.

MOVING BED BIOREACTOR

Some plants in the world

Vitivinícola del Ribeiro, España	318 Kg DQO/d
Nufri, España	17.000 kg DQO/d
Bonduelle, Portugal	5.200 Kg DQO/d
E.T.A.R. Pranchinha, Portugal	20.000 hab.equiv.
Bergamo, Italia	220.000 hab.equiv.
Bury St. Edmunds, Reino Unido	17.000 hab.equiv.
Caboolture, Australia	40.000 hab.equiv.
Gardermoen, Noruega	50.000 hab.equiv.
Solvay Paperboard, EEUU	3.000 kg DBO/d
Stora Enso Langerbrugge, Bélgica	36.000 kg DQO/d
UPM Schongau Mill, Alemania	20.000 kg DQO/d
Coca Cola Apizaco, México	4.200 kg DBO_5/d
Stora Enso Intercell, Polonia	22.000 kg DQO/d

MOVING BED BIOREACTOR

MOVING BED BIOREACTOR

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Stora Enso Intercell, Polonia	22.000 kg DQO/d

MOVING BED BIOREACTOR

MOVING BED BIOREACTOR

CMPC Santa Fe, Chile	127.000 kg DQO/d
Greenfield, Francia	19.000 kg DQO/d
SCA Puigpelar, España	1.700 kg DQO/d
Broomfield, Colorado, EEUU	73.500 hab.equiv.
Alier, España	15.000 kg DBO_7/d
Klippan WWTP, Suecia	7.000 hab.equiv.
Tafall - Olite, España	34.000 hab.equiv.
Klabin Kimberly, Brasil	5.500 kg DQO/d
Irving Pulp & Puper, Canadá	10.000 kg DQO/d
AstraZeneca, Suecia	1.500 kg TOC/d

OUR RESEARCH RESULTS

✓ **Comparative study of carrier type**

❑Martín-Pascual, Jaime; Lopez-Lopez, Cristina; González-López, Jesús; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel (2011). **Comparative Kinetic Study of Carrier Type in a Moving Bed System Applied to Organic Matter Removal in Urban Wastewater Treatment.** Water, air & soil pollution 223 (1) 1699-1712

❑Lopez-Lopez, Cristina; Martín-Pascual, Jaime; González-Martínez, Alejandro; Calderón-Alvarado, Kadiya Del Carmen; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel (2012). **Influence of filling ratio and carrier type on organic matter removal in a moving bed biofilm reactor with pretreatment of electrocoagulation in wastewater treatment.** Journal of Environmental Science and Health, Part A 47 1-9

❑Calderón-Alvarado, Kadiya Del Carmen; Martín-Pascual, Jaime; Poyatos-Capilla, José Manuel; Rodelas-González, María Belén; González-Martínez, Alejandro; González-López, Jesús (2012), **Comparative analysis of the bacterial diversity in a lab-scale moving bed biofilm reactor (MBBR) applied to treat urban wastewater under different operational conditions.** Bioresource technology 121 (1) 119-126

OUR RESEARCH RESULTS

✓ **Kinetic behaviour of the hybrid biomass**

❑Leyva-Diaz, Juan Carlos; Calderón, Kadiya; Rodríguez, Francisco Alejandro; González-López, Jesús; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel (2013). **Comparative kinetic study between moving bed biofilm reactor-membrane bioreactor and membrane bioreactor systems and their influence on organic matter and nutrients removal**.Biochem. Eng. J.

❑Martín-Pascual, Jaime; Reboleiro-Rivas, Patricia; González-López, Jesús; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel (2013). **Influence ot hydraulic retention time on heterotrophic biomass in a wastewater moving bed membrane bioreactor treatment plant.** Int. J. Environ. Sci. Technol. DOI 10.1007/s13762-013-0329-6

OUR RESEARCH RESULTS

✓ **Behaviour of a membrane bioreactor**

❑Martín-Pascual, Jaime; Rodríguez-Íñiguez, Francisco Alejandro; Reboleiro-Rivas, Patricia; González-López, Jesús; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel (2012). **Influence ot the temperature in the permeate flux of the membrane in a membrane bioreactor with moving bed biofilm reactor,** Procedia Engineering 44 (2012) 275-277

❑Rodríguez-Íñiguez, Francisco Alejandro; Martín-Pascual, Jaime; GARCÍA-MESA, JUAN JOSÉ; González-López, Jesús; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel(2012). **Influence of pure oxygen or air to suply the aerobic conditions in membrane bioreactor in the recovery of permeability of the membrane.** Procedia Engineering 44 (2012) 1970-1973

❑García-Mesa, Juan José; Martín-Pascual, Jaime; Muñío-Martínez, María Del Mar; Delgado-Ramos, Fernando; Hontoria-García, Ernesto; Poyatos-Capilla, José Manuel (2012). **Wastewater particle size distribution variation in a real membrane bioreactor plant,** Procedia Engineering 44 (2012) 942-945

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Schrobenhausen, Augburg, Wolnzach,
Germany

Thank you for your attention

Membrane Bioreactor (MB-MBR)

Microbiology and Environmental Technologies
(MITA)

University of Granada (UGR)

ELEMENTS OF CORSICA REPORT

2011-1-CY1-GRU06-01523

Octobre 2011- Octobre 2013

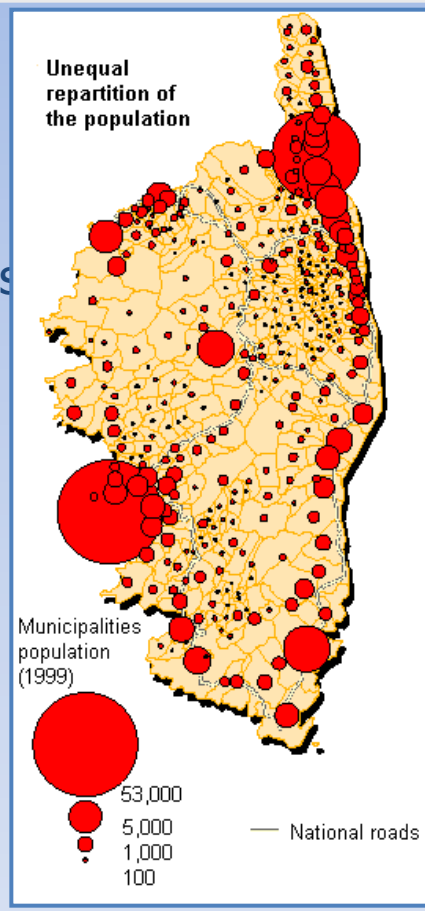
Meeting in Germany

. B. KHOUMERI (Université de Corse) avec la collaboration de
F. Moracchini (ODARC) et A.Honorez (OEHC)

Schrobenhausen 2013

POPULATION (source insee) :

- **316 578** inhabitants (2012). Since 1999 the population is increasing due to emigration.
- Population older than the national average.
- Today Corsica is more urban than rural, even if rural areas represent 80 % of the territory.
- Total **active population** : 103 700 (2010).
- Unemployment rate : **9,6 %** (2011)
- **Unequal repartition** of the population : concentration on coastal regions and around major roads. On the contrary, the villages of the interior are abandoned.
- Average **density** : 35,5 inh/km^2 the weakest of France.



- **Touristic population** very important mainly in summer : **3 millions** in summer 2009. Approximatively 10 tourists per inhabitant.

Water ressources

Total theoritical storage	106 thousands of m3
Total Mean yearly precipitation 2009-2010	9.536 thousands of m3
Yearly average rainfall	900 mm < 700 mm in plain, > 1000 mm in mountain
Highest interseasonal Capacity of Storage	**< 2 %**

Unequal repartition in space and in time

Main interseasonal storage water structures

Department	Conces-sionnary	Structures (dams and water detention)	Storage Capacity (thousands of m3)	Uses		
				Irrigation	Drinking supply	Electricity
Sud Corsica	EDF	TOLLA	32	X	X	X
North Corsica	EDF	CALACUCCIA	25	X		X
Sud Corsica	EDF	SAMPOLO	1.6	X		X
Sud Corsica	EDF	RIZZANESE	1.3	X		X
North Corsica	OEHC	ALESANI	10.6	X		X
North Corsica	OEHC	ALZITONE	5.6	X		
North Corsica	OEHC	TEPPE-ROSSE	4.4	X		
North Corsica	OEHC	PERI	3.0	X		
North Corsica	OEHC	BACCIANA	2.4	X		
North Corsica	OEHC	GUAZZA	0.3	X		
North Corsica	OEHC	CODOLE	6.6	X	X	
North Corsica	OEHC	PADULA	1.9	X		
Sud Corsica	OEHC	FIGARI	5.6	X	X	
Sud Corsica	OEHC	OSPEDALE	3.3	X	X	
Sud Corsica	OEHC	ORTOLO	2.9	X		X

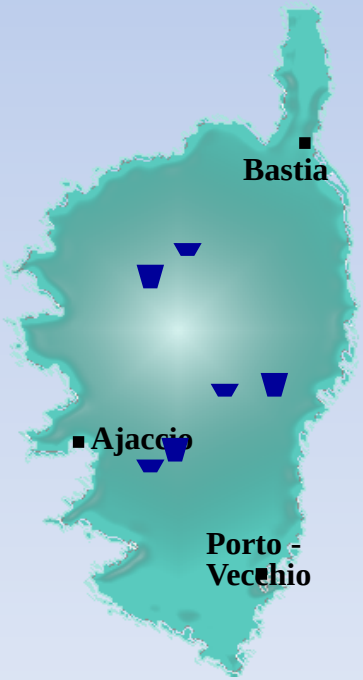
Source : EDF, OEHC

Dams and Reservoirs

The artificial water reserves can have 3 kinds of uses:

- Production of hydroelecticity (E)
- Irrigation (I)
- Drinking water supply (AEP)

EDF Dams



Dams and reserves of OEHC (Corsican Hydraulic Equipment Agency)

Mobilization of the resource:

- 65 millions of m^3 of water stored
- 6 dams
- 6 « collinaire » reserves
- 20 points of draw-off in rivers

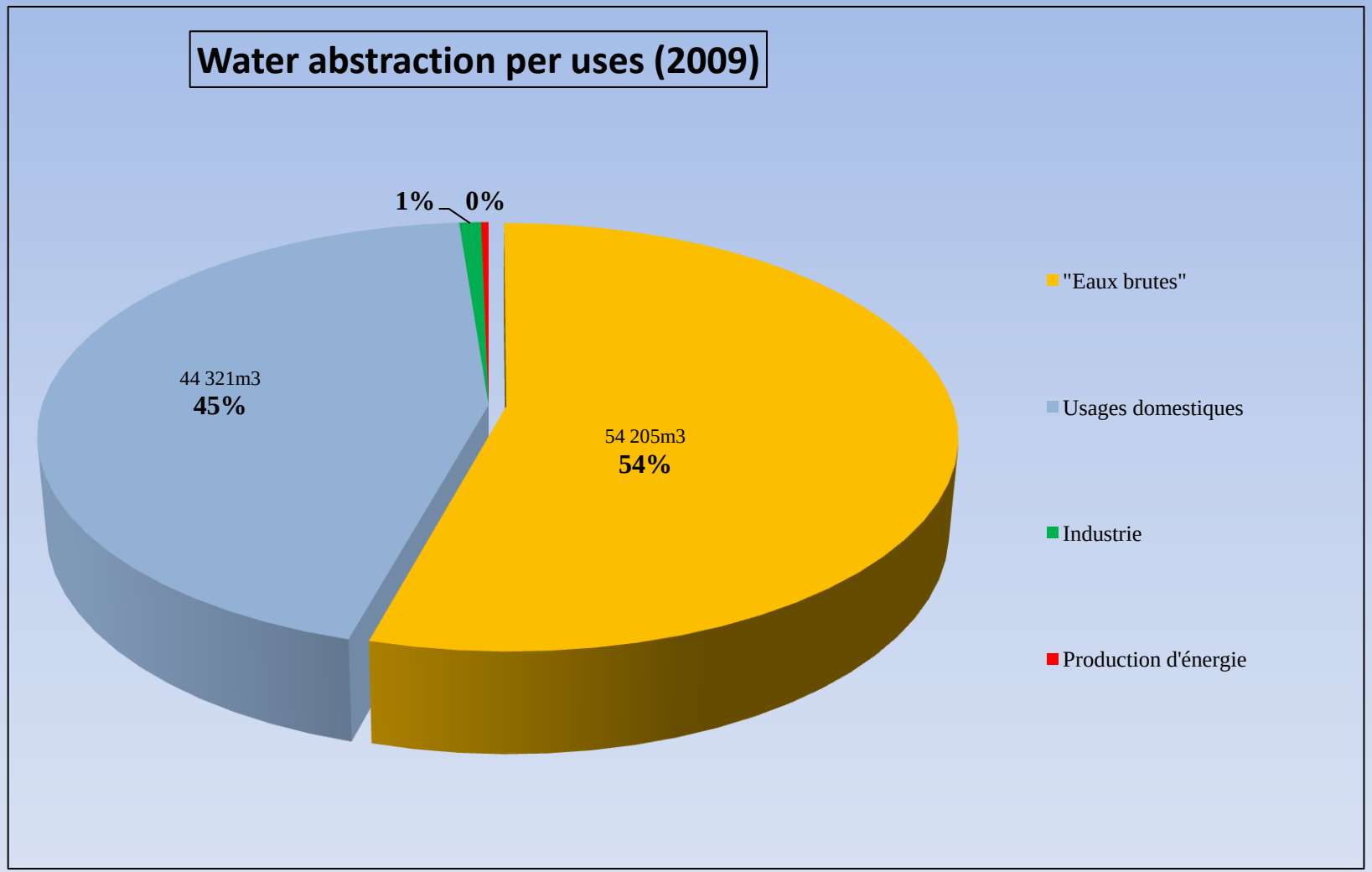
Distribution:

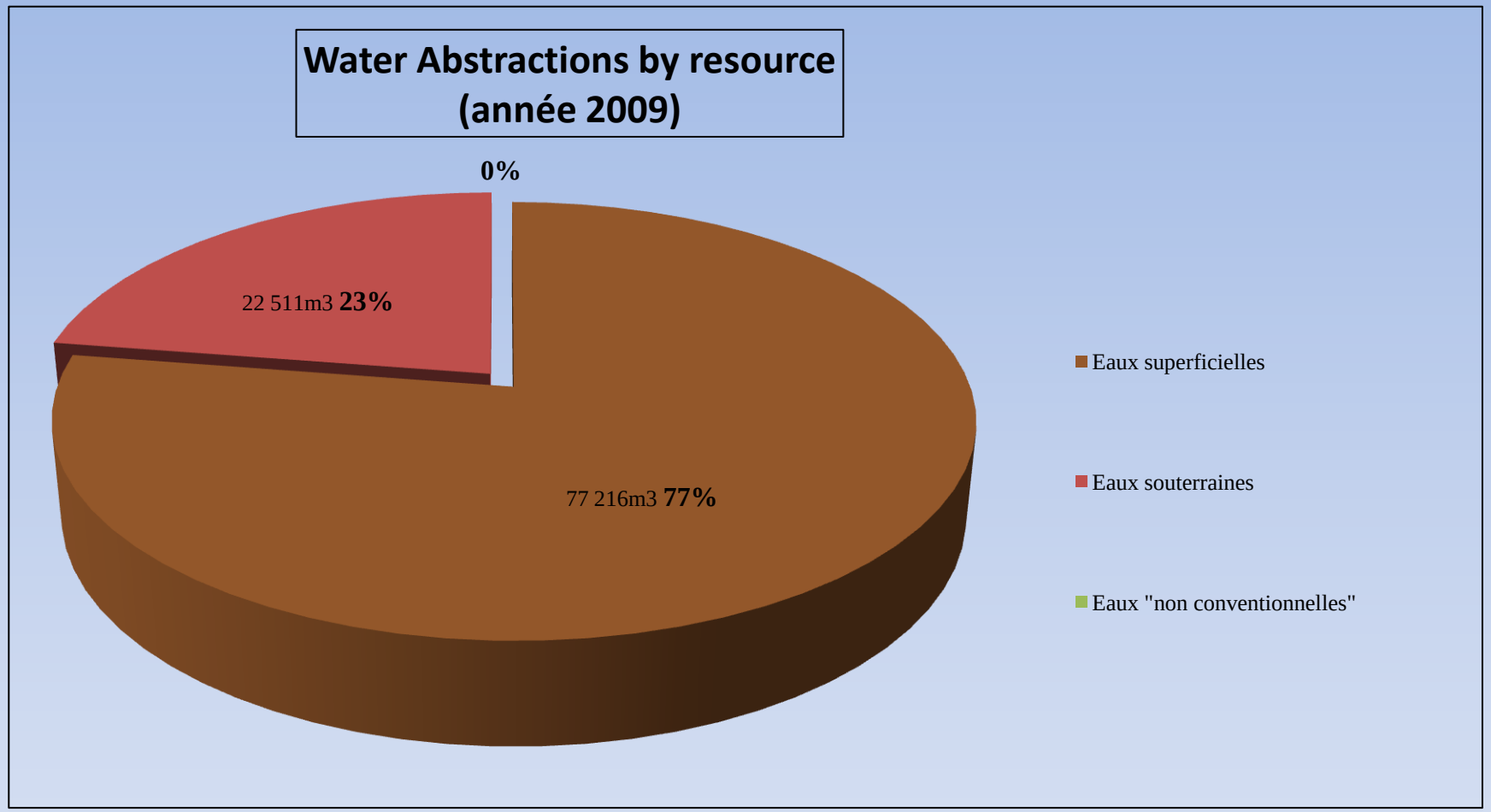
- 53 stations of pumping
- 200 Km of drain
- 30 stations of treatment

Total Water abstraction

Resources Thousands of m^3	Water abstraction per uses (2009)				Total	
	Agriculture	Domestic uses	Industry	Energy production	Corsica	France
Surface water	54 205	22 560	148	303	77 216	27 421 113
Groundwater	0	21 761	750	0	22 511	6 022 188
« Non conventional« water	0	0	0	0	0	-
Total	**54 205**	**44 321**	**898**	**303**	**99 727**	**33 443 301**

Source : MEDDE, Agence de l'Eau RM&C


Water abstraction per uses (2009)
1%
0%
44 321m3
45%
54 205m3
54%
"Eaux brutes"
Usages domestiques
Industrie
Production d'énergie


Water Abstractions by resource (année 2009)
0%
22 511m3 23%
77 216m3 77%
Eaux superficielles
Eaux souterraines
Eaux "non conventionnelles"

Agricultural water uses

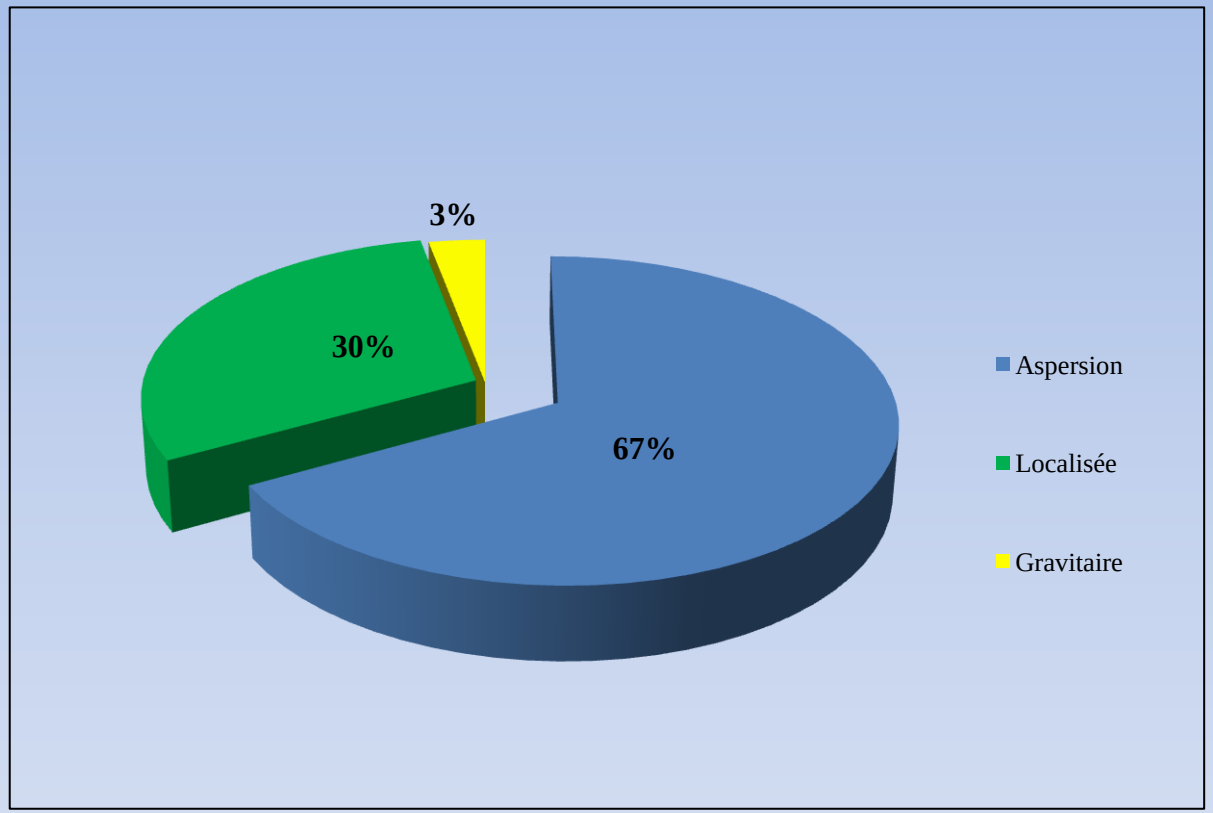
Consumptions of natural water recorded on the OEHC ' s network

Natural water Thousands of m^3	**2007**	**2008**	**2009**	**2010**	**2011**
Natural irrigation water	22 131	18 030	19 619	16 101	20 104
Natural water not used for irrigation	8 054	6 628	7 665	7 228	7 806
Total	**30 185**	**24 658**	**27 284**	**23 329**	**27 910**

Source : ODARC, OEHC

Price of agricultural water (without subscription) in 2012 €/m^3	
volume < 1 000 m^3	**0,024 €/m^3**
volume > 1 000 m^3	**0,036 €/m^3**

Irrigation practises



- Total SAU : 155 659 Ha
- Irrigated Cultures : 12 419 Ha
  8% of total SAU
- Irrigables Cultures : 17 169 Ha
  11% of total SAU

Drinking water supply and waste water treatment

	Drinking water supply		Waste water treatment	
	Population %	Communes %	Population %	Communes %
Direct Management	23	81	24	77
Intermediary Management Kyrnolia (41%) OEHC (22%)	77	19	76	21
No collective waste water treatment	-	-	0	3

Quality drinking water supply

Boreholes and water spring catchments for drinking water supply

Water spring catchments with Declaration of Public Utility (DUP)	53
Population who accesses to improved water	88 %

- **In RMC basin : 45 % of Delegated Management**
- **Price of water** depends on way of management

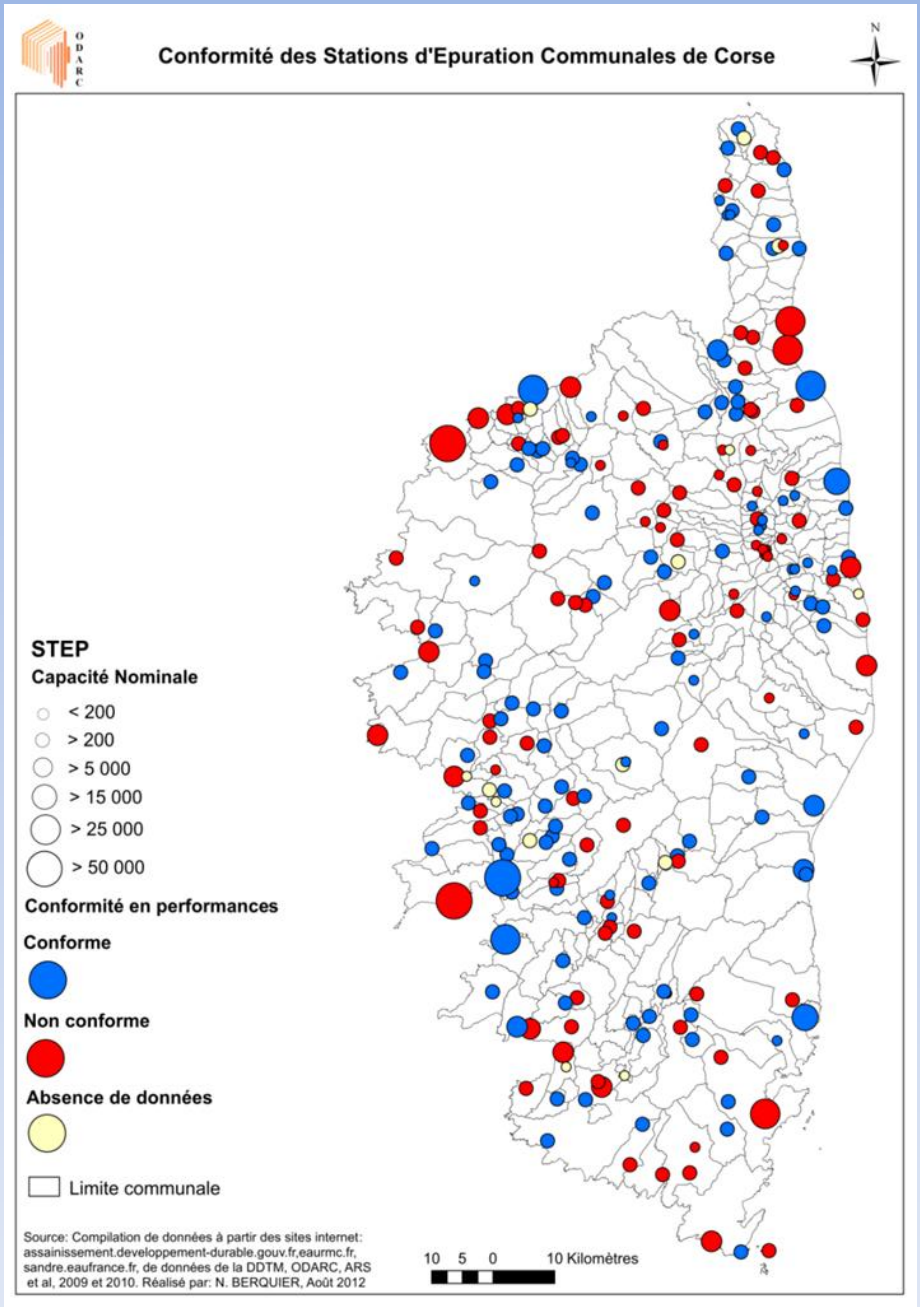
 - Average price in Corsica in 2007 : 3.34 €/m^3 (2.89 € for the RMC Basin)

The price was 1.72 € in 1992

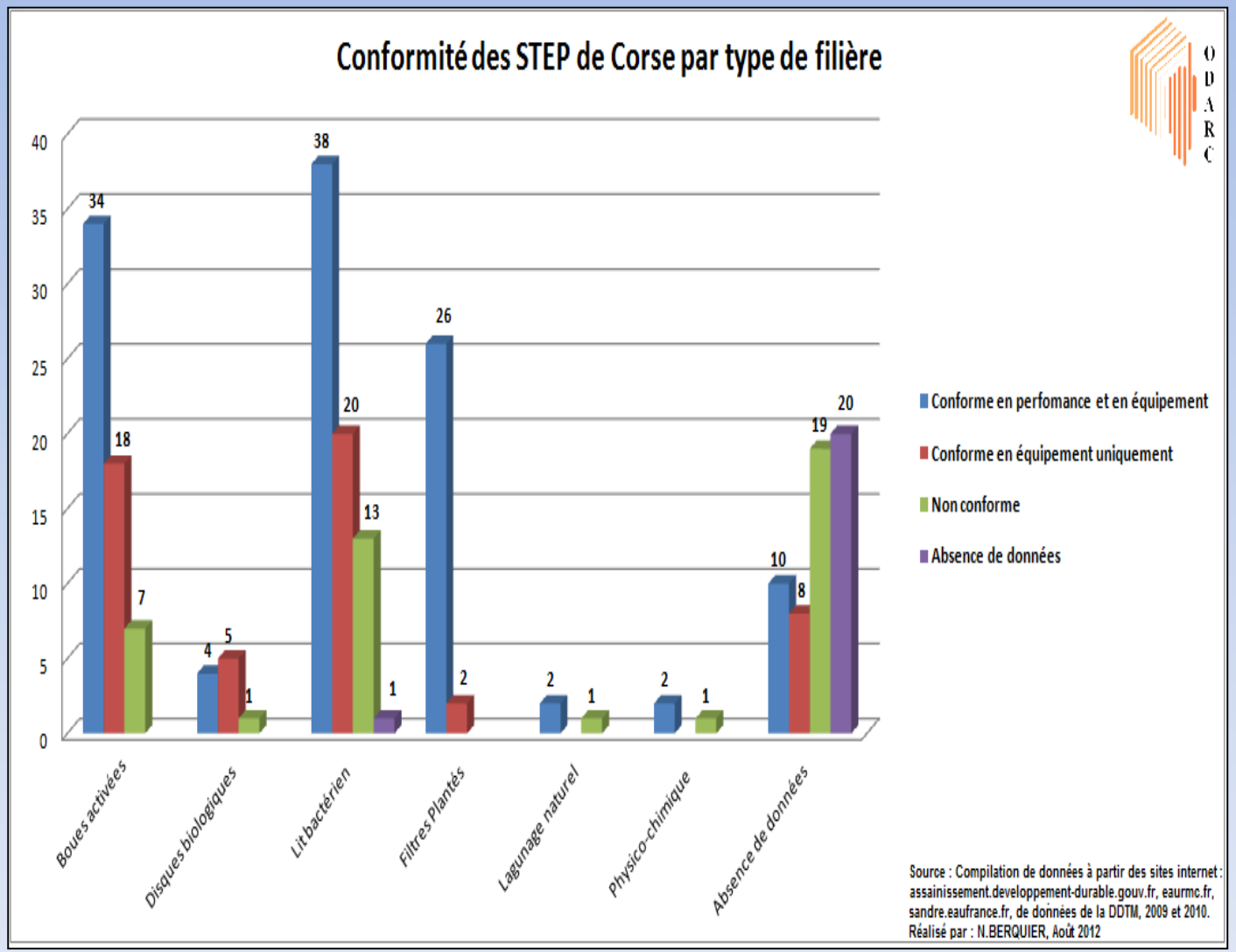
Waste water treatment

Number of waste water plants	239	360 communes
Conformity in equipment and functioning (%)	50	Minimum values because the conformity is unknown for 22 plants
Conformity in equipment only (%)	23	

Source : MEDDE (2010), ODARC



Source : ODARC


Conformité des STEP de Corse par type de filière
ODARC
40
35
30
25
20
15
10
5
0
34
18
7
4
5
1
38
20
13
1
26
2
2
1
2
1
10
8
19
20
Boues activées
Disques biologiques
Lit bactérien
Filtres Plantés
Lagunage naturel
Physico-chimique
Absence de données
Conforme en perfomance et en équipement
Conforme en équipement uniquement
Non conforme
Absence de données
Source : Compilation de données à partir des sites internet : assainissement.developpement-durable.gouv.fr, eaurmc.fr, sandre.eaufrance.fr, de données de la DDTM, 2009 et 2010.
Réalisé par : N.BERQUIER, Août 2012

Quality according to the WFD

87% of streams and rivers of Corsica basin are in good or very good ecological status.

However efforts remain to be done : SAGE and « river contracts » have to be implemented.

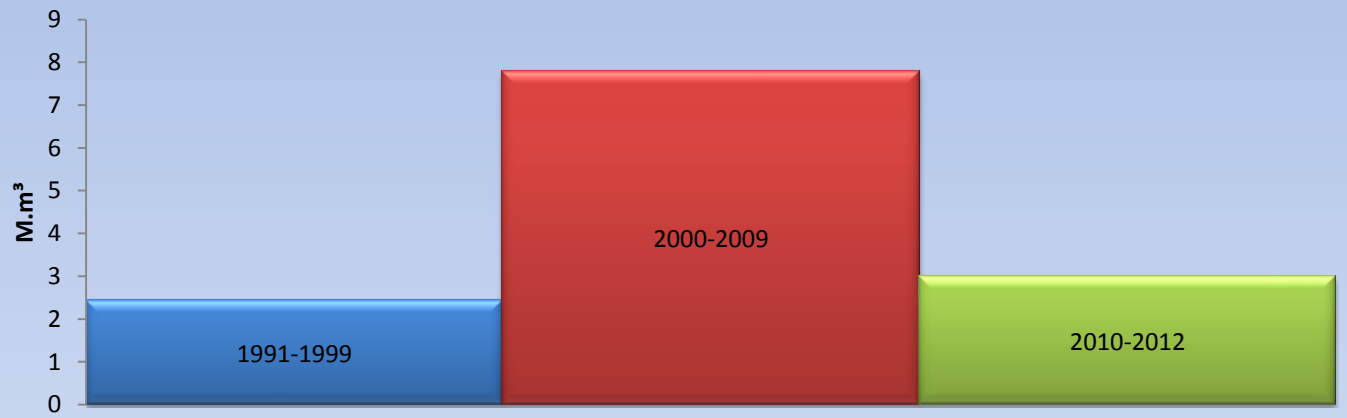
Climate change

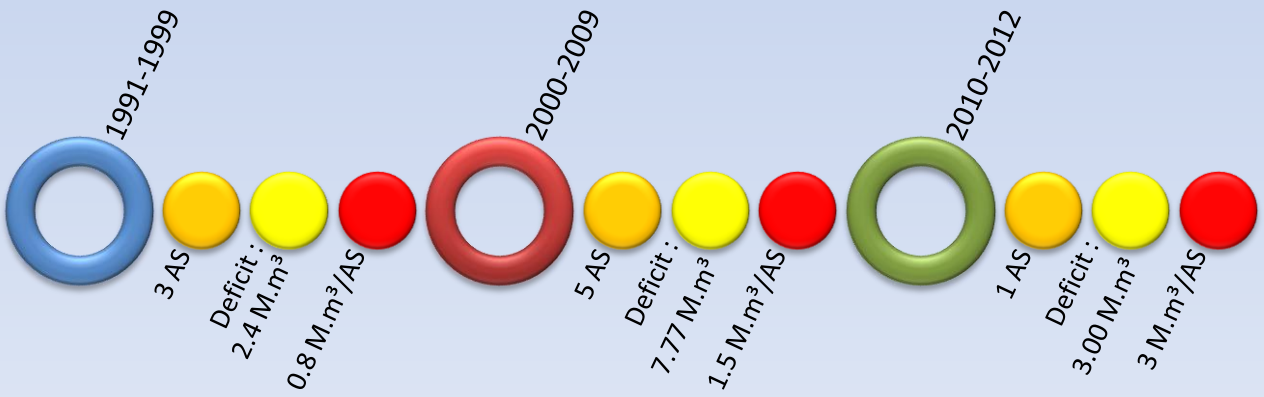
Increase of the global water deficit

Climate change is a reality. Effects are :

- Decrease of precipitations
- Recurrence of the dry years more important
- Increase of temperature.
- Extreme events

Deficit (*difference between the input and the volumes taken off*) cumulated on 10 years





AS (Année Sèche) : Dry years

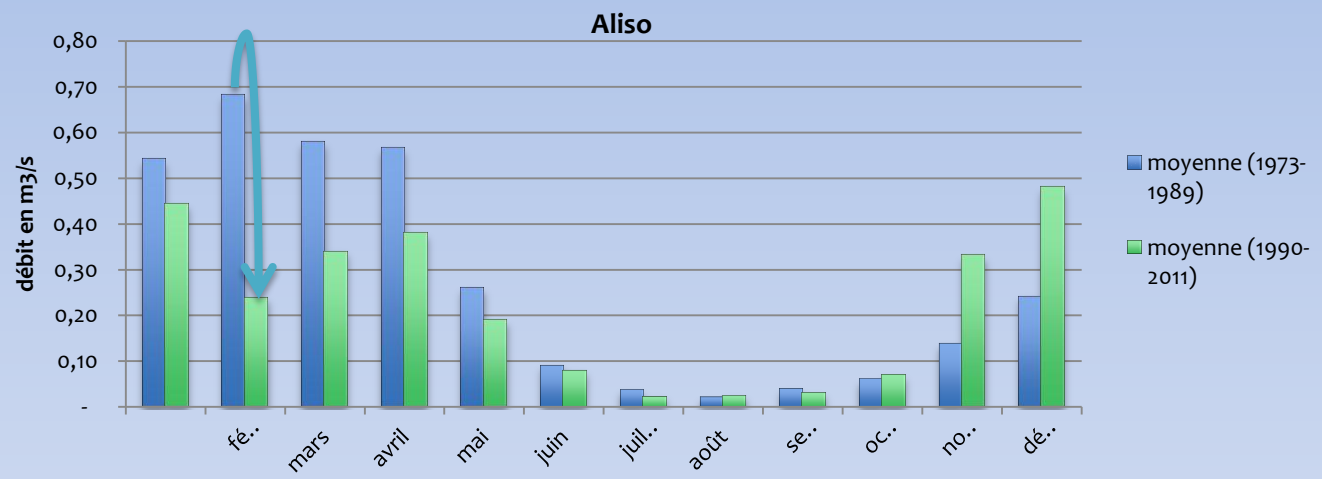
Source : A.Honorez (OEHC)

Hydrology of streams and rivers

Influence of climate warming on streams hydrology

Focus on stream flows

Aliso river



Important deficit in spring

Deficit of 65% in Februar

Excedent of water in automn

Global deficit

18.6%

Source : A.Honorez (OEHC)

To conclude…

Corsica is an island, it has to supply water needs of the population without exterior help

Even precipitations are significant in Corsica , they are unequally distributed :

- Micro-régiions that are the lesast watered as Balagne
- Are often the most touristic

Consumptions are important and increase specially on the short summer period

Equitable sharing

- Sharing between 28 watersheds and 37 communes

Politics of reduction of water wastage

- Looking for losses
- Suppressing of illegal connections

To raise public awareness of the climate changes

- Tourism professionals
- Farmers
- Individual customers

Environmental preservation

Adapt the « Fisching law » in defining a relevant biological flood

To conclude…

Corsica is an island, it has to supply water needs of the population without exterior help

Even precipitations are significant in Corsica , they are unequally distributed :

- Micro-regions that are the less watered as Balagne
- Are often the most touristic

Consumptions are important and increase specially on the short summer period

Agricutural politics
- Most adapted cultures that need less water

Politics of reduction of water wastage
- Improving of irrigation practises
- Formation of farmers
- Adapted prices

Increase the storage capacity
- Only 1% is stored
- INTER-annual plants
- Interconections

Increase the resources
- Non conventional resources as treated waste water.

Source : A.Honorez (OEHC)

THANK YOU FOR YOUR ATTENTION !

Prunelli

(http://www.offrench.net/photos/gallery-4.php)

Profesorado

Curso académico 2011-2012

- Castillo Martín, Antonio
- Delgado Ramos, Fernando
- González Gómez, Francisco
- González López, Jesús
- Hontoria García, Ernesto
- Juárez Jiménez, Belén
- Malpica Cuello, Antonio
- Martínez-Toledo, M. Victoria
- Osorio, Francisco
- Poyatos Capilla, José Manuel
- Pozo Llorente, Clementina
- Rodelas González, Mª Belén

Más información sobre el proyecto:

http://www.water-and-life.eu/

Información de contacto.

Coordinador Proyecto Grundtvig:
Prof. Fernando Delgado Ramos
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Coordinadora Seminario:
Prof. Clementina Pozo Llorente
Correo electrónico: clpozo@ugr.es

ORGANIZAN:

Instituto del Agua

ugr Universidad de Granada

EL AGUA: PASADO, PRESENTE Y FUTURO

Acción formativa dentro de la *Asociación de Aprendizaje Grundtvig 2011*

Water and Life
2011-1-CY1-GRU06-01523 2

Instituto del Agua
Aula Permanente de Formación Abierta
Vicerrectorado de Relaciones Internacionales

Universidad de Granada

EL AGUA: PASADO, PRESENTE y FUTURO

Curso académico 2011-2012

Lugar de celebración:
Facultad de Ciencias – Aula G2
Universidad de Granada

El agua es un **recurso** esencial y limitado para la vida en nuestro planeta. En este seminario estructurado en conferencias, se aborda el estudio del agua en nuestro pasado, su implicación e importancia en el arte, en la ingeniería civil, en nuestra sociedad. Se hace hincapié en el presente y futuro de este recurso, reseñando las distintas tecnologías existentes y necesarias para su tratamiento, preservación y adecuación.

En este marco de conocimiento y dentro del Proyecto Europeo ***"Water and Life"*** **(Asociación de Aprendizaje *Grundtvig* 2011-1-CY1-GRU06-01523 2),** es donde presentamos la siguiente acción formativa, planteada como un seminario de 2º ciclo de la programación docente ofertada por el *Aula Permanente de Formación Abierta* de la Universidad de Granada.

Dentro del marco de este proyecto, se facilitará además un programa de movilidad intraeuropeo de alumnos mayores que permita el intercambio de experiencias y aprendizaje en el ámbito del estudio de este recurso.

PROGRAMACIÓN

Seminario 1.
El agua en el pasado de España. Preocupación medioambiental
Fecha: 31 de enero de 2012

Seminario 2.
El agua y la Alhambra.
Fecha: 7 de febrero de 2012

Seminario 3.
Los Aljibes.
Fecha: 14 de febrero de 2012

Seminario 4.
Agua y energía
Fecha: 21 de febrero de 2012
Visita: *Centro de Interpretación. Moraleda de Zafayona. Granada*

Seminario 5.
Nuestros manantiales.
Fecha: 6 de marzo de 2012

Seminario 6.
El precio del agua para usos residenciales.
Fecha: 13 de marzo de 2012

Seminario 7.
I+D+i en la Ingeniería Civil y su relación medioambiental.
Fecha: 20 de marzo de2012

Seminario 8.
Tecnologías avanzadas de tratamiento de aguas residuales.
Fecha: 27 de marzo de 2012

Seminario 9.
Aplicación de las microalgas al tratamiento de aguas residuales.
Fecha: 10 de abril de 2012

Seminario 10.
La necesidad de la reutilización.
Fecha: 17 de abril de 2012

Seminario 11.
La desalación del agua. Una alternativa con futuro y presente.
Fecha: 24 de abril de 2012

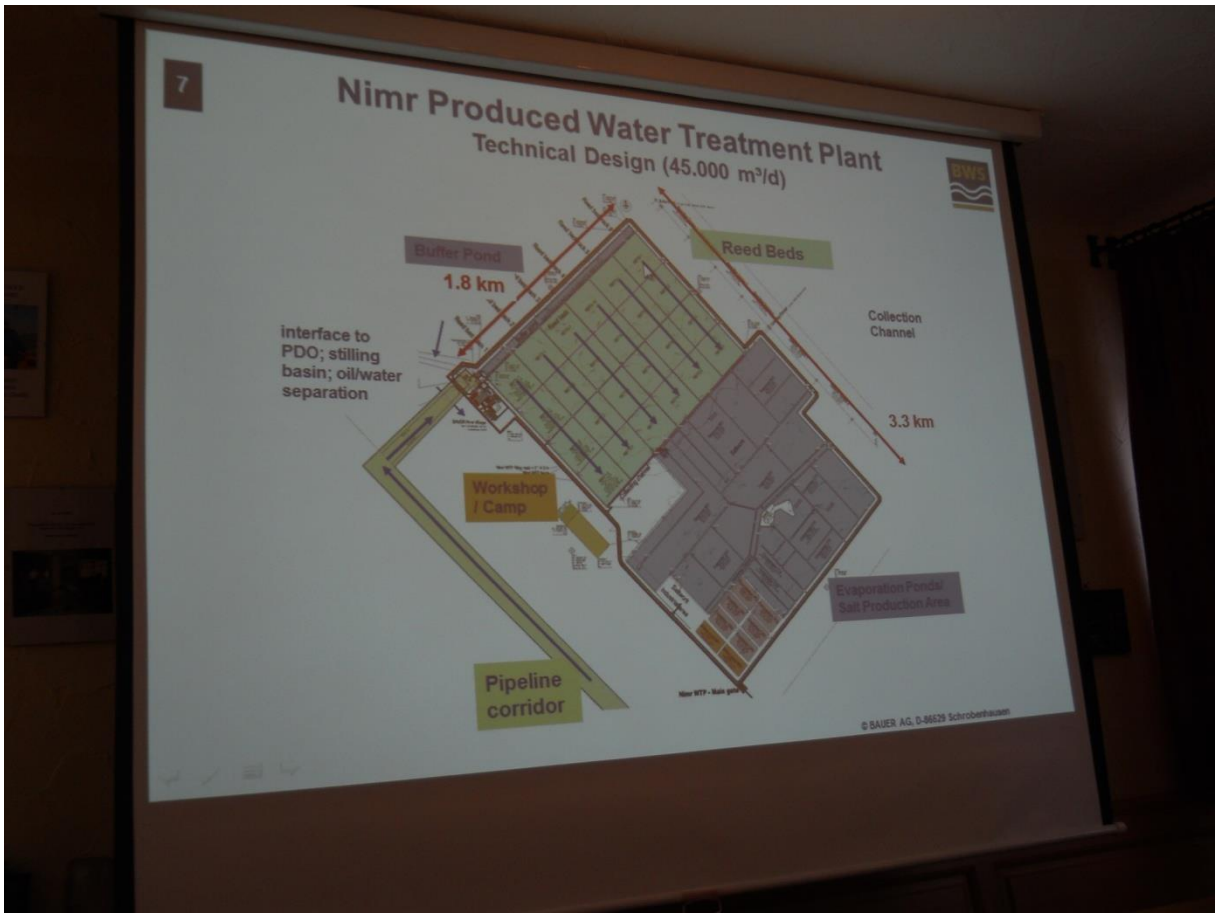
Seminario 12.
Visita al Aljibe del Rey. Fundación AguaGranada
Fecha: por determinar (mayo de 2012)

Rapport

MEETING Allemagne

Visit of construction company Esau & Hueber

Spanish team

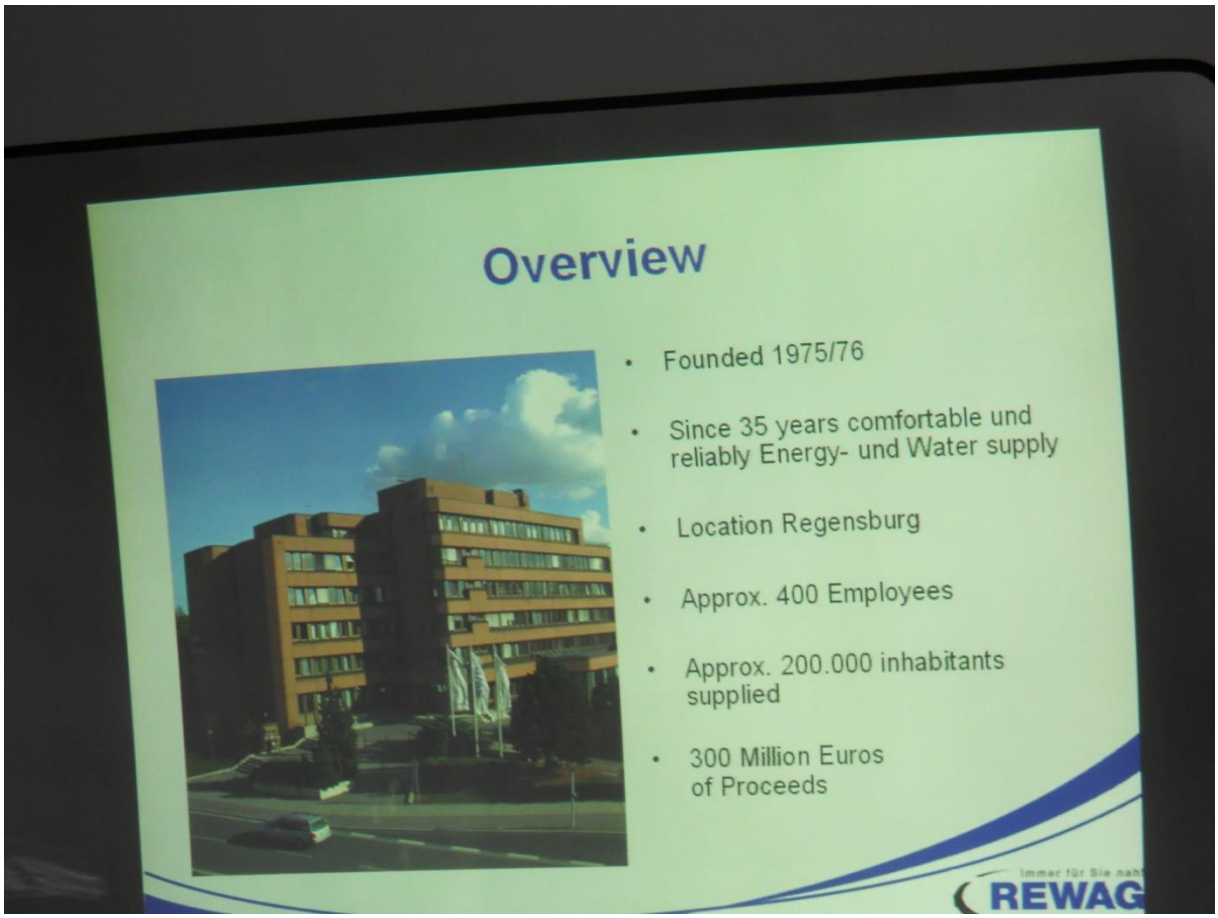

7
Nimr Produced Water Treatment Plant
Technical Design (45.000 m³/d)
BWS
Buffer Pond
1.8 km
Reed Beds
Collection Channel
interface to PDO; stilling basin; oil/water separation
3.3 km
Workshop / Camp
Evaporation Ponds/ Salt Production Area
Pipeline corridor
© BAUER AG, D-86529 Schrobenhausen

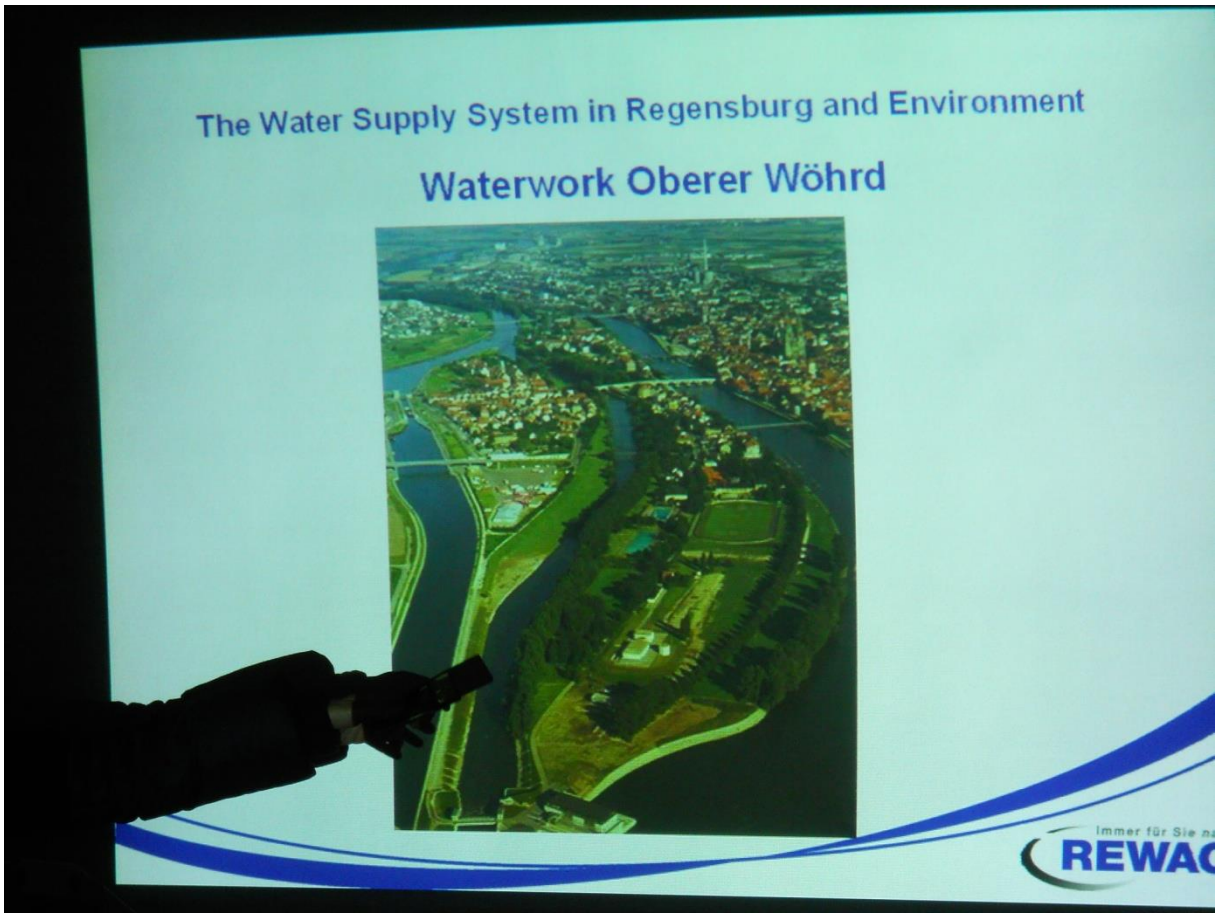
7
Nimr Produced Water Treatment Plant
Pipeline Works / Buffer Pond
BWS
6.000 m
Pipelines
145.000 m²
HDPE Lining
at Buffer Pond
© BAUER AG, D-86529 Schrobenhausen

Guided visit of the brewery “Schneider Weiße” in Kehlheim.

Visit of the water provider REWAG at Regensburg

REWAG
Wasserwerk Sallern


Overview
Founded 1975/76
Since 35 years comfortable und reliably Energy- und Water supply
Location Regensburg
Approx. 400 Employees
Approx. 200.000 inhabitants supplied
300 Million Euros of Proceeds
REWAG


The Water Supply System in Regensburg and Environment
Waterwork Oberer Wöhrd
REWAC

Der Brunnen im Querschnitt
Zur Aufbereitungsanlage
Brunnenhaus
0,00 m
Lehm
1,20 m
Ton hellgrau
10,80 m
Sand tonig
19,70 m
Ton blau
34,50 m
Kalkstein brüchig
58,60 m
Dolomit grau
73,80 m
Kalkstein gelbgrau stark klüftig
94,60 m
4,90 m Ruhewasserspiegel
In 19,80 m Tiefe: 3 Pumpen, Leistung: 2 x 300 und 1 x 150 Liter/Sekunde
68,20 m unverrohrte Strecke
Wassereintritt aus den erbohrten Klüften
End-Bohr-Durchmesser 80 cm

Wo kommt Tobis Lieblingsgetränk her?

1. Oberflächenwasser versickert durch verschiedene Gesteinsschichten und wird zu sauberem Grundwasser.
2. Bis zu 160 Meter tief sind die Brunnen, aus denen das Wasser nach oben gefördert wird. (Der Regensburger Dom ist 105 Meter hoch).
3. Filteranlagen im Wasserwerk reinigen das Wasser.
4. Bevor das Trinkwasser das Wasserwerk verlässt, wird es noch einmal genau überprüft.
5. Im Tiefbehälter wird das Wasser gesammelt.
6. Das Trinkwasser wird in die Hauptleitungen und zu den Hochbehältern gepumpt.
7. Das Leitungsnetz, in dem das Wasser in die Häuser kommt, ist über 1000 Kilometer lang. Das entspricht der Strecke von Regensburg nach Rom.

Meeting Granada

Water and historical engineering: Visit to Hydraulic Laboratory and rural Water Interpretation Center (*Fernando Delgado*)

Seminar 4 : Water and Energy (Prof F. Delgado)

EL AGUA: PASADO,

PRESENTE y FUTURO

Curso académico 2011-2012

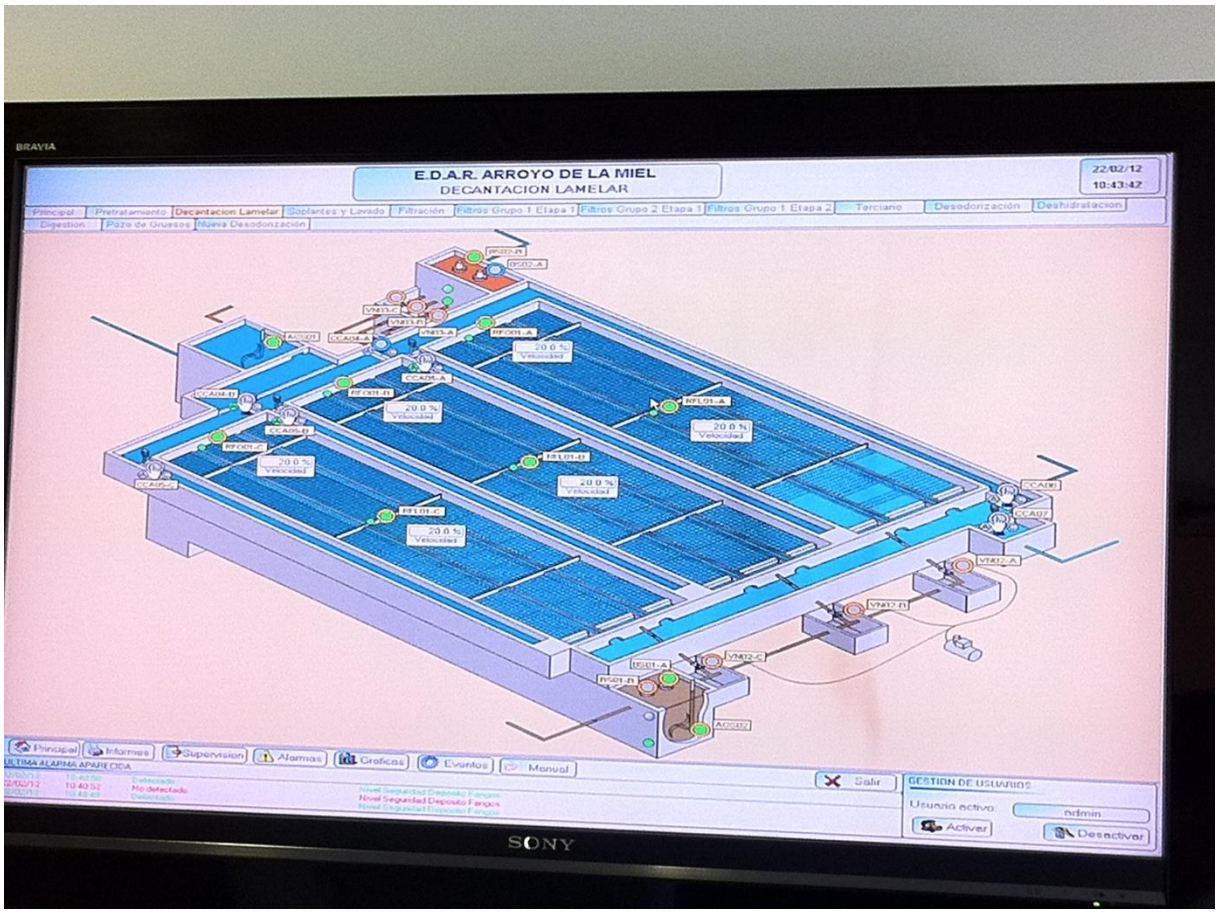
Facultad de Ciencias – Aula G2

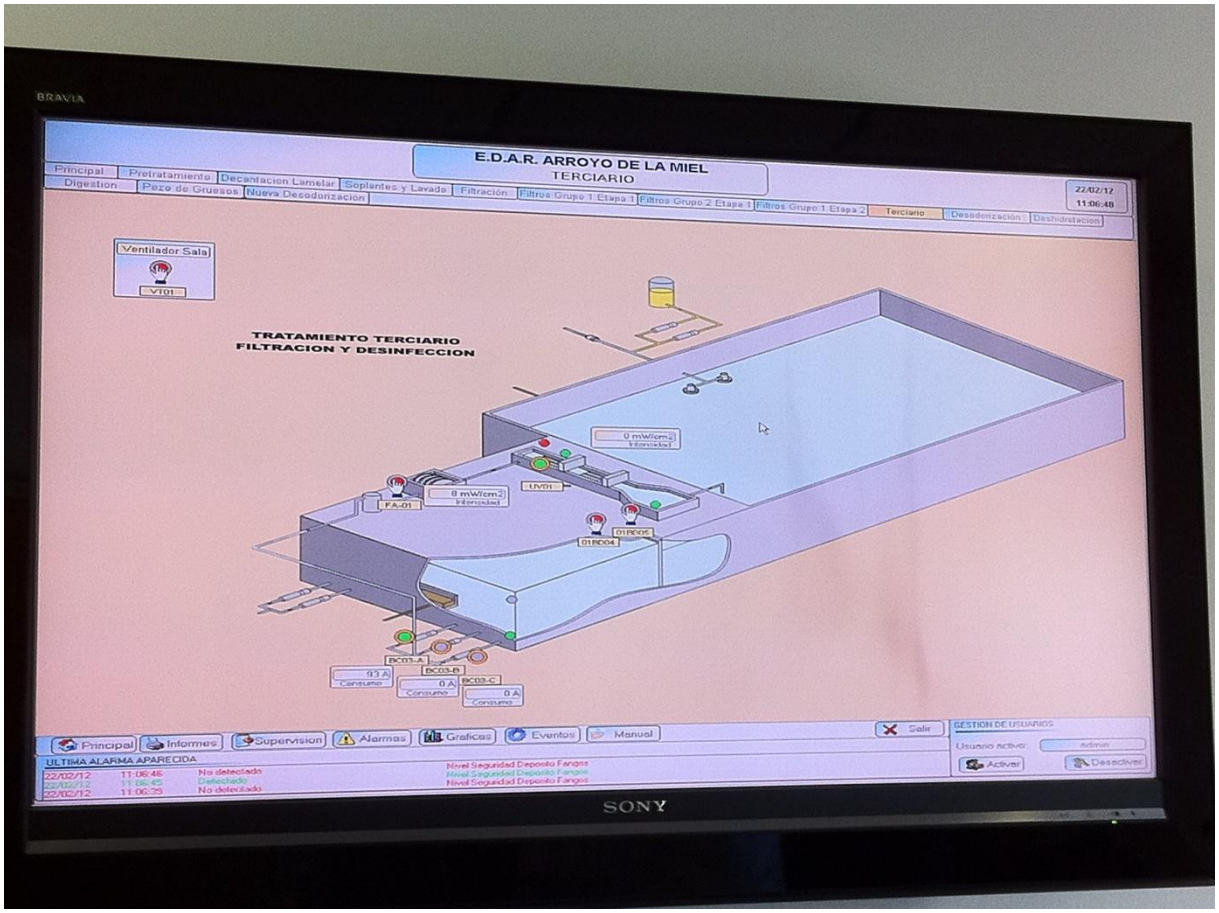
Universidad de Granada

(cf triptyc : GRUNDTVIG_triptico_1112_aula_de_mayores.pdf)

INTRODUCCIÓN HISTÓRICA
"FUERZA BRUTA"
HOMBRE
ANIMALES
FUERZAS NATURALES
VIENTO
AGUA
"UN GRAN DESCUBRIMIENTO... POCO APROVECHADO"
FUEGO
"LA PRIMERA GRAN REVOLUCIÓN ENERGÉTICA"
MÁQUINA DE VAPOR
"LA SEGUNDA GRAN REVOLUCIÓN ENERGÉTICA"
ELECTRICIDAD
Producción – transporte - transformación
"LAS GRANDES FUENTES DE ENERGÍA DISPONIBLES"
FÓSILES
E. NUCLEAR
RENOVABLES
2

Water quality: visit to a modern Wastewater treatment plant,
(Benalmádena, Málaga)

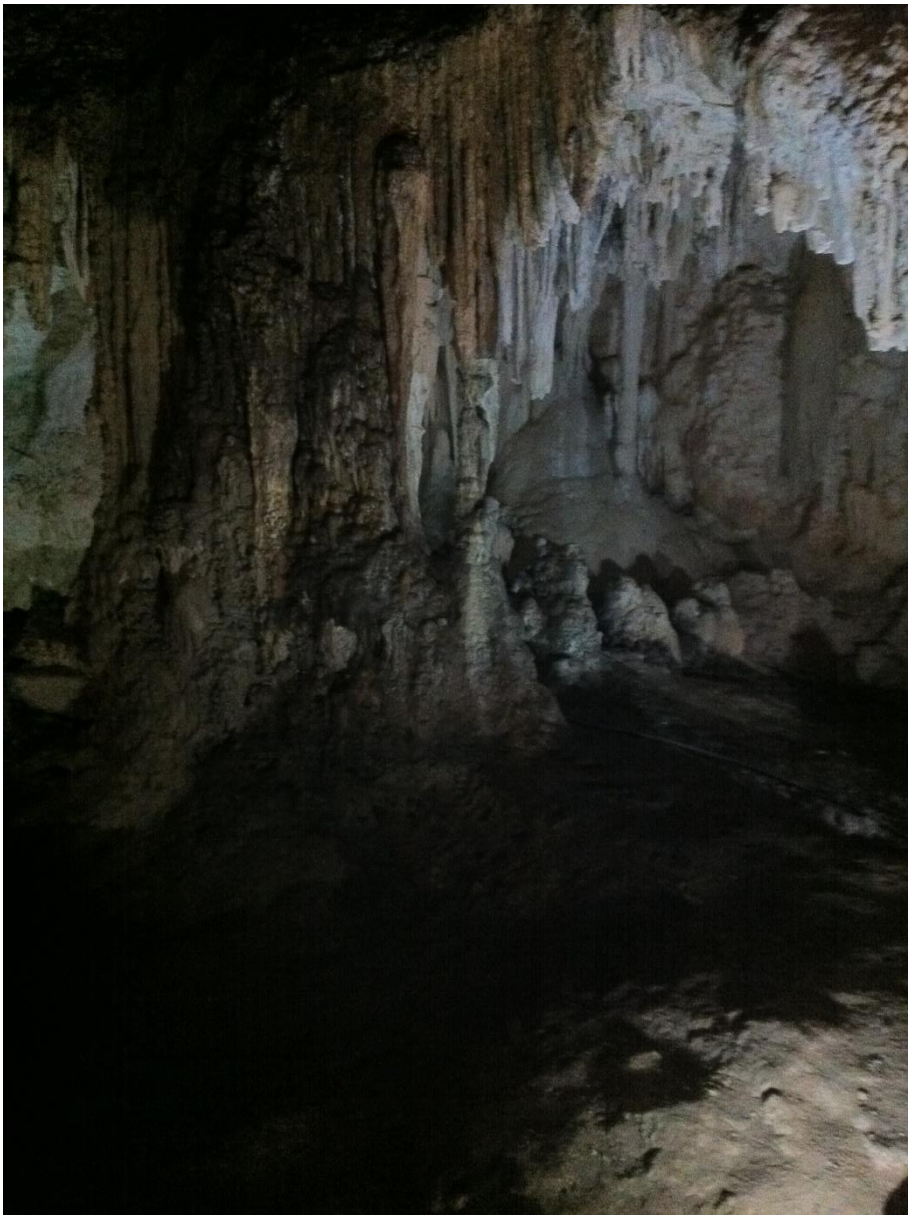

BRAVIA
E.D.A.R. ARROYO DE LA MIEL
DECANTACION LAMELAR
22/02/12
10:43:42
Principal
Pretratamiento
Decantacion Lamelar
Soplantes y Lavado
Filtración
Filtros Grupo 1 Etapa 1
Filtros Grupo 2 Etapa 1
Filtros Grupo 1 Etapa 2
Terciario
Desodorización
Deshidratación
Digestión
Pozo de Gruesos
Nueva Desodorización
Velocidad
Informes
Supervisión
Alarmas
Gráficas
Eventos
Manual
Salir
ULTIMA ALARMA APARECIDA
GESTION DE USUARIOS
Usuario activo:
admin
Activar
Desactivar
SONY


BRAVIA
E.D.A.R. ARROYO DE LA MIEL
TERCIARIO
22/02/12
11:06:48
Principal
Pretratamiento
Decantacion Lamelar
Soplantes y Lavado
Filtración
Filtros Grupo 1 Etapa 1
Filtros Grupo 2 Etapa 1
Filtros Grupo 1 Etapa 2
Terciario
Desodorización
Deshidratación
Digestión
Pozo de Gruesos
Nueva Desodorización
Ventilador Sala
VT01
TRATAMIENTO TERCIARIO
FILTRACION Y DESINFECCION
0 mW/cm2
Intensidad
8 mW/cm2
Intensidad
FA-01
UV01
01BC04
01BC05
BC03-A
BC03-B
BC03-C
93 A
Consumo
0 A
Consumo
0 A
Consumo
Informes
Supervisión
Alarmas
Gráficas
Eventos
Manual
Salir
ULTIMA ALARMA APARECIDA
22/02/12 11:06:46 No detectado Nivel Seguridad Deposito Fangos
22/02/12 11:06:45 Detectado Nivel Seguridad Deposito Fangos
22/02/12 11:06:29 No detectado Nivel Seguridad Deposito Fangos
GESTION DE USUARIOS
Usuario activo:
admin
Activar
Desactivar
SONY

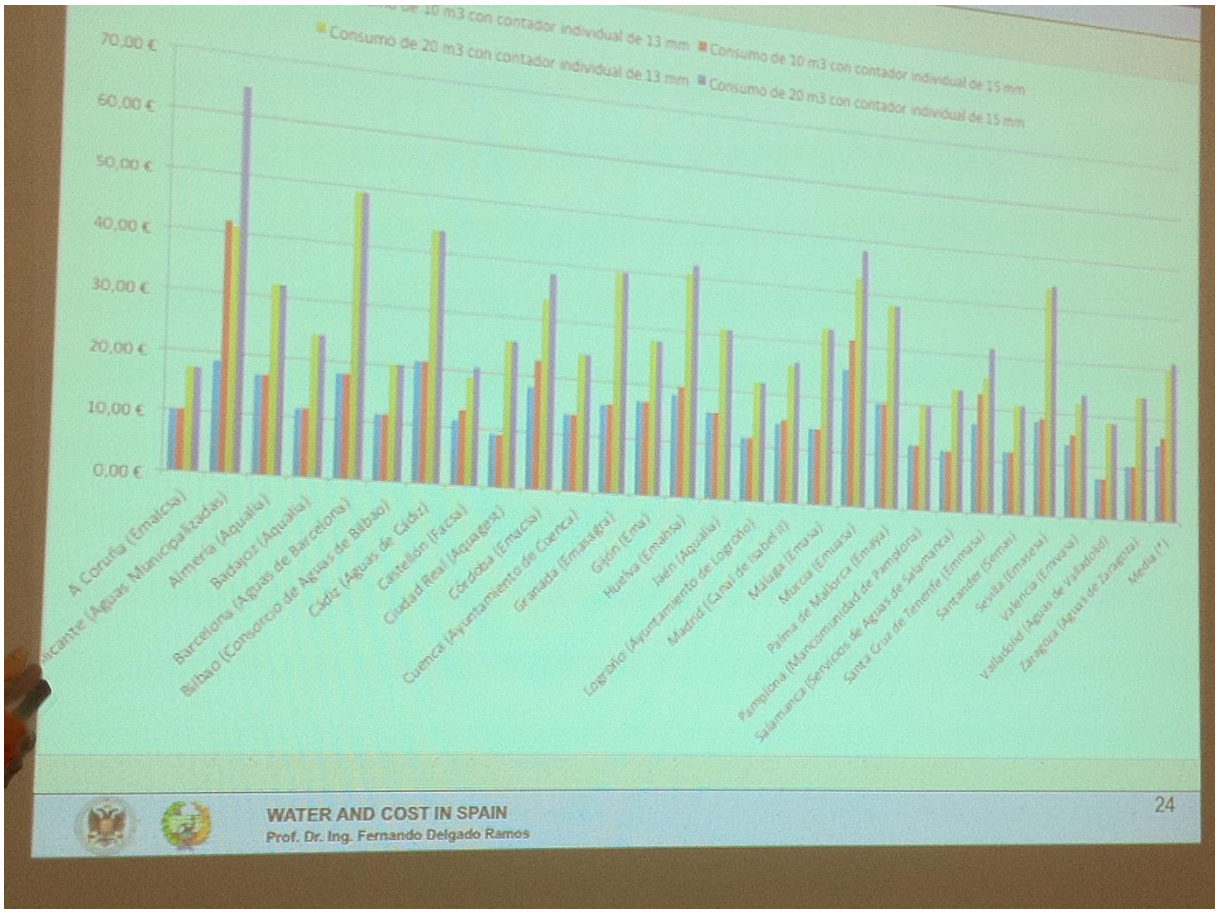
Biofilm system

Water after treatment

Water and geology: visit to Nerja's karstic caves, (Málaga)



Water and cost: debate on the cost of water in different European countries


Consumo de 10 m3 con contador individual de 13 mm
Consumo de 10 m3 con contador individual de 15 mm
Consumo de 20 m3 con contador individual de 13 mm
Consumo de 20 m3 con contador individual de 15 mm
70,00 €
60,00 €
50,00 €
40,00 €
30,00 €
20,00 €
10,00 €
0,00 €
A Coruña (Emalcsa)
Alicante (Aguas Municipalizadas)
Almería (Aqualia)
Badajoz (Aqualia)
Barcelona (Aguas de Barcelona)
Bilbao (Consorcio de Aguas de Bilbao)
Cádiz (Aguas de Cádiz)
Castellón (Facsa)
Ciudad Real (Aquagest)
Córdoba (Emacsa)
Cuenca (Ayuntamiento de Cuenca)
Granada (Emasagra)
Gijón (Ema)
Huelva (Emahsa)
Jaén (Aqualia)
Logroño (Ayuntamiento de Logroño)
Madrid (Canal de Isabel II)
Málaga (Emasa)
Murcia (Emuasa)
Palma de Mallorca (Emaya)
Pamplona (Mancomunidad de Pamplona)
Salamanca (Servicios de Aguas de Salamanca)
Santa Cruz de Tenerife (Emmasa)
Santander (Semas)
Sevilla (Emasesa)
Valencia (Emivasa)
Valladolid (Aguas de Valladolid)
Zaragoza (Aguas de Zaragoza)
Media (*)

Date 29 Mars 2012

COMMUNIQUE DE PRESSE du Secrétariat International de l'eau, d'ECOREM, de la Collectivité Territoriale de Corse, de l'Office de l'environnement Corse, de l'Agence de l'eau Rhône Méditerranée Corse et de l'Université Corse

Pour Diffusion Immédiate

Le Voilier de la Solidarité : « Partageons nos Solutions » fait escale à Ajaccio

Le **1er et le 2 Mars** le "Voilier de la Solidarité" fait escale sur le **quai d'honneur du port d'Ajaccio** (http://ecorem.fr/voilierdelasolidarite). Le Voilier est parti, début Janvier, à la rencontre des Méditerranéens pour **parler d'eau, douce et salée et leurs multiples usages**. Il est déjà passé par **Tanger, Oran, Bizerte, Palerme, Bonifacio** et passera par **La Ciotat et Marseille**, pour terminer sa tournée le 22 Mars, lors de la journée mondiale de l'eau à **Barcelone.**

L'eau, vecteur de développement humain, social, et économique, pourvoyeur de santé et d'énergie, garant de la production alimentaire et du maintien de la biodiversité, n'est pas qu'une affaire de spécialistes mais nous concerne tous. Alors que ces questions seront abordées autour du thème « le temps des solutions » par les 25 000 participants du 6eme **Forum mondial de l'eau** du 12 au 17 Mars 2012 à Marseille, **Notre Dame des Flots,** un **voilier classé au patrimoine Français, part récolter et relayer les solutions mises en place localement et participer aux efforts de sensibilisation et de formation en matière d'eau**. Ce projet est à l'initiative du **Secrétariat International de l'Eau**, organisation International œuvrant à l'amélioration de l'accès à l'eau potable et l'assainissement dans le monde, et d'**ECOREM**, association Ciotadenne, impliquée dans la formation et la mise en partage des connaissances pour une amélioration des comportements environnementaux. Le projet est parrainé par **l'Union pour la Méditerranée**, et bénéficie du soutien du **World Wide Fund for Nature** (WWF), du **Conseil général des Bouches du Rhône**, de **l'Agence de l'eau Rhône Méditerranée Corse**, et est labellisé projet « racine citoyenne » dans le cadre du 6ème Forum Mondial de l'Eau.

Pour son passage à Ajaccio, **La Collectivité Territoriale de Corse (CTC), l'Office de l'environnement Corse (OEC), l'Université de Corse, l'Agence de l'eau Rhône Méditerranée Corse (AERMC), la CAPA, le Comité de bassin Corse, le Comité régional des pêches maritime (CRPEM), la Chambre de commerce et d'industrie territoriale d'Ajaccio (CCITACS), le CPIE Corte Centre Corse et L'Association des régates impériales** s'unissent pour proposer à la population des activités d'information et de sensibilisation sur la **gestion de l'eau en Corse et les solutions** mises en place.

1er Mars :

De 10h à 12h Conférence débat sur la **protection du Littoral Corse** organisée par l'office de l'environnement Corse avec l'intervention de l'Agence de l'eau Rhône Méditerranée et Corse, le Comité régional des pêches maritimes, la Chambre de commerce et d'industrie territoriale d'Ajaccio (« Port propre et accueillant », plan pêche, etc…) au **palais des congrès Salle Fred Scamaroni** au 1er étage

De 14h30 à 16h : Visite de la nouvelle **station d'épuration de de Campo dell'Oro** organisé par la CAPA

2 Mars :

De 10h à 11h : Signature, à bord du Voilier, du **"Pacte d'Istanbul pour l'eau"** par les collectivités territoriales Corse **en présence du M. Paul GIACOBBI, Député de Haute-Corse, Président du Conseil Exécutif de Corse**. Le Pacte d'Istanbul pour l'eau est un accord non contraignant défini lors du 5ème Forum mondial de l'eau à Istanbul en 2009, invitant maires et élus de collectivités locales du monde entier à formuler un engagement commun pour la gestion des ressources en eau face aux changements mondiaux, afin d'encourager les actions en faveur de l'eau et de l'assainissement.

De 11h à 12h : **Conférence/débat** organisée par l'Université de Corse, sur le thème de la **gestion de l'eau en Corse** et en Europe dans le cadre du projet éducatif européen Grundtvig "Water and Life". Palais des congrès, Salle Claude Papi.

De 14 h à 15h : Table ronde animée par le comité de bassin Corse et l'Université de Corse sur les ressources en eau en Corse et dans les îles méditerranéennes. Palais des congrès Salle Claude Papi.

Le 1er et 2 Mars Exposition sur l'eau dans le Hall du Palais des Congres d'Ajaccio.

« Les mémoires de l'Eau en Méditerranée »" E mimorie di l'acqua in u Mediterraniu"
Cette exposition itinérante est destinée à faire redécouvrir le patrimoine domestique oublié lié à l'eau en Méditerranée. Elle a été réalisée dans le cadre du programme Euromed Héritage 4 et plus particulièrement du projet REMEE, Redécouvrons Ensemble La Mémoire de l'Eau en Méditerranée (REMEE) par l'APARE (Association pour la Participation et l'Action Régionale, chef de file du projet) en collaboration avec les 6 autres partenaires du programme : l'Office de l'Environnement de la Corse (France), CME Maroc, CME Grèce, AERE (Tunisie), AREA ED (Algérie), GAS Der (Turquie).

Corsica Terra d'Acqua :
Le territoire : La Corse avec 8 milliards de m3 d'eau annuels fait figure d'exception s'imposant comme un véritable château d'eau naturel au cœur de la Méditerranée. Cette exposition réalisée par le CPIE Corte Centre Corse en partenariat avec l'Office de l'Environnement de la Corse, le CG 2B et l'Agence de l'Eau Rhône Méditerranée Corse.

Contact Presse :
Sabrina André : Coordinatrice du projet
sandre@sie-isw.org
+33 6 03 49 15 78

Le 9 Janvier 2012
Communiqué de presse du Secrétariat international de l'eau et l'Espace collaboratif de ressources en éducation au développement durable en Méditerranée (ECOREM)
Pour Diffusion Immédiate

« Le Voilier de la Solidarité - partageons nos solutions » part à la rencontre des méditerranéens pour parler d'eau.

Quoi de plus naturel pour rencontrer les méditerranéens et leur parler d'eau, que de passer par la mer et de choisir, pour cela, un voilier, symbole de développement durable, de rapprochement et d'échanges entre les peuples?

Le voilier Notre Dame des Flots, ketch en bois de 1942, classé au patrimoine français, a été rebaptisé pour l'occasion « Le voilier de la Solidarité - partageons nos solutions » . **Il a quitté les quais du musée maritime de la Rochelle, Samedi 7 Janvier 2012, et fait maintenant route sur la Méditerranée.**

« Le voilier de la Solidarité - partageons nos solutions » **part pour une tournée de 3 mois, en Méditerranée occidentale, afin de relayer les initiatives citoyennes en matière d'eau et permettre ainsi que ces bonnes pratiques soient reproduites. Plus particulièrement, le projet se concentrera sur les initiatives de sensibilisation et de formation permettant une amélioration des comportements et la mise en place de processus de décisions participatifs. Dans cette optique, lors de ses escales au** Maroc, Algérie, Tunisie, Italie, France, Espagne**, des ateliers pédagogiques et des rencontres multi-acteurs seront organisés à bord, par des associations locales.**

Lancement officiel

C'est à Marrakech, le 20 décembre, que « Le voilier de la solidarité - partageons nos solutions » a été lancé devant les 350 participants, venus au 1er Forum méditerranéen de l'eau, discuter des perspectives méditerranéennes en matière d'eau.
Ce projet est à l'initiative du **Secrétariat international de l'eau**, organisation international

œuvrant à l'amélioration de l'accès à l'eau potable et l'assainissement dans le monde et d'**ECOREM**, association Ciotadenne, impliquée dans la formation et la mise en partage des connaissances pour une amélioration des comportements environnementaux. Le projet bénéficie du soutien de l'Union pour la Méditerranée, du **World Wide Fund for Nature** (WWF), du Conseil général des Bouches du Rhône et est labellisé projet « racine et citoyenneté » dans le cadre du **6e Forum Mondial de l'Eau** qui se tiendra à **Marseille du 12 au 17 Mars 2012**.

L'eau l'affaire de tous: Focus sur les solutions initiées par la société civile

Vecteur de développement humain, social, et économique, pourvoyeur de santé et d'énergie, garant de la production alimentaire et du maintien de la biodiversité, l'eau n'est pas qu'une affaire de spécialistes mais nous concerne tous. Alors qu'aujourd'hui, ses problématiques représentent plus que jamais un défi essentiel pour les êtres humains et la planète, des groupes d'individus mettent en place des solutions. Leurs initiatives concernent, entre autres, l'éducation de la jeunesse, la sensibilisation des consommateurs et des décideurs, l'implication dans les processus de décisions et dans les actions de protection de la nature, l'amélioration de l'accès à l'eau et l'assainissement, etc… C'est ces solutions que le voilier se propose de recueillir, en invitant à son bord, des membres d'associations, de syndicats, de groupes de concertation, d'enseignants et d'élus. Les témoignages et les exemples des bonnes pratiques initiées par ces acteurs du changement seront partagés en ligne, sur les différents sites des partenaires ainsi que sur **Facebook**, **Youtube** et **Twitter**. Un film documentaire, mêlant mini reportages et interviews micro trottoir, retracera les différentes rencontres et se fera l'écho des voix citoyennes.

Le voilier, ses cales pleines d'images, de propositions et de recommandations fera notamment, cap sur Marseille, pour partager ses richesses avec les 25 000 participants du **6e Forum mondial de l'eau**. Au terme d'une tournée de 3 mois, avec une empreinte carbone quasi nulle, le voilier arrivera **à Barcelone, le 22 Mars**, pour la célébration de la journée mondiale de l'eau.

Sensibilisation et Formation à la source d'un changement durable: Des Escales pédagogiques

La prise de conscience des politiques, des industriels et des utilisateurs finaux, sur l'impact environnemental de leur mode de gestion, de production et de consommation, est nécessaire. Cette prise de conscience passe par de la sensibilisation, de l'éducation, et de la concertation, et permet ainsi l'émergence d'alternatives et l'amélioration des comportements. L'information, la formation, la participation des populations sont nécessaires au succès et à la pérennité des projets de gestion intégrée des ressources en eau.

C'est pour cela qu'à chaque escale, des activités d'éducation et de sensibilisation seront organisées par des formateurs locaux impliqués dans la gestion des eaux douces et salées. C'est ainsi, que plus de 200 jeunes et moins jeunes marocains, algériens,

tunisiens, italiens et français, n'ayant parfois jamais vu la mer ou n'ayant pas la chance d'avoir accès à l'eau potable, embarquerons à bord d'un voilier, classé au patrimoine national français, pour quelques heures de découverte. Tel l'effet papillon, à leur retour dans leur famille, village, quartier, ils pourront partager leurs expériences et ainsi participer à la dissémination des connaissances et des bonnes pratiques en matière d'eau, d'assainissement et d'environnement.

Parallèlement, l'arrivée du voilier dans les ports sera l'occasion d'attirer l'attention des populations sur les problématiques de l'eau à travers des conférences de presse et diverses activités culturelles, et artistiques. Le voilier fera notamment escale à **La Ciotat, du 6 au 14 Mars** où, durant une semaine, la municipalité fêtera l'eau avec des activités culturelles, artistiques et pédagogiques. C'est durant cette semaine que des rencontres entre formateurs et éducateurs à l'environnement, de l'ensemble, de la Méditerranée seront organisées.

Cap sur le futur

Au delà, des actions ponctuelles de sensibilisation et de formation menées lors des escales, le projet s'inscrit dans le temps, en permettant de faire connaître des solutions pouvant être reproduites facilement ailleurs. De même, en facilitant la rencontre des formateurs méditerranéens, et l'échange de leurs expériences et connaissances, notamment à travers les outils internet mis à leur disposition par ECOREM, le projet contribue à la construction d'une collaboration méditerranéenne autour de l'éducation à l'eau.

Quelques chiffres clés sur la situation en eau dans le bassin Méditerranéen et dans le monde

Il ne faut pas oublier, qu'il y a encore dans le monde, 5 millions de personnes qui meurent chaque année, de maladies liées à l'eau, plus d'une personne sur dix, soit 1.1 milliard de personnes, qui n'ont pas accès à l'eau potable et 2,6 milliard qui n'ont pas accès à des dispositifs d'assainissement. *(Source: Secrétariat International de l'Eau)*

En 2000, 108 millions de personnes du pourtour Méditerranéen (soit 1 personne sur 4), ont été dans une situation de « stress » hydrique et 45 millions de personnes ont souffert de « pénurie en eau ». Selon différentes études, en 2025, un peu plus de 10% de la

population méditerranéenne sera en situation de pénurie d'eau. *(Source: Plan Bleu)* Parallèlement, il est constaté un peu partout sur la planète et notamment en Méditerranée, que l'usage de l'eau n'est pas efficient; en irrigation traditionnelle, les pertes par évaporation et infiltration s'élèvent à 70 %, sur les réseaux d'eau potable et le taux de fuite est estimé à 50 % *(Source: Données environnementales).*

Aujourd'hui, 80% des pollutions de la Mer Méditerranée sont de sources continentales, avec 70 % d'eaux usées non traitées déversées chaque année, à travers les 69 fleuves qui s'y jettent, et les milliers de villes qui la bordent dont 15 villes ayant dépassé les 2 millions d'habitants *(Source: Données environnementales)* La méditerranée est l'une des 25 zones les plus rares de la planète, mais également l'une des plus exploitées. Elle abrite sur ses côtes, 150 millions d'habitants principalement concentrés dans les villes, avec un taux d'urbanisation avoisinant les 70% *(Source: Préfecture maritime de Méditerranée)*. Elle concentre un peu moins du 1/3 du commerce maritime mondial sur seulement 0,7% des mers. Elle accueille 200 millions de touristes par an, ce qui en fait la 1ère région touristique. La Méditerranée reste cependant, un réservoir majeur de biodiversité, accueillant plus de 25 000 espèces de végétaux marins, dont la moitié ne se trouve nulle part ailleurs.

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http://www.worldwaterforum6.org/fr/news/article/article/le-voilier-de-la-solidarite-partageons-nos-solutions-part-a-la-rencontre-des-mediterrane/

http://ecorem.fr/voilierdelasolidarite/wakka.php?wiki=PagePrincipale

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Retour sur la conférence « Pour une meilleure connaissance et gestion de la ressource en eau souterraine à Bonifacio »

Le 6 octobre dernier, les locaux de la médiathèque de Bonifacio ont été le lieu de rencontres et d'échanges entre les enseignants-chercheurs de l'Université de Corse et les Bonifaciens sur le thème de l'eau.

Emilie Garel

La commune de Bonifacio souhaite depuis quelques années augmenter son parc de forages pour accroître sa production d'eau potable. Pour permettre une gestion durable de la ressource, il est important de caractériser le fonctionnement hydrogéologique de cet aquifère littoral qui est encore aujourd'hui mal connu. L'équipe d'hydrogéologie du Laboratoire Sciences Pour l'Environnement CNRS / Université de Corse, dans le cadre du projet Gestion des Eaux en Méditerranée, a mis en place depuis Mai 2011, sur une quinzaine de forages, un suivi du niveau des nappes et de leurs caractéristiques physico-chimiques et isotopiques.

La **conférence d'Emilie GAREL**, a permis de présenter les actions réalisées sur le terrain et les premiers éléments de réponses sur le parcours de l'eau souterraine à Bonifacio.

Une **maquette 3D du bassin sédimentaire de Bonifacio** conçue et réalisée par Michelle FERRANDINI et Yvonne ORSINI a permis aux bonifaciens de se plonger dans l'histoire géologique de leur région.

Cette maquette à l'échelle du 1/25000 présente les reliefs terrestres et sous-marins de la région de Bonifacio et également la géologie. Elle s'ouvre suivant deux directions pour montrer les rapports géométriques entre le granite et les trois formations sédimentaires.

Un **échange nourri entre le public et les chercheurs** a suivi la présentation, le public a abordé des questions aussi bien scientifiques (génèse et âges des formations géologiques, pollution de l'aquifère par l'intrusion d'eau marine, surexploitation de la nappe...) que patrimoniales, historiques et économiques. Près de 40 personnes ont assisté et participé à ces échanges parmi lesquels les propriétaires qui ont donné accès aux points de prélèvement situés sur leur terrain.

Projet Water and life

Cette rencontre a été organisée dans le cadre du partenariat européen GRUNDTVIG d'éducation et de formation tout au long de la vie «Water and life». Celui-ci, est conduit à l'Université de Corse sous la responsabilité de Béatrice KHOUMERI, en partenariat avec l'Université de Granada (Espagne), l'Institut de formation de Munich (Allemagne) et l'Institut agronomique de Crète (Grèce) et au niveau local avec l'Office du Développement Agricole et Rural de la Corse (ODARC), l'Office de Développement Hydraulique de la Corse (OEHC), le CPIE Centre-Corse A Rinascita et la Fédération de la Corse pour la Pêche et la Protection des Milieux Aquatiques (FCPPMA).

Il a pour but de former et d'informer différents publics adultes sur des problématiques liées à l'eau. Ce programme de mobilités permet l'échange d'expériences entre partenaires européens.

L'eau est essentielle à la vie. Si l'on tient compte de la croissance démographique et des changements climatiques, le problème de l'eau sera crucial dans le futur pour la plupart des régions dans le monde. La population doit prendre conscience de l'importance de la qualité de l'eau, des ressources et doit contribuer à sa durabilité non seulement au niveau local mais aussi à une échelle plus globale. C'est le principal objectif du projet en région.

D'autres conférences auront prochainement lieu dans l'ensemble du territoire insulaire pour débattre de problématiques locales sur l'eau.

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Journée

CHANGEMENT CLIMATIQUE

QUELS IMPACTS SUR NOTRE AGRICULTURE ?

QUELLES SOLUTIONS POUR LA RESSOURCE ?

Mardi 4 décembre 2012
dès 10h

Université de Corse
Campus GRIMALDI - IUT salle 115

Programme de la Journée

CHANGEMENT CLIMATIQUE

Quels impacts sur notre agriculture ?
Quelles solutions pour la ressource ?

10h00 : Accueil des invités, café

10h15 : Ouverture de séance par **Jean-Marc Venturi,** Président de la Chambre d'agriculture de Haute-Corse et de Corse

10h25 : Présentation Météo France

-Introduction par **Jean-Paul Giorgetti**, Météo France Région Corse

-Intervention d'**Emmanuel Clopet,** Service Agro Météo France Toulouse

- Les différents types de modèles
- Les résultats et prévisions obtenus en fonction des modèles utilisés
- Les conséquences climatologiques
- Les conséquences potentielles sur les cultures
- Les choix géopolitiques

12h00 : Débat animé par **Jean-Paul Giorgetti, Emmanuel Clopet** et **Cyril Giuntini,** Chambre d'Agriculture de Haute-Corse

12h30 : Buffet

14h00 : Présentation des outils de gestion raisonnée de l'eau d'irrigation par **Cyril Giuntini,** Chambre d'Agriculture de Haute-Corse : « site extranet » et bulletin irrigation à la parcelle mis en place en partenariat avec Météo France

- Historique des travaux réalisés
- Présentation de l'outil
- Présentation des modules complémentaires conceptualisés

15h30 : La Réutilisation des Eaux Usées Traitées : une option pour limiter les effets de la sécheresse estivale en Corse par **Bruno Molle**, Irstea (ex Cemagref) Aix en Provence

- Quels enjeux au niveau méditerranéen, résultats du projet MEDIWAT
- Maîtrise des dangers au travers des pratiques d'irrigation

16h30 : Questions diverses

17h00 : Clôture de la journée, café

Meeting in Germany: 17th – 22nd October 2011

http://www.water-and-life.eu/

German participants – vhs Schrobenhausen:

Roland Schneidt

Ulrike Beierl

Benno Bickel

Wolfgang Murr

Facts and Figures about Schrobenhausen

http://www.schrobenhausen.de/ http://www.verkehrsverein.com/images/Weihnachtskarte%202010.jpg

History

Schrobenhausen, situated near the river Paar in Upper Bavaria, was first mentioned in the 8th century. Nowadays about 17,000 people live in the town, and its districts, which is considered as a centre of asparagus cultivation. One of its most famous sons is the Realist painter Franz von Lenbach, who portrayed important contemporary citizens and politicians like the chancellor Otto von Bismarck. The building in which he was born in 1836 is a well-known museum today.

Sights

Further cultural attractions like the asparagus museum, the museum at the Pflegschloss and the Zeiselmeierhaus, the oldest building in town, can be visited in the recently constructed museums' area.

The Lenbach museum

http://maps.google.de

The Lenbach museum, incorporated into the city wall, is the birth place of the most famous portrait painter in the early 19th century, Franz von Lenbach (1836 – 1904). The building was rebought in 1936 by his widow and turned into the present museum. Today there are numerous works of art as well as some of his belongings and furniture. On the ground floor, there are three rooms, which are dedicated to the well-known animal painter, his friend Johann Baptist Hofner (1832 – 1913).

St. Jacob's Church

Photo: Franz Albrecht, Schrobenhausen.

St. Jacob's Church, which dates back to the 15th century, was designed following the example of Our Lady's Church in Ingolstadt. In the course of its restoration in 1955, researchers discovered noticeable late Gothic frescos.

Economy

Schrobenhausen is not only interesting from a cultural point of view, but it has also a recognizable economic status with the internationally connected enterprises Leinfelder (paper manufacture), BAUER (special construction) and EADS (development and production of missile systems).

City Wall

The city centre is surrounded by a footpath, called Stadtwall, constructed in the 15th century. Its well preserved ramparts show the ancient defensive wall and its towers, bearing the names of their former inhabitants, for example Hebammenturm (midwives).

Water in Schrobenhausen

Schrobenhausen's supply water is sourced from six deep wells and retained in two high-level tanks, which are located in the surrounding area of Schrobenhausen. The wells are between 80 and 240 meters deep. There are water pipelines that convey the water from the high-level tanks to the individual estates. Those pipelines, which are about 110 m long, support over 15,000 people with tap water. Each year, our region is supplied with 800,000 m^3 of fresh water.

Schrobenhausen's tap water is of very good quality so that it can be used to prepare baby food without any additives to purify the water. In order to maintain the good quality, the laboratories in Ingolstadt are responsible for the regular control of the water quality.

Quiz: *Did U NO?*

1. How many liters of water are needed for the production of a car?

a) 10000 l b) 40 000 l c) 300 000 l

2. How many liters of water do you need to make 1 kg of paper?

a) 280 l b) 450 l c) 970 l

[1]

3. How much water is required to get one liter of milk?

a) 2 l b) 3 l c) 5 l

4. How much water do you need for the production of 1 kg of sugar?

a) 50 l b) 120 l c) 320 l

[2]

5. How many liters of water are used for the production of 1 kg of steel?

a) 10 – 30 l b) 20 – 50 l c) 70 – 90 l

6. How much water do you need to get 1 l of beer?

a) 5 – 10 l b) 10-15 l c) 15-25l

7. How many liters of water are consumed during one stage of your washing machine program?

[2]

a) 25 – 40 l b) 45 – 60 l c) 100-125 l

[1 2 3] http://office.microsoft.com/de

The Deutsches Museum

The Deutsches Museum (German Museum) in Munich, Germany, is the world's largest museum of technology and science, with approximately 1.5 million visitors per year and about 28,000 exhibited objects from 50 fields of science and technology. The museum was founded on June 28, 1903, at a meeting of the Association of German Engineers (VDI) as an initiative of Oskar von Miller. The full name of the museum in English is German Museum of Masterpieces of Science and Technology (German: Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik). It is the largest museum in Munich.

Photo: www.wikipedia.de

The Deutsches Museum possesses over 100,000 objects from the fields of science and technology. The large number of valuable original exhibits makes the Deutsches Museum one of the most important museums of science and technology in the world. The collections are not restricted to any specialized range of topics: they include objects from mining to atomic physics, from the Altamira cave to a magnified model of a human cell. They extend from the Stone Age to the present time. Collecting historically significant objects is still one of the Museum's central tasks, so that the stock is constantly growing.

About a quarter of the objects are on exhibition – in the main museum on the island in the river, at the transport museum on the Theresienhöhe, in the hangar at Schleißheim airfield, and in the Deutsches Museum Bonn. These illustrate important developments in science and technology, as well as current research.

Among the particular highlights (besides many others!) are the first motorized aircraft built by the Wright brothers, the U1 submarine, the first program-controlled computer (Conrad Zuse's Z3), and Diesel's original engine on the island; the first motorcar by Karl Benz in the transport museum; the Douglas DC3 at Schleißheim; and the first Fischer wall plug in Bonn.

Isar

The river Isar flows through Tyrol, Austria and Bavaria, Germany. Its source is in the Karwendel range of the Alps in Tyrol; it enters Germany near Mittenwald, and flows through Bad Tölz, Munich, and Landshut before reaching the Danube near Deggendorf. It is 295 km in long, thus it is the fourth largest river in Bavaria, after the Danube, the Inn, and the Main. The Isar drains a substantial part of the Alps and parts of the Karwendel mountains northeast towards the Danube river.

Since the 1920s the water of the Isar has been used for the generation of electricity. This has had far-reaching consequences not only for the local fauna and flora but also for people. To provide the 28 hydroelectric power plants with enough water power the river's water is diverted several times and almost the whole river was canalized. Lately, there have been attempts to re-naturalize the Isar. For example, since May, 2000, the river has been re-naturalized in the southern part of the river's passage through the city of Munich (see the chapter below). To achieve this, the riverbed has been widened, the banks were flattened and small gravel islands were built along with near-natural ramps to slow the water flow. Also, the dams were enlarged in width and height. Besides an improved protection against flooding, the river was, thus, brought into an almost natural state and this resulted in an improved quality of the recreational area within the city of Munich. The quality of the water has also improved due to the upgrading of the sewage plants along the river. The number of germs, however, is still relatively high.

Photo: www.wikipedia.de

The Isar Experience – Urban River Restoration in Munich

Since the beginning of the year 2000, an urban river restoration project has been in progress on the River Isar. Within the scope of the "Isar Plan", local flood protection has been improved and ecologically valuable habitats for fauna and flora have been restored. At the same time, the growing demand of city dwellers for natural landscapes in central urban areas for leisure and recreational use is met in an ideal manner. In all, the joint project of the State of Bavaria and the City of Munich is more than just the restoration of a stretch of the River Isar extending over 8 kilometers in the Munich area, it is also an investment in the future. This urban river concept combines the nature-oriented redesign of a river with an urban lifestyle, it goes well beyond simple cost-benefit analyses and is of immeasurable value for the population.

►For further information please consult the report „The Isar Experience" attached to your information folder.

The Hofbräuhaus in Munich

http://www.hofbraeuhaus.de/

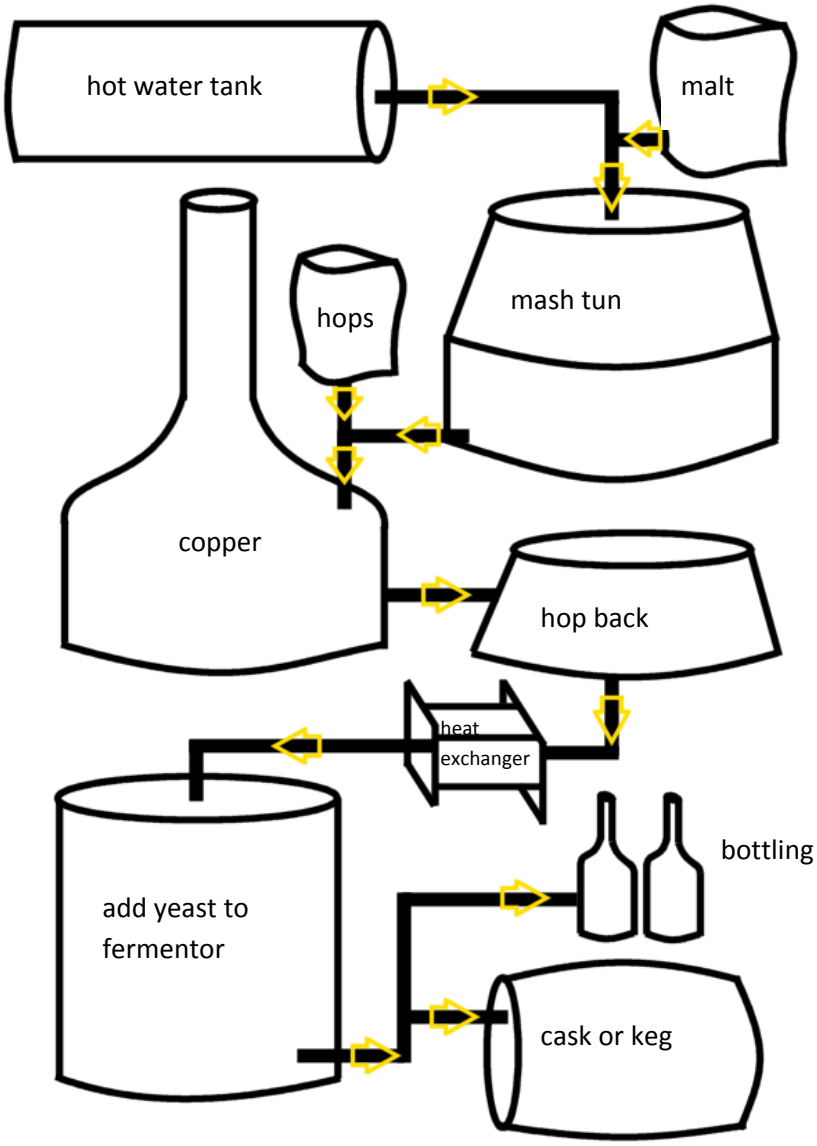
Wilhelm V, who was the Duke of Bavaria from 1578 to 1597, had a thirsty royal household. As they were dissatisfied with the beer brewed in Munich, they had to import their beer, which became very expensive over the time. In 1589, Wilhelm's council members and chamberlains approached him with the idea to brew their own beer and thus they founded the Hofbräuhaus. First, the brewery was called the "brown" Hofbräuhaus because they only brewed brown ale there.

The Brewery “Schneider Weiße” in Kehlheim

http://www.schneider-weisse.de

The brewery Schneider Weiße in Kehlheim was founded in 1872 by the Schneider family. Today, it is still directed by this family. It is the eldest wheat beer brewery in the world. They only produce natural finish beer which is fermented in the bottle.

The process of brewing beer



http://en.wikipedia.org/wiki/Brewing

REWAG

REWAG is a company that provides the city of Regensburg and its surroundings since 1976 with fresh water and energy. There are two water works that convey the water through a water pipe network that is 1035 km long. They are situated in the middle of vast water protection areas. This assures the inhabitants of Regensburg that their water is hygienic and natural. The value of nitrate is 28 mg/l, wihich is clearly under the permitted limit value.

Regensburg

www.regensburg.de/tourismus

source: ZDF-achieves

Facts and Figures

Regensburg is situated in Upper Palatinate on the river Danube as its economic and cultural center. With its 150,000 inhabitants living on 80.7 km², it is the most densely populated town in the region. The university, which counts some 22,000 students, makes Regensburg an important center of science and education. At the beginning of the 1980s, the BMW group settled near Regensburg and started manufacturing cars, which contributes to its rise a center of commerce.

History

Located on the Danube River, the Old Town of Regensburg with Stadtamhof is an exceptional example of a central-European medieval trading center, which illustrates an interchange of cultural and architectural influences. A notable number of buildings of outstanding quality bear testimony to its political, religious, and economic significance from the 9th century. The historic fabric reflects some two millennia of structural continuity and includes ancient Roman, Romanesque, and Gothic buildings. Regensburg's 11th - to 13th -century architecture still defines the character of the town marked by tall buildings, dark and narrow lanes, and strong fortifications. The buildings include medieval patrician houses and towers, a large number of churches and monastic ensembles as well as the 12th-century Stone Bridge. The town is also remarkable as a meeting place of general assemblies until the 19th century. Numerous buildings testify to its history as one of the centers of the Holy Roman Empire.

Aerial photograph of Castra Regina (Regensburg) during the Roman period

source: ZDF-achieves

Around 90 A. D. Erection of a Roman cohort-fort in the district of the present-day suburb Kumpfmühl.

179 A. D. The Roman fortress Castra Regina (fortress by the river Regen) is founded for the Third Italic Legion during the reign of Emperor Marcus Aurelius.

6th Century A. D. Castra Regina is known as Reganespurc, and is made the residence of the Dukes of the House of Agilolf, and the first capital City of Bavaria.

Sights

Porta Praetoria, an original Romanesque structure from 179 A.D.

Coming into the city center from the river, you can see Germany's most ancient stone building, the Porta Praetoria, a gateway dating from 179 A. D. Giant blocks of stone were used to construct this gate in the northern wall of the Roman military camp. It has survived as a reminder of Castra Regina, the Roman settlement.

Bad Gögging

http://www.limes-therme.de

The top-modernized Limes-Therme in Bad Gögging is located amid splendid landscapes, embedded between the Altmühltal, the Danube and the hop country “Hallertau”. Thanks to the particular geological realities, the spa, as the only place in Bavaria, has all of the three important natural occurrences at its disposal for therapy, prophylaxis and recuperation: Sulphur springs, natural moor and mineral thermal water.

As early as 80 A.D. the Romans knew how to benefit from these natural occurrences and built 60 x 30 m bathing facilities including a hot and cold water pool and a sauna, exactly at the same place where the present spa is located. Unfortunately the whole complex was destroyed in 400 A.D. by the Huns, who invaded the region.

Some Basics on Volkshochschule Schrobenhausen

- In Germany adult education ("Volkshochschule" or "vhs") is in the responsibility of town and district administrations.
- In Bavaria quite a lot of adult schools are managed by non-profit incorporated societies on behalf of the town administration.
- These societies are funded by local administrations on the town and district level and (very little) by the state of Bavaria, but are often forced to act more in an economical than in a pedagogical way by lack of aid.
- Volkshochschule (vhs) Schrobenhausen is a non-profit organisation founded in 1947.
- vhs Schrobenhausen is serving the town of Schrobenhausen and its environs totalling about 35 000 inhabitants.
- vhs Schrobenhausen offers courses in various faculties: languages (English, French, Spanish, Italian, Greek, Russian, Czech, Chinese and German), information technology, psychology and education, history, law, literature, painting and music, health, stress relaxation, dancing, ecology, environmental issues, cookery courses.
- vhs Schrobenhausen offers about 600 courses, seminars, lectures and other performances a year.
- vhs Schrobenhausen counts 5000 to 5500 attendants a year.
- vhs Schrobenhausen is managed by the headmaster and three part-time assistants. There are 152 free-lance teachers and lecturers.

For further information please contact:
Volkshochschule Schrobenhausen eV
vhs-Haus, Lenbachstr. 22, D-86529 Schrobenhausen
Tel.: +49 8252 89400
FAX: +49 8252 407 20 70
Email: vhs@vhs-sob.de
Internet: www.vhs-sob.de

Water and life

Sokrates Grundtvig Learning Partnership 2011 - 2013

Volkshochschule Schrobenhausen e. V.

Schrobenhausen Project Meeting

- 18th October 2011:
  Schrobenhausen
- 19th October 2011:
  Munich
- 20th October 2011:
  Kehlheim, Regensburg, Bad Gögging

Schrobenhausen – some Basics (I)

- Schrobenhausen is a rural town in Southern Bavaria 60 km north of Munich
- Schrobenhausen has almost 17 000 inhabitants
- The beginnings of the town date back to the 9th century

Schrobenhausen – some Basics (II)

Aspargus and underground engineering

Schrobenhausen – some Basics (III)

European Asparagus Museum

Franz von Lenbach (1836-1904) Portrait Painter

Schrobenhausen: Characteristics

vhs – some Basics (I)

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vhs – some Basics (II)

- vhs Schrobenhausen counts 5000 to 5500 attendants a year.
- We offer courses in 10 languages, information technology, psychology, education, history, law, literature, painting, music, health, dancing, cookery, ecology etc.
- vhs Schrobenhausen is managed by the headmaster and three part-time assistants. There are 156 free-lance teachers and lecturers.

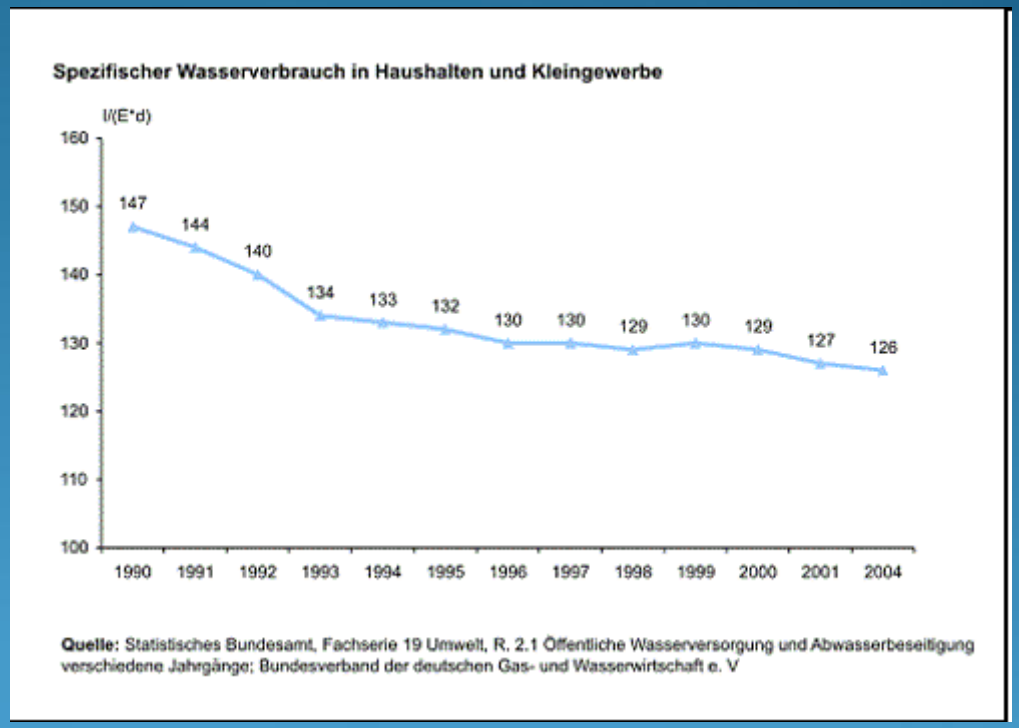
vhs Schrobenhausen‘s Head Office in the historic town centre.

Phase I: Qualitiy of Water

- Environment protection – a new term disseminates
- Water pollution – a countrywide menace
- Sewage plants and successful water protection

Phase II: Quantity of Water

- The discovery of sustainability
- Mostly technical solutions
- Water consumption decreases from 147 to 126 litres per capita and year

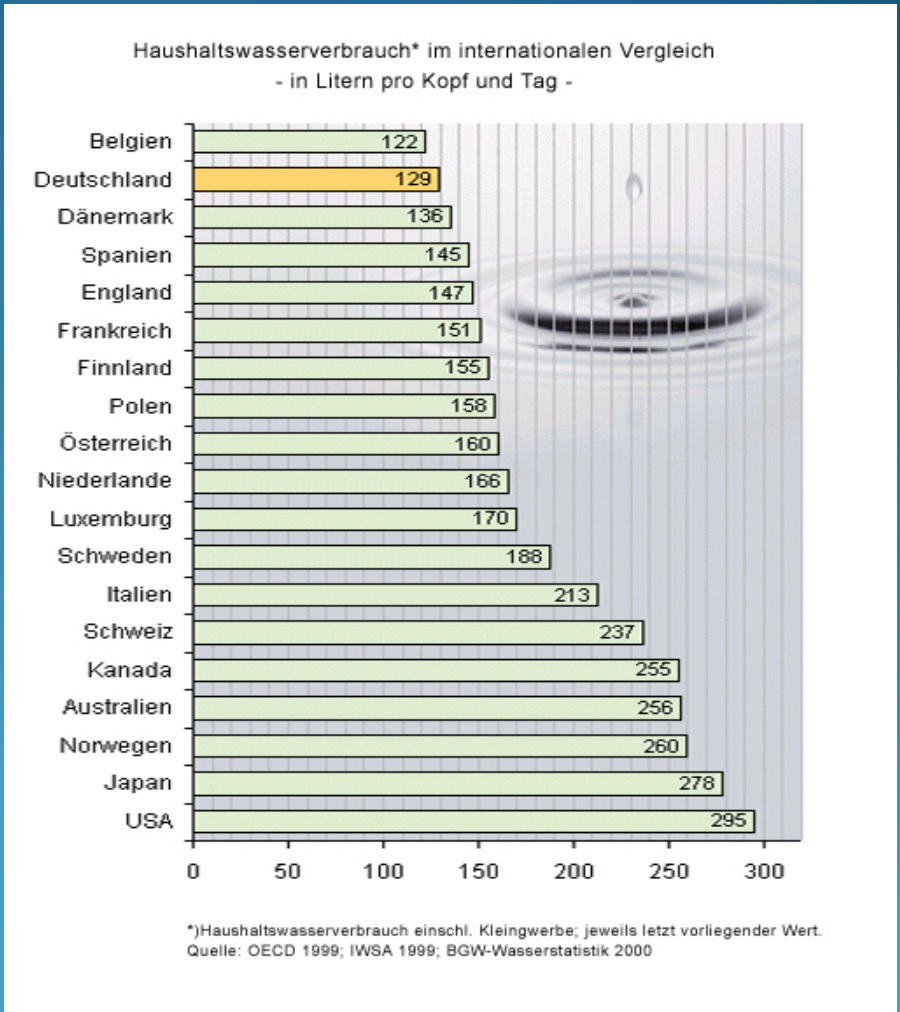


Our targets – our efforts:

- 1994: Water saving courses and workshops
- 2000: Sustainable handling of water
- 2009: Water and globalisation – Water conflicts
- 2010: Virtual water and personal liability

Our courses

- Hydrological basics
- Worldwide water supply
- Worldwide water consumption
- Worldwide water shortage and water quality
- Water crisis, waterborne diseases



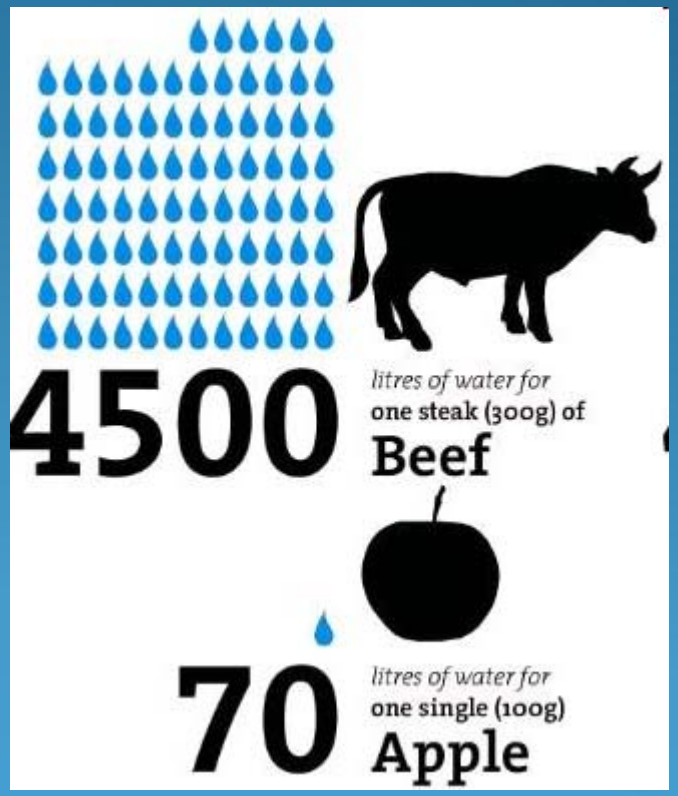
Our courses

- Water and the poor
- Water privatisation versus water as public good
- Water conflicts (e. g. Turkey and Syria; Israel and Palestine)
- Water as a human right

Öffentlicher Wasserhahn in Südafrika.
©APGraphicsBank

Phase III: Virtual Water

The Virtual Water Concept (VWC) measures how much water is embedded in the production and trade of food and consumer products.



Water and life: our new objectives

Three main subjects:

- Water and urban development
- Water and quality of life
- Water and privatisation: change of trend?

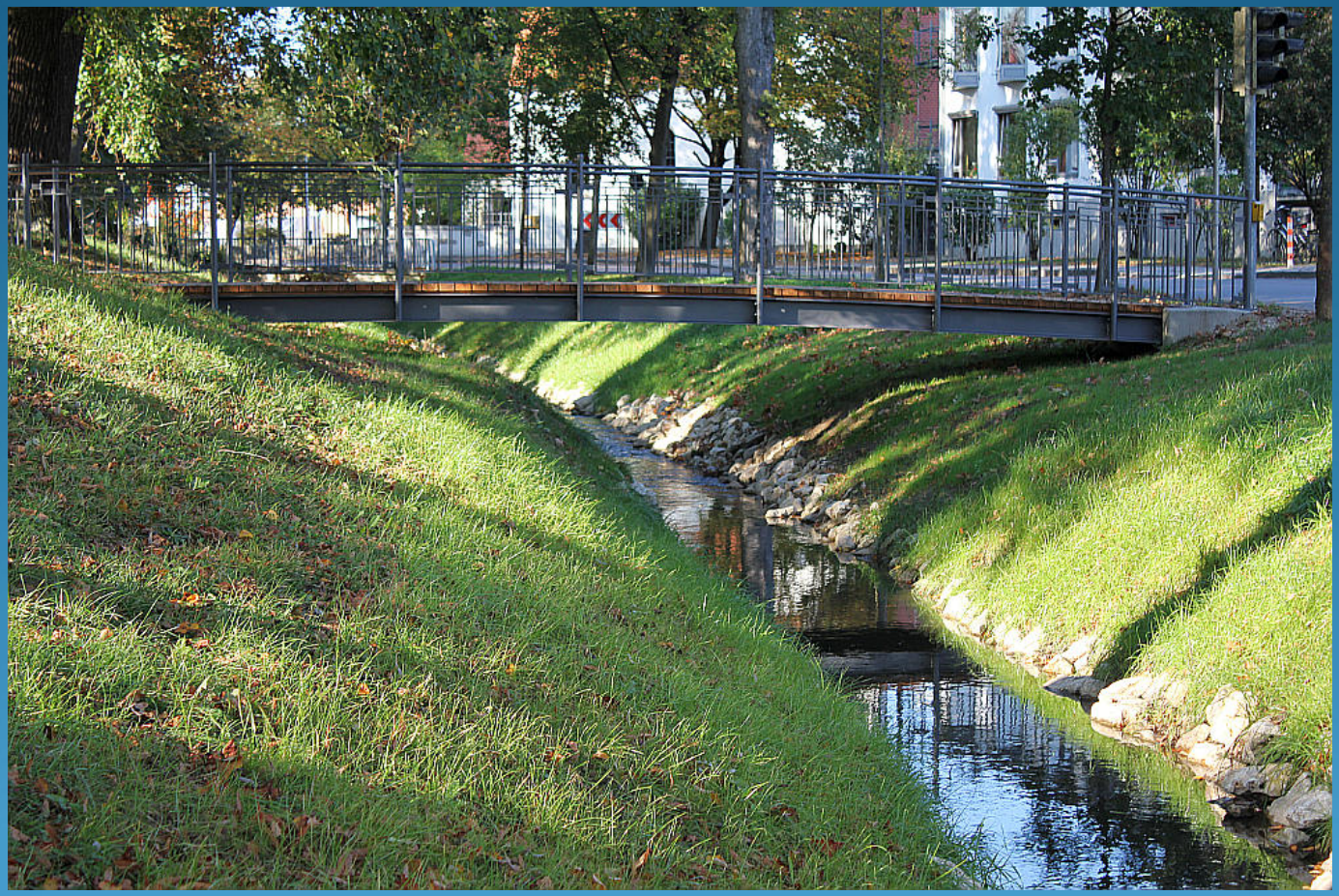
Water and urban development (I)

Nuremberg

Water and urban development (II)

Munich

Water and urban development (III)



Schrobenhausen

Thank you very much!

Water and Life

Crete Meeting
29th Oct – 1st Nov 2012

Sokrates Grundtvig Learning Partnership 2011 - 2013
Volkshochschule Schrobenhausen e. V.

Die vhs Volkshochschule

SCHROBENHAUSEN

vhs – some Basics

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- vhs Schrobenhausen is serving the town of Schrobenhausen and its environs totalling about 35 000 inhabitants.
- 600 courses, 5500 attendants a year.
- Ecology and environmental issues: 40 courses a year.

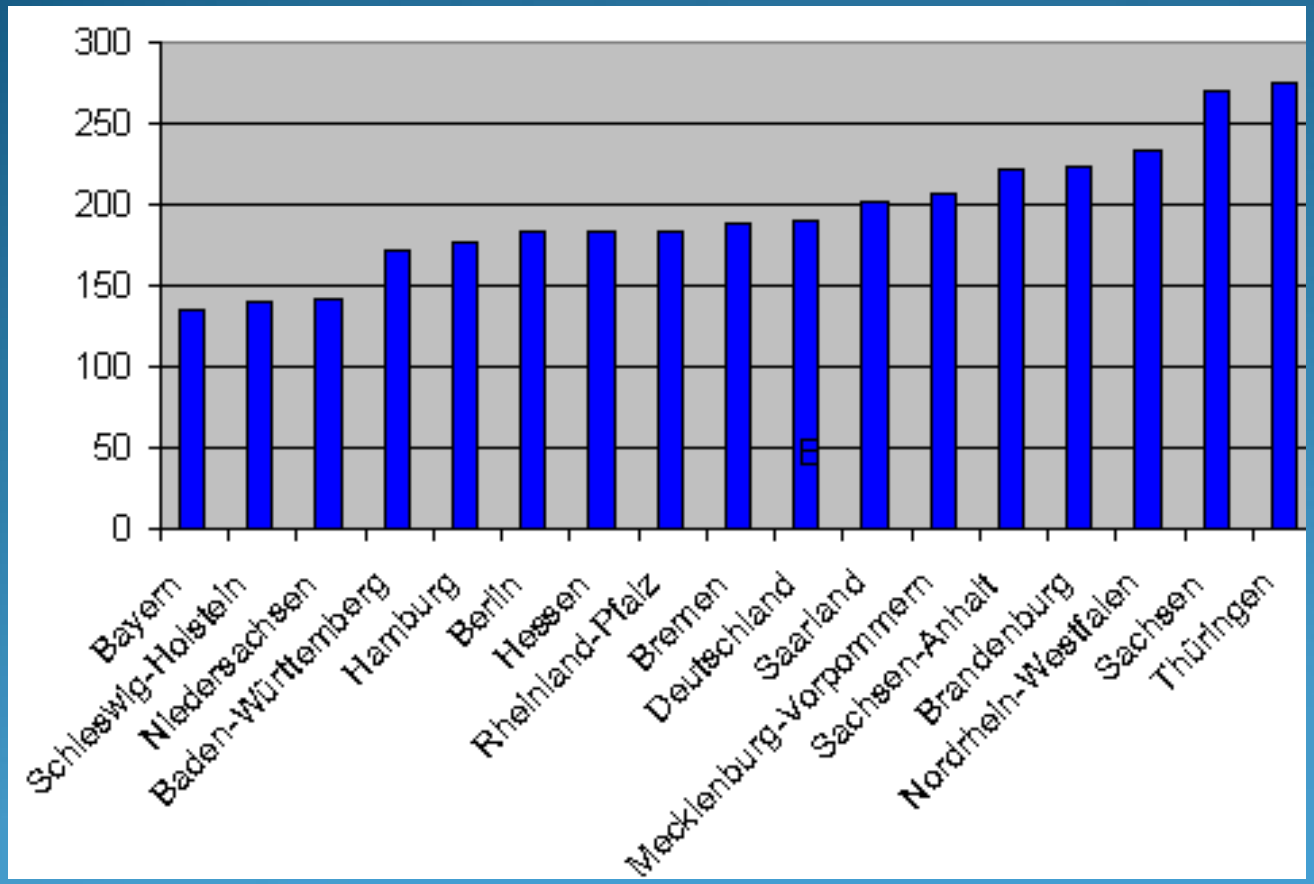
Water and life

- From 2011 to 2013
- Partners: Crete, Corsica, Germany, Spain
- Objectives:
  - ►Water, ecology, and quality of urban life
  - ►Virtual Water concept
  - ►Water, water rates and privatisation

Water management in Germany

- Consumption: 5,1 milliards litres/year (122 litres per day per capita)
- Origin of water: 65 % ground water, 21 % surface water, 9 % wells
- Water works: 90 % public utilities (more than 6000, often very small)

Consumer water rates in Germany

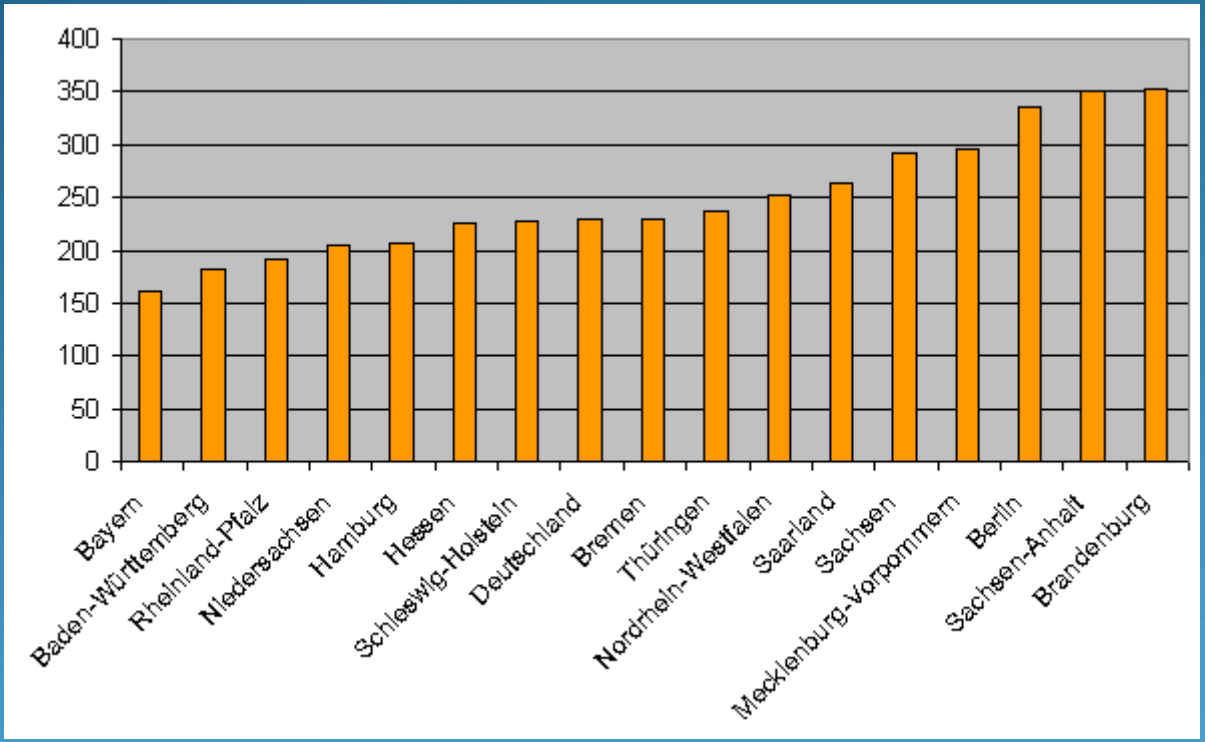


Average water rate in Euro for 80 m³ in a year (2008) in different German states.

German average:

189,56 €

Consumer waste water rates in Germany



Average waste water rate in Euro for 80 m³ in a year (2008) in different German states.

German average:

229,50 €

Water rates and privatisation

- Water rates are higher if there is more private capital involved in water management.
- First example: Berlin
- Second example: East German states with a high amount of private capital in new built water facilities after 1990.

Water rates and privatisation: the example of Berlin (I)

Berlin water works were partly privatised (49,9 %) in 1999.

Consequences:

- 35 % increase in water rates since 2004
- Loss of 2000 jobs
- Reduced water quality, reduced services
- Berlin municipality seems to pay more than before privatisation (confidential contracts)

Water rates and privatisation: the example of Berlin (II)

Protests in Berlin:
Water meets democray

Protest against privatisation

Referendum in 2011: 600 000 votes for transparency

June 2012: Antitrust agency: Berlin water is too expensive

23rd October 2012: Big parties to propose a first 15 % reduction of water rates (60 million Euro).

Chance of recommunalisation

Water privatisation (I):

- Historically water was considered as a public good.
- Water shortage – a new chance for making money.
- IMF and World Bank urge developping world states to privatise public services (water, transport, communication) by means of infamous „structural adjustment programs“: no privatisation, no more money.

Water privatisation (II): Promises

- Fiscal advantages
- Private sector is more efficient, cost-effective and competitive
- Better quality of service
- Private sector financing helps to provide clean and affordable water for more people.

Water privatisation (III): Reality

- Increases in consumer water rates
- The poor can't pay for their water bills
- Lack of investment in water infrastructure
- Jobs killed and trade unions threatend
- Pollution and environmental problems
- No or less expenditure in pipe systems and sewage plants
- More public costs for the benefit of shareholders.
- Protests and social turmoil.

Water privatisation (IV): Fiascos worldwide

- Buenos Aires
- Manila
- Jakarta
- Atlanta
- London and Great Britain
- Jakarta

Water privatisation (V): A way back?

Tendencies in opposite directions:

- Recommunalisation (France, e. g. Paris)
- Big water corporations desinterested in Third World
- New recommendation for privatisation
- A human right to water and sanitation (UN Res. 64/292)?

The right to water

"It is now time to consider access to safe drinking water and sanitation as a human right, defined as the right to equal and non-discriminatory access to a sufficient amount of safe drinking water for personal and domestic uses — drinking, personal sanitation, washing of clothes, food preparation and personal and household hygiene — to sustain life and health. States should prioritize these personal and domestic uses over other water uses and should take steps to ensure that this sufficient amount is of good quality, affordable for all and can be collected within a reasonable distance from a person's home."

Chania

Σας ευχαριστούμε!

Thank you!

Schrobenhausen

Water and Life

Schrobenhausen Meeting
2. – 4. July 2013

Sokrates Grundtvig Learning Partnership 2011 - 2013

Volkshochschule Schrobenhausen e. V.

Water and life

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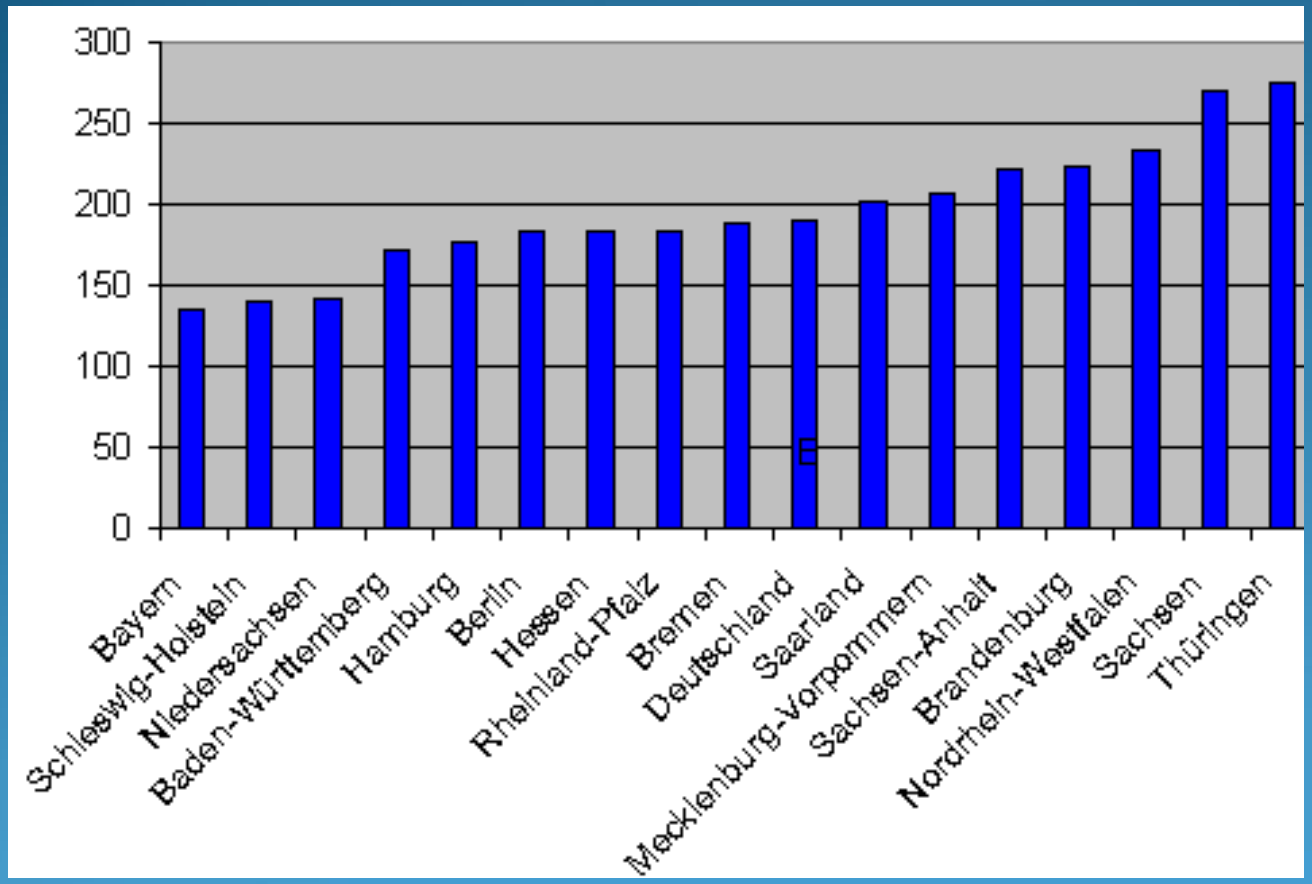
Water privatisation

- is an excellent way to sell bad water for good (i. e. high) prices
- is an excellent way to produce impoverished communities and ever richer big international private companies

Consumer water rates in Germany



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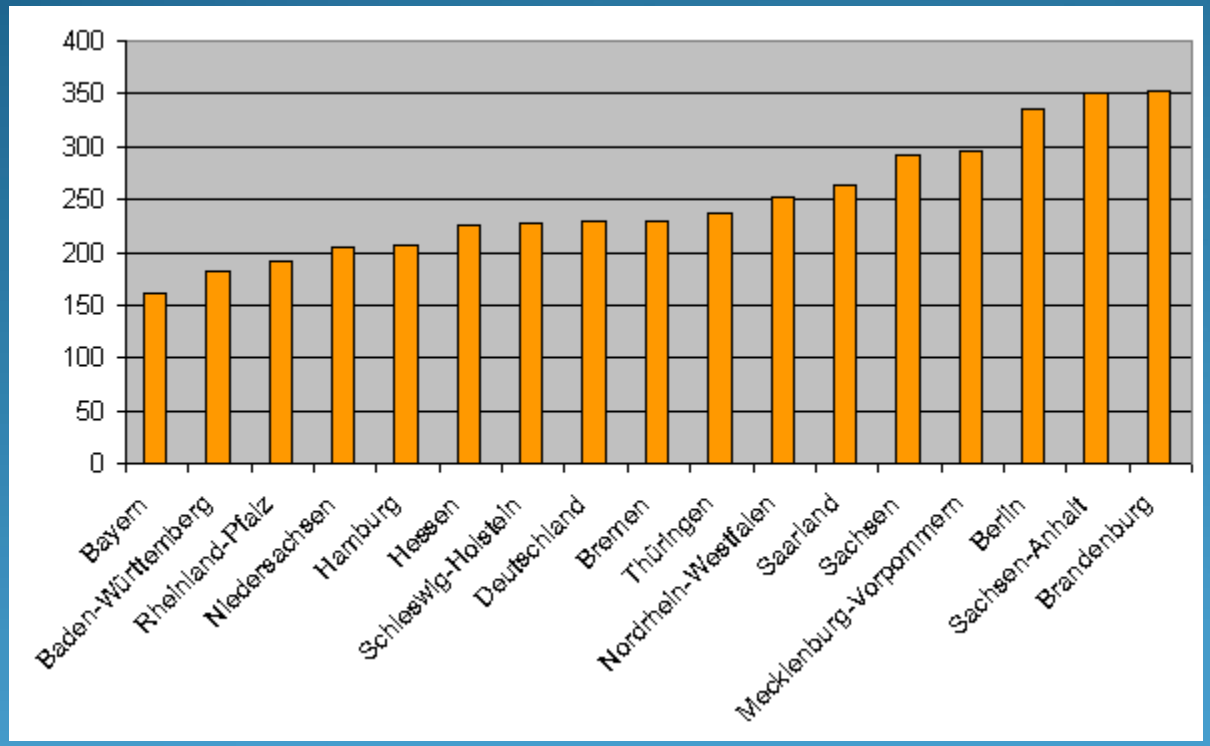

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Water rates (I)

Explanation to Water Rates I and II

	Public company
	Public company, formally privatised
	Formally privatised, profit goes completely to public budgets
	Private company
	most expensive
	least expensive

Water rates (II)

The most expensive towns in Germany

3 Personen

	WATER FEE PER YEAR					
TOWN	1 Person	2 Persons	3 Persons	4 Persons	5 Persons	
Chemnitz	221,23 €	311,18 €	401,13 €	491,08 €	581,03 €	N
Mainz	214,25 €	309,10 €	403,95 €	498,80 €	593,64 €	A
Rostock	239,41 €	324,01 €	408,62 €	493,23 €	577,84 €	N
Erfurt	222,37 €	317,67 €	412,96 €	508,26 €	603,55 €	N
Hagen	247,76 €	331,47 €	415,19 €	498,91 €	582,62 €	A
Essen	254,36 €	338,07 €	421,79 €	505,51 €	589,22 €	A
Zwickau	250,86 €	336,36 €	421,85 €	507,35 €	592,85 €	N
Gera	227,70 €	327,00 €	426,31 €	525,61 €	624,91 €	N
Bergisch Gladb.	252,21 €	340,38 €	428,55 €	516,72 €	604,89 €	A
Jena	246,70 €	339,32 €	431,95 €	524,57 €	617,19 €	N

Water rates (III)

The cheapest towns in Germany

	WATER FEE PER YEAR					
TOWN	1 Person	2 Persons	3 Persons	4 Persons	5 Persons	
Ingolstadt	77,71 €	116,89 €	156,08 €	195,27 €	234,45 €	A
Regensburg	86,88 €	137,65 €	188,41 €	239,18 €	289,94 €	A
Augsburg	74,09 €	135,09 €	196,10 €	257,10 €	318,11 €	A
Oldenburg	85,95 €	145,62 €	205,29 €	264,96 €	324,63 €	A
Kaiserslautern	82,91 €	146,15 €	209,38 €	272,61 €	335,84 €	A
Hannover	99,23 €	165,58 €	231,93 €	298,28 €	364,63 €	A
Halle	111,34 €	173,23 €	235,13 €	297,03 €	358,92 €	N
Cottbus	134,92 €	188,35 €	241,79 €	295,22 €	348,66 €	N
Freiburg	96,27 €	172,86 €	249,45 €	326,05 €	402,64 €	A
München	123,47 €	186,71 €	249,94 €	313,17 €	376,40 €	A

Water rates (IV)

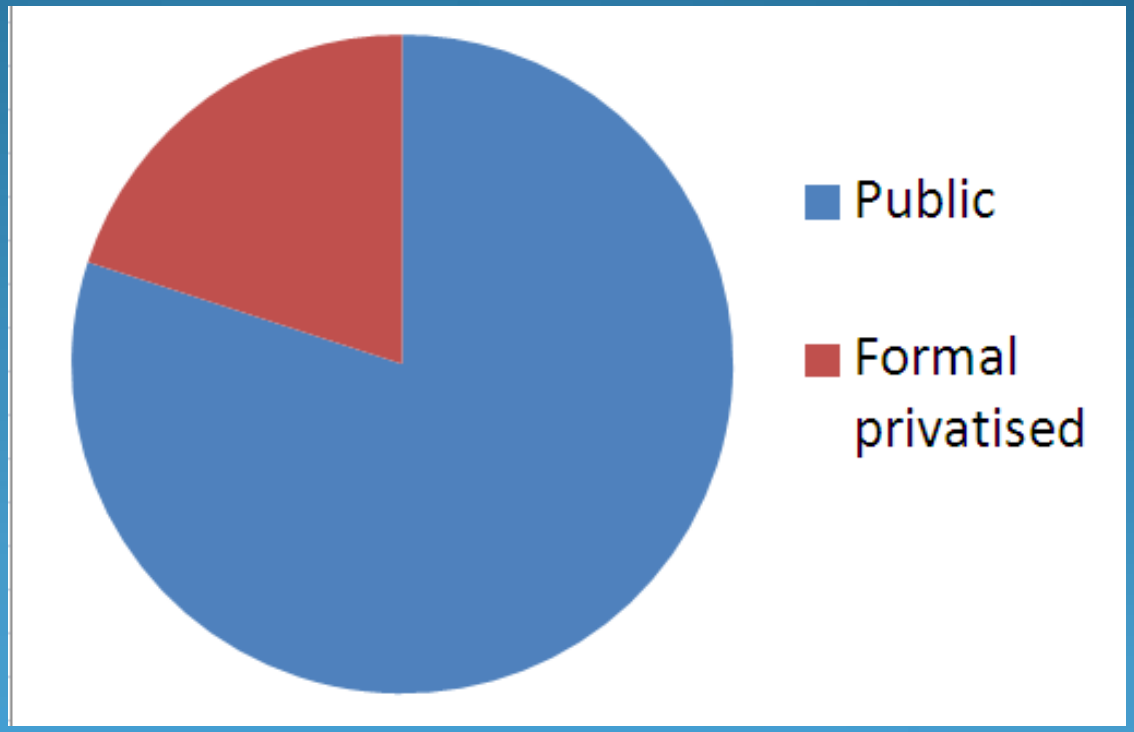
Town	Basic fee	Drinking water fee/m^3	Drinking water fee for 80 m^3/p.a.	Waste water fee/m^3	Combined water fee for 80 m^3/p.a.
Aresing (Paartal)	49,08 €	0,82 €	114,60 €	1,20 €	210,68 €
Aresing (Beinberg)	36,00 €	1,02 €	117,60 €	1,20 €	213,60 €
Ingolstadt	36,00 €	0,91 €	108,80 €	1,68 €	243,20 €
Schrobenhausen	25,00 €	1,40 €	137,00 €	2,24 €	251,20 €
München	82,44 €	1,58 €	208,84 €	1,56 €	333,64 €
Jena	154,08 €	1,85 €	302,08 €	1,58 €	429,08 €
Essen	227,79 €	1,88 €	378,19 €	2,74 €	597,39 €

Findings (I)

- Out of ten towns with the highest water prices: 6 private companies, 3 formally privatised or partly privatised companies and 1 public company
- Out of ten towns with the lowest water prices: 8 public companies and 2 formally privatised or partly privatised companies
- Also very small public utilities are able to offer very low water rates.

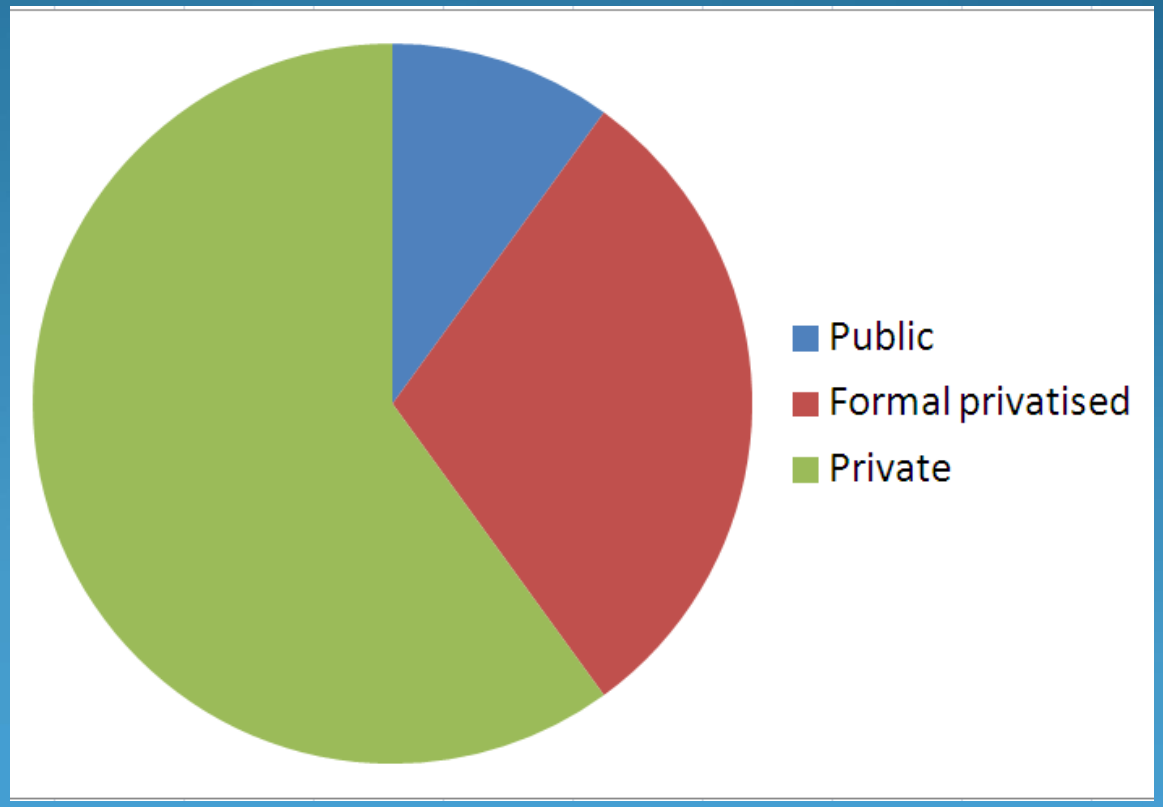
Findings (II)

The most expensive towns:



Findings (III)

The least expensive towns:



Grundtvig-Project

Water and Life

Thank you!

vhs Schrobenhausen

Hydropower - Position of BUND Naturschutz Bayern

BUND Naturschutz in Bayern e.V.

Hydropower – Good or Bad?

Unused barrage near Hörzhausen,
Foto: Schwäricke (2002)

Enviromental Scientist

Renate Schwäricke
Speaker of the
Work Group „Water“

BUND Naturschutz
in Bayern e.V.

3 of July 2013

Water and Life,
Vhs Schrobenhausen

Ecological Services of Natural Floating Watersystems

BUND Naturschutz in Bayern e.V.

„Rivers and their floodplains are the ecological backbone of our landscape“
Thomas Goppel (CSU), 1996

Paartal near Schrobenhausen, Foto: Schwäricke (2002)

To Nature

- living space with high dynamic potential
- high biodiversity
- creates, suplies and conects wetlands (floodplains, riversides, swamps a.o.)

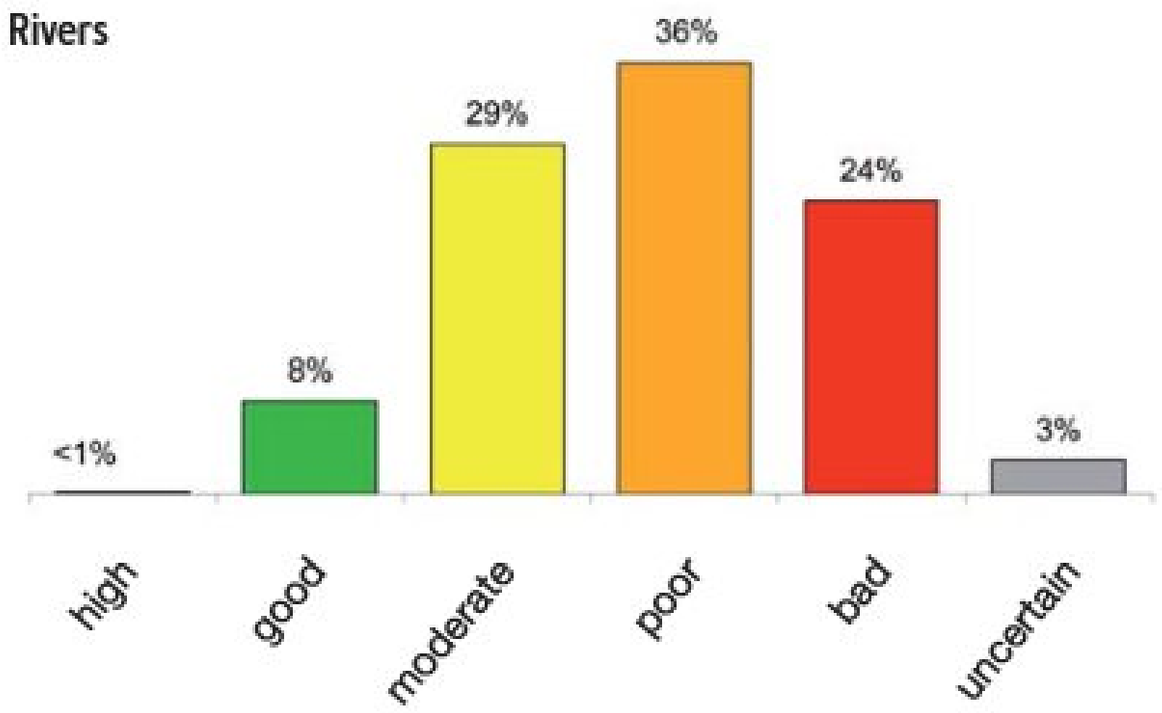
To People

- natural flood prevention
- recreation
- groundwater developement
- source for drinking-water
- compensation in climate change
- source for food (spec. protein)

WFD-Inventory, State of Rivers

BUND Naturschutz in Bayern e.V.

Ecological Status of Rivers in Germany

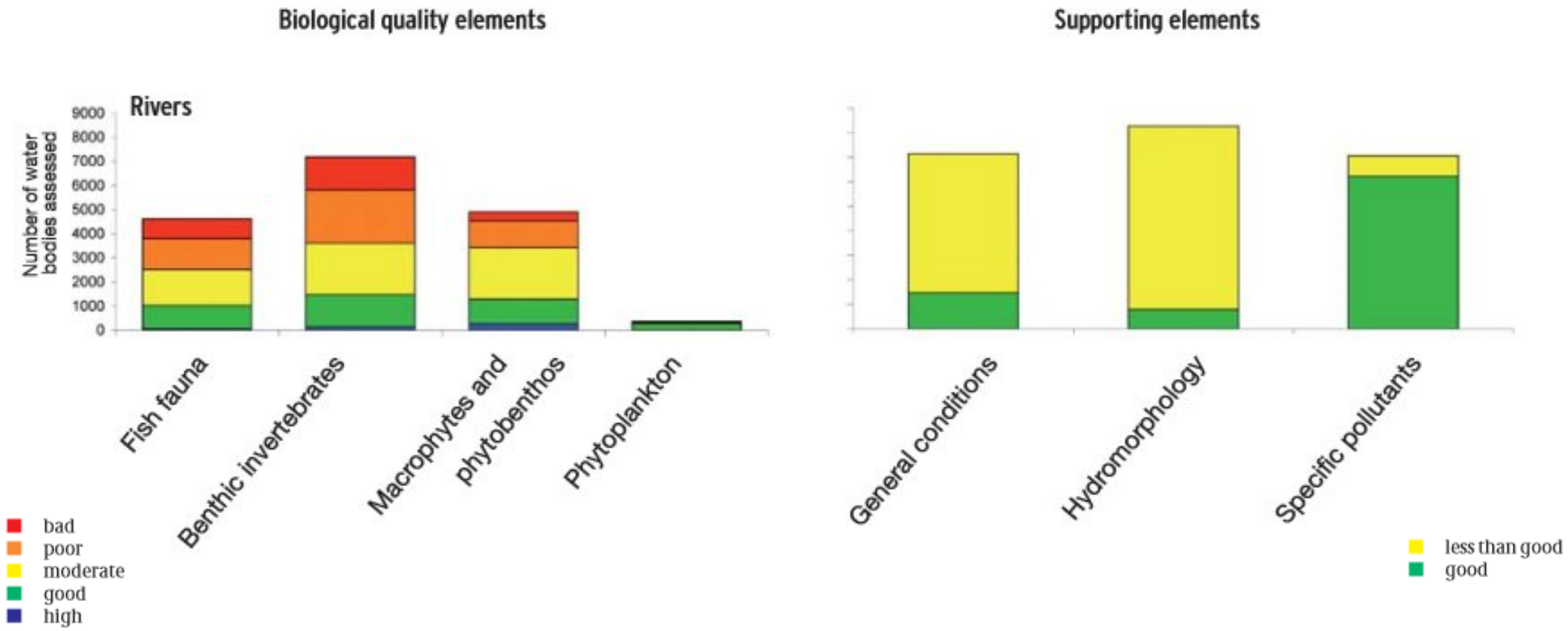


Source: Portal Wasserblick/ BfG; last updated 22 March of 2010

WFD-Inventory, State of Rivers

BUND Naturschutz in Bayern e.V.

Quality Element Status for Rivers in Germany



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WFD-Inventory, State of Rivers

BUND Naturschutz in Bayern e.V.

Canal of power unit Fa. Leipa Schrobenhausen Foto: Schwäricke (2002)

Major Problems

- hydromorphological degradation
  - disrupted river contiunity
  - river bank construction
  - inadaquatly structured river beds
- eutrophication and sedimentation
- decline in fish stocks

Disarranged River Contiunity

- in around 60.000 barrages, 4250 hydroelectric plants, most of them impassable for fish and bedload
- measures are expensive and because of the private water rights difficult to enforce

Flowing Waters Good Structure WFD – Indicator - Fishes

BUND Naturschutz in Bayern e.V.

How Hydropower Affects Fish

- migration barriers
- death and damage by passaging the turbine (killing rate up to 90%)
- sedimentation destroy spawning ground
- aggregation of the riversoil (loss of fisch feed, benthic invertebrates)
- loss of bedload
- monotone riverbed
- change in range of species

Brown trouts after the passage of a hydropower turbine
Source: Rückbau einer Kleinwasserkraftanlage, Landesfischereiverband Bayern e.V. (2006)

94% of fish species in Bavaria are endangered or lost!

Hydropower Facts Germany

BUND Naturschutz in Bayern e.V.

- 20 TWh electricity generation from hydropower annually
- 4% of Germany‘s total energy demand
- in around 7600 hydropower-plants (HPP):
  - 354 middle and big HPP (>1MW installed output) generates 91% of the hydropower
  - 7300 small HPP (<1MW) generates only 9%
  - most in the southern states (in Bavaria 4250 HPP)
- share of small hydropowerplants in generation of totaly produced electricity: 0,3%,
- this corresponds to a <u>CO_2-avoidance of 0,09%.</u>

➔ ***There is no need to enforce the number of small HPP***

Hydropower and Climate Change

BUND Naturschutz in Bayern e.V.

Future Changes Caused by Climate Change:

- change in the hight and intensity of precipitation, increase of droughts
  - change of water availibility
  - extended period of low water, also more frequent floods
- melting of the glaciers

What are the Consequences for Hydropower?

- loss of energy generation 1- 4% in near future, - 15% in the more distant future
- especially in periods of low water, there is an ecological demand for more residual water (from „Potentialermittlung für den Ausbau der Wasserkraftnutzung in Deutschland“, BMU 2010)

Hydropower and Greenhouse Gas

BUND Naturschutz in Bayern e.V.

Free of Carbon Dioxid Isn`t Free of Greenhouse Gas!

- **1990: first proof for Methane (CH_4)-developing process from waterplant in Brasil:**

  „The methane-emissions produced by the sediment of the Curuá-Una-Reservoir are 3,5x higher than generating the same quantity of energy from oil“

  Philip Fearnside, Brasilianisches Institut for Amazonas-Reseaerch in the „New Scientist“

- **2010: proof for CH_4- developing process in a suisse reservoir**
- **2012: initial research contract for a german university (Koblenz-Landau) and the BfG: proof for massive CH_4-formation and outgassing from barrages in the river (Saar)**
- **2013: the results are confirmed by further investigations at the river Main**

CH_4: greenhouse effect is 25 times stronger than CO_2

Hydropower and Climate: Conclusion of BUND Bayern

BUND Naturschutz in Bayern e.V.

Climate Protection with Hydropower as Renewable Energy:

- **small HPP: contribution is insignificant by causing big ecological damages, responsible for problems in reaching the goals of WFD** (Umweltbundesamt, Hrsg.: „Umweltverträglichkeit kleiner Wasserkraftwerke – Zielkonflikte zwischen Klima- und Gewässerschutz“. UBA Texte 13, 1998)
- **big HPP: methane-formation isn‘t considered in the climate balance, the latest studies have shown that the emissions are very high** (Forschungsauftrag der Bundesanstalt für Gewässerkunde und der Universität Koblenz/ Landau seit 2012)

Measurement of upcoming methane-bubbles in the river Main by Universität Koblenz-Landau

Hydropower isn‘t good for climate protection!

Hydropower and WFD: Conclusion of BUND Bayern

BUND Naturschutz in Bayern e.V.

Restoration of the Continuity of Watercourses as an Integral Element of WFD :

- restoration at the highest level at existing HPP
- with new HPP at weirs we can‘t achieve river-contuinity, but more risk for fish because of the turbine
- fish pass upstream doesn‘t work for all sizes and species
- fish pass downstream still needs a lot of research

„Fish-Stairs“ in Mittelfranken, Foto: Schwäricke (2009)

With Hydropower we wouldn‘t achieve the good ecological status of our rivers!

Hydropower isn‘t a Green Energy

BUND Naturschutz in Bayern e.V.

Living Rivers Need Their Energy for Themselves!

The Ammerschlucht, view from Echelsbacher Brücke
Source: Infobroschüre Ammer-Allianz „Für eine naturnahe Ammer ohne neue Wasserkraftwerke!“ (2008)

Enviromental Scientist

Renate Schwäricke
Speaker of the
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3 of July 2013

Water and Life,
Vhs Schrobenhausen

Water resources management in the island of Crete: present situation, problems and perspectives

K. Chartzoulakis, M. Bertaki,

NAGREF, Institute for Olive Tree and Subtropical Plants, Chania, Crete

Introduction

- The area of Crete: 8335 km^2
- Total population: about 600,000 people
- Climate: sub-humid Mediterranean, with humid and relatively cold winters and dry and warm summers
- Average annual precipitation: about 927 mm
- Total water used 410 Mm^3/yr
- The major water use (85.2%) is for irrigation in agriculture, 12.7% for domestic use (including tourism industry) and 2.1% for industrial use
- The main issue in water resources management on the island is focused on the uneven geographical and seasonal distribution of water resources in relation to the water demand hotspots.

Hydrological balance

- Water resources management: key issue in the island of Crete mainly due to – the spatial and temporal variation of the rainfall events
  – the intense water uses (tourism, farming)
- Cultivated land has not increased significantly during the past 50 years but the irrigated land during that period has been doubled ⇒ the water requirements for agriculture have been doubled

Table 1: Estimated Hydrological balance of Crete (in Mm^3)

Hydrologic conditions	Precipitation	Actual Evapotr/tion	Runoff	Groundwater recharge
Normal year	7690	4830 (62.8%)	740 (9.6%)	2120 (27.6%)
Wet year	10330	6480 (62.8%)	990 (9.6%)	2850 (27.6%)
Dry year	5070	3180 (62.8%)	490 (9.6%)	1400 (27.6%)

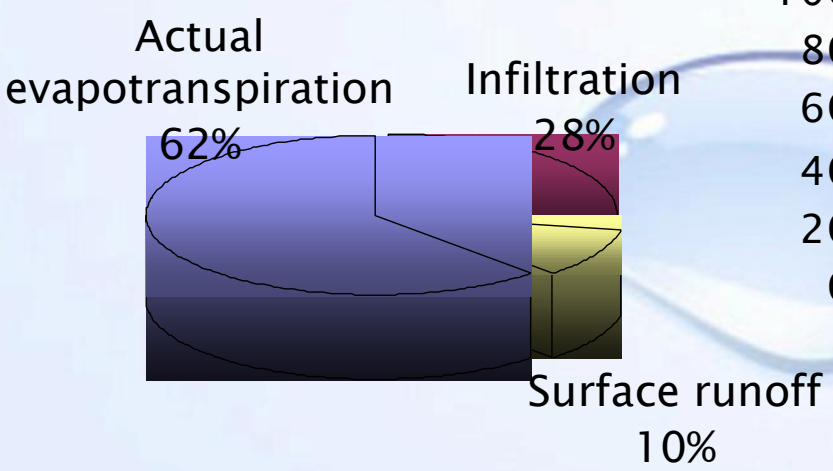
Water resources in Crete

- Total available water resources in Crete: 2860 Mm^3

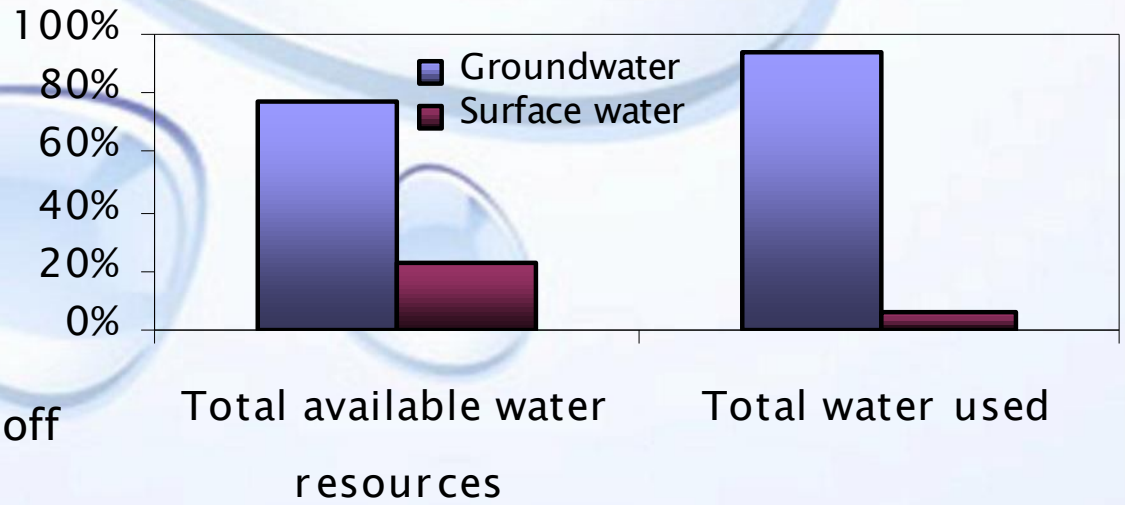
2232 Mm^3 (78 %) come from groundwater resources

628 Mm^3 (22 %) come from surface water

- Total exploitable water resources: 857 Mm^3,
- The water supply (410 Mm^3) does not fully cover the demand (536 Mm^3)



Hydrological balance of Crete



Available and used water resources

Water in agriculture

- **Agriculture:**
  - important sector of the local economy
  - contributes 13% to the GDP
  - occupies around 6.7% of the active island employees
- **Main crops**: olives (85 % of the total tree crops), citrus, grapevines, vegetables and avocados
- **Irrigation networks**: modern type made of pressurized distribution systems with delivery of water to the farm outlets. Are constructed by:
  - the government ⇨ large irrigation schemes
  - the local authorities ⇨ medium scale local network
  - private individuals ⇨ small scale local networks
- **Irrigation methods used:**
  - drip irrigation (vegetables, vine-yards, tree crops),
  - sprinkler (forage crops and vegetables)

Irrigated crops

❖ **Irrigation scheduling:**

For vegetables: empirically or using tensiometers (greenhouses)
For tree crops: Empirically or based on meteorological parameters (mainly Class A pan) or on advisory systems

❖ **Irrigated area in Crete:**

- 42.3% of the available agricultural land
- increased more than 55% in the last 15 years

Water demand and deficit in Crete (RGC,2002).

Water use	Estimated demands (Mm^3)	Consumption (Mm^3)	Deficit (Mm^3)	Cover percentage
Irrigation	458.37 *	302.06	156.31	65.9%
Domestic & other uses	77.34	69.75	7.59	90.2%
Total	535.71	371.81	163.90	72.2%

Agricultural water management

Bodies involved in agricultural water management:

- The Local Farmers Irrigation Organizations (TOEBs) and individual farmers that own small water supplies (springs, wells, etc). They manage irrigation water only.
- Municipalities provide and manage water for a variety of uses (drinking water, tourism, agriculture).
- Other semi-governmental entities, like OADYK in western Crete, which is responsible for the supply of water to a variety of organizations for numerous water uses.
- The Prefectures that play an advisory/supervisory role and are also involved in decision making
- The Region of Crete, which is involved in decision making and suggestion of solutions or better management from a large scale perspective

Water pricing

Agricultural use:

- The price of irrigation water varies greatly among areas in the island or even among catchments due to different pricing structure, policies and managing organization.

  In Chania Prefecture the price of irrigation water is 0,07–0,12 €/m^3 in networks operated by TOEB, 0,10–0,17 €/m3 operated by OADYK, 0,15 – 0,22 €/m^3 operated by Municipalities, whereas in some private projects it reaches 0.30–0.35 €/m^3.
- Irrigation water tariffs must cover the O&M cost of water use and services
- volumetric water metering is obligatory
- an increasing block tariff charging system, for those exceeding crops' critical water requirements, must be established

Municipalities

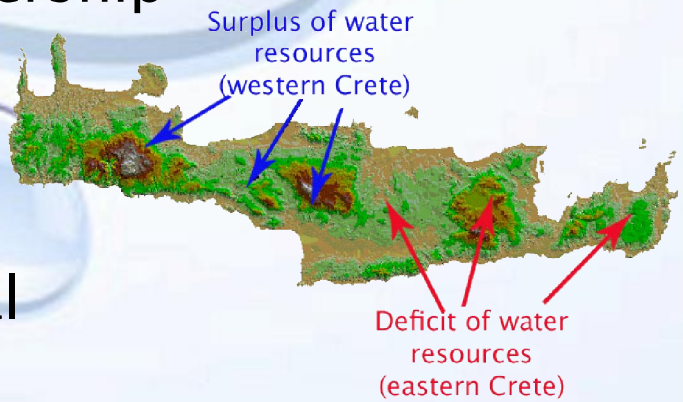
- Price is variable according to use (drinking supply, tourism, agriculture) and the area (0.15 – 1.5 €/m^3)
- Prices scaling up relatively to consumption

Pressures in water management

Water availability in average terms is not the limiting factor. Much more important are the significant regional and seasonal variations in water availability and demand (Fig 4).

Pressures in water management:

- Water use conflicts (when different uses served, mainly in coastal areas where tourist industry is prevailing)
- Water distribution from one region to another due to misconception on water resources ownership
- Human impact on water resources
  - ⇒ Quantity: overexploitation of groundwater resources
  - ⇒ Quality: sea water intrusion in coastal aquifers and pollution events (fertilizers, pesticides, effluents)



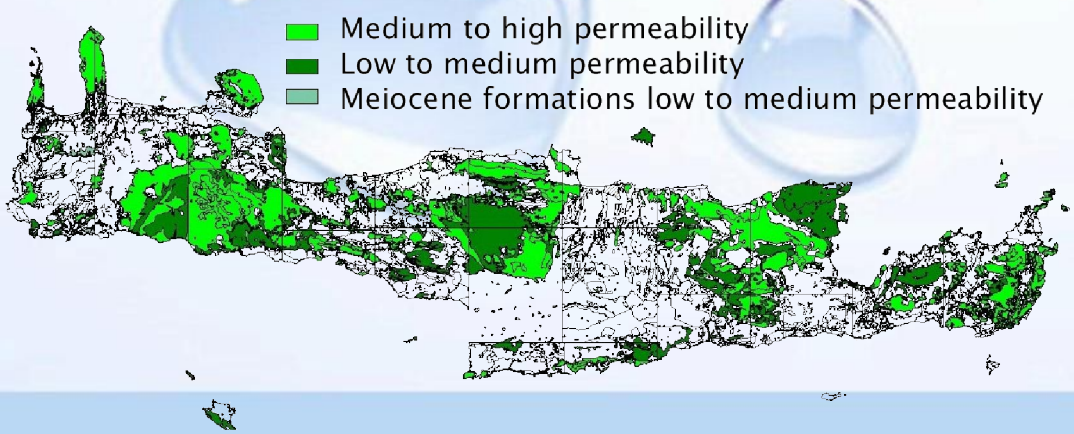
Pressure in water management

Problems in water management

- Institutional and administrative problems:
  - too many organizations involved in water resources management at a prefecture and river basin level
  - coordinative and competence problems are generated over the management of the same water resources
  - different stakeholders manage different uses and the priorities in use are not maintained
- Infrastructure problems:
  - need for funds from EU and government for projects of unexploited resources
- Legal problems:
  - the implementation of the Groundwater Framework Directive 2000/60 was voted in the Greek Parliament in December 2003 (N. 3199/2003). However, there is a delay in the implementation
  - full cost recovery is still an issue.

Key actions for water management in Crete

- ✓ Exploitation of Un(der) Exploited Aquifers such as Karstic Aquifers
- ✓ Improved Freshwater Storage and Transport. GW Recharge promotion
- ✓ Pollution Control of surface and ground water. Water Quality Monitoring.
- ✓ Policy against overexploitation.
- ✓ Protection of Coastal Aquifers.
- ✓ Utilization of Untapped Surface Water Sources. Inter-basin Transfer.



Karstic aquifers of Crete.

Key actions for water management in Crete

- ✓ Demand Reduction: Agricultural, Industrial and Domestic.
- ✓ Water Management Plan / System. Water Resources Inventory. Groundwater bodies definition (WFD).
- ✓ The evaluation of different development scenarios
- ✓ The determination of optimal measures / projects in conditions of extreme events (droughts of floods)
- ✓ The capability of dynamic water resources management in short time steps (e.g. 1 month) and the optimal use of water resources
- ✓ The optimal planning development and water projects
- ✓ Reuse of treated effluent water for irrigation

Grundtvig-Project
Water and Life

THANK YOU

ΕΛΓΟ ΔΗΜΗΤΡΑ
ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ & ΥΠΟΤΡΟΠΙΚΩΝ ΦΥΤΩΝ

ΔΗΜΟΣ ΑΠΟΚΟΡΩΝΟΥ

ΓΔ Εκπαίδευση και πολιτισμός
Πρόγραμμα διά βίου μάθηση

ΕΣΠΕΡΙΔΑ
Ορθολογική Διαχείριση του Νερού Άρδευσης στις Καλλιέργειες

Ο.Α.ΔΥ.Κ
ΟΡΓΑΝΙΣΜΟΣ ΑΝΑΠΤΥΞΗΣ ΔΥΤΙΚΗΣ ΚΡΗΤΗΣ
Πρόγραμμα Εταιρικής Κοινωνικής Ευθύνης

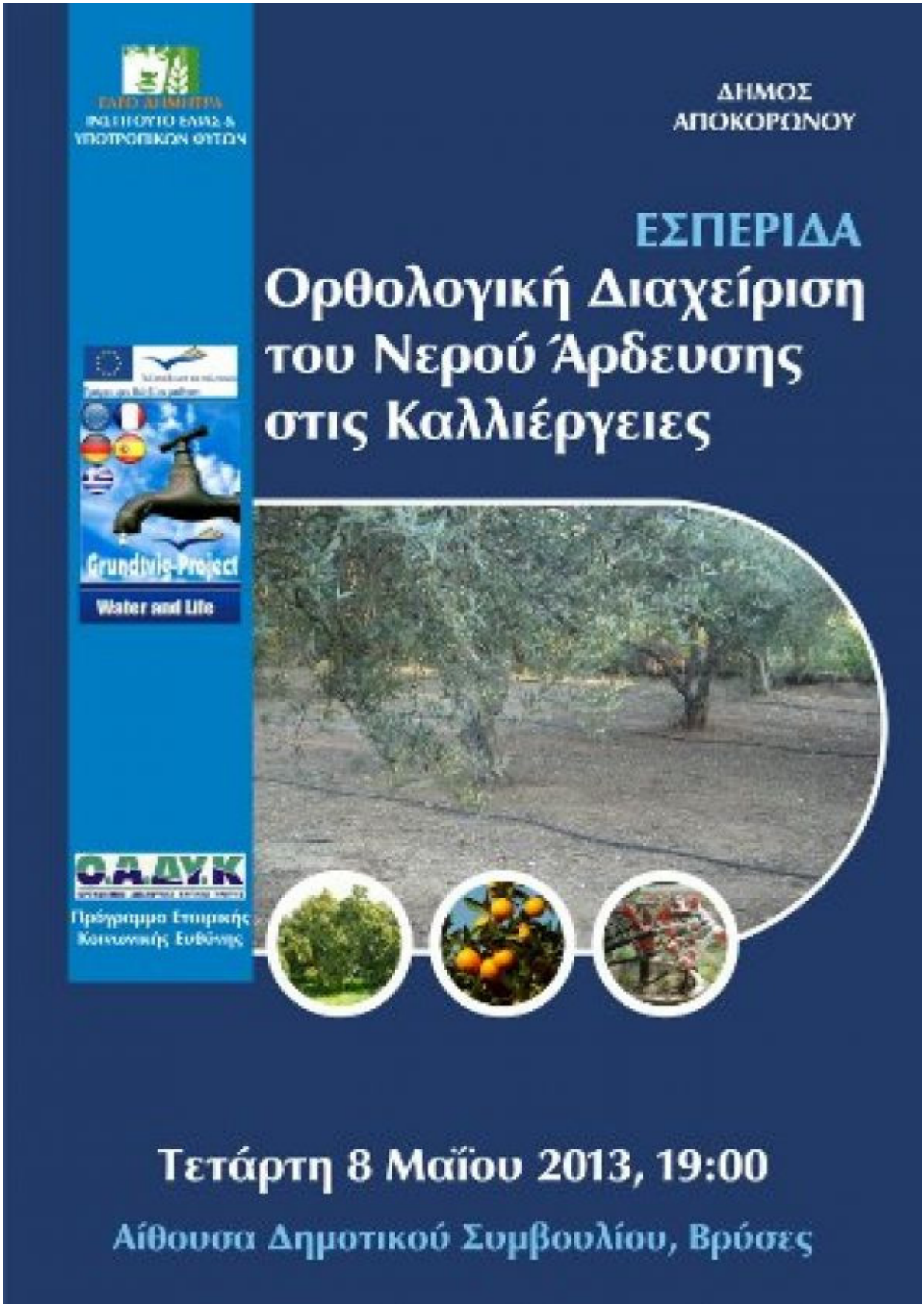
Τετάρτη 8 Μαΐου 2013, 19:00

Αίθουσα Δημοτικού Συμβουλίου, Βρύσες

Εσπερίδα για τη διαχείριση του νερού άρδευσης

| Εκτύπωση |

Δημοσιεύτηκε Τρίτη, 07 Μαΐου 2013



Εσπερίδα για την ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες θα πραγματοποιηθεί την Τετάρτη 8 Μαΐου 2013, στις 19:00 στην Αίθουσα του Δημοτικού Συμβουλίου, στις Βρύσες Αποκορώνου. Το πρόγραμμα περιλαμβάνει τους χαιρετισμούς καθώς και τα θέματα:

19:30: Άρδευση: Έργα υποδομής - Κόστος διαχείρισης

Γιάννης Μπατζέλης, Γενικός Διευθυντής ΟΑΔΥΚ

19:50: Άρδευση των καλλιεργειών - Ανάγκες σε νερό

Κ. Χαρτζουλάκης, Ινστιτούτο Ελιάς & Υποτροπικών

20:10: Σχεδιασμός/λειτουργία συστημάτων τοπικής άρδευσης

Μ. Μπερτάκη, Ινστιτούτο Ελιάς & Υποτροπικών

20:30: Χρήση υποβαθμισμένων νερών στη γεωργία

Γ. Ψαρράς, Ινστιτούτο Ελιάς & Υποτροπικών

20:50: Ερωτήσεις – Συζήτηση

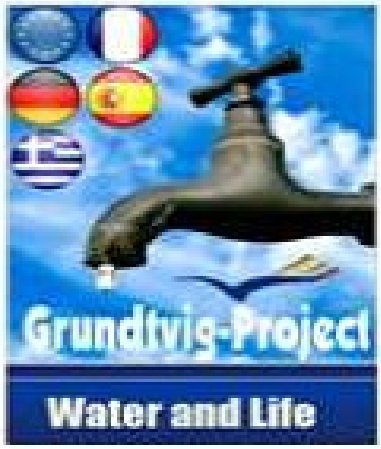
ΔΗΜΟΣ ΑΠΟΚΟΡΩΝΑ

ΔΗΜΟΣ ΑΠΟΚΟΡΩΝΑ

HELLENIC AGRICULTURAL ORGANIZATION - DEMETER
DIRECTORATE GENERAL OF AGRICULTURAL RESEARCH
N.AG.RE.F.

ΓΔ Εκπαίδευση και πολιτισμός
Πρόγραμμα δια βίου μάθησης GRUNDTVIG

EU Project GRUNDTVIG 'WATER and LIFE'



PROGRAMME

4th Project meeting

October 30th to November 1st, 2012 Chania, Crete, Greece

Institute for Olive Tree & Subtropical Plants

ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ &
ΥΠΟΤΡΟΠΙΚΩΝ ΦΥΤΩΝ

ΓΔ Εκπαίδευση και πολιτισμός
Πρόγραμμα δια βίου μάθησης GRUNDTVIG

ΠΡΟΣΚΛΗΣΗ

Grundtvig-Project
Water and Life

Το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων σας προσκαλεί
στην Ημερίδα για τη διαχείριση του νερού και την ευαισθητοποίηση του κοινού,
η οποία θα πραγματοποιηθεί την Πέμπτη 1 Νοεμβρίου 2012, στις 9:30 π.μ.
στην Αίθουσα "Νίκος Ψυλλάκης" του Ινστιτούτου,
στα πλαίσια του έργου "Water and Life",
του Προγράμματος δια βίου μάθησης Grundtvig της Ε.Ε.

Ο Δ/ντής του Ινστιτούτου

Δρ. Κων/νος Χαριτζουλάκης

Σάββατο, 03 Νοεμβρίου, 2012 | 17:35

Like 21,643 people like this.

Ημερίδα για το νερό στο Ινστιτούτο Ελιάς και Υποτροπικών Φυτών

Ημερίδα για τη διαχείριση του νερού και την ευαισθητοποίηση του κοινού έγινε στο Ινστιτούτο Ελιάς και Υποτροπικών Φυτών την Πέμπτη 1/11/2012 στα πλαίσια της 4ης συνάντησης του έργου 'Water and Life' του προγράμματος δια βίου μάθηση Grundtvig. Στο έργο συμμετέχουν πανεπιστήμια, ερευνητικά ινστιτούτα, φορείς διαχείρισης νερού και δήμοι από την Γερμανία, Ισπανία, Γαλλία, Ελλάδα και Κύπρο. Την ημερίδα παρακολούθησαν εκπρόσωποι των Δήμων, των ΔΕΥΑ, του ΟΑΔΥΚ, του ΜΑΙΧ, του ΤΕΙ Κρήτης και των ΤΟΕΒ.

Ο Δ/ντής του Ινστιτούτου Δρ. Κ. Χαρτζουλάκης καλωσορίζοντας τους συμμετέχοντες τόνισε ότι το νερό είναι ζωτικής σημασίας για όλες τις μορφές ζωή και αν λάβουμε υπόψη την τάση αύξησης του πληθυσμού της γης και τις κλιματικές αλλαγές, η επάρκεια νερού, τόσο σε επίπεδο ποιότητας όσο και ποσότητας, θα είναι σε κρίσιμο σημείο στο μέλλον για τις περισσότερες χώρες. Η αειφορική διαχείριση του νερού και η ευαισθητοποίηση των χρηστών στην ορθολογική χρήση του είναι ένα παγκόσμιο ζητούμενο. Το πρόγραμμα στοχεύει στην ανάπτυξη και εφαρμογή δράσεων για την ευαισθητοποίηση των χρηστών σε θέματα διαχείρισης του νερού, ενισχύοντας την επικοινωνία μεταξύ των φορέων διαχείρισης και του κοινού και ενημερώνοντας για τις ορθές πρακτικές χρήσης (στην ύδρευση, την γεωργία και το περιβάλλον) ώστε να αντιμετωπιστούν οι προκλήσεις του μέλλοντος σχετικά με το νερό (ποιότητα, διαθεσιμότητα, χρήση).

Στην ημερίδα η γεωπόνος Μ. Μπερτάκη από το Ινστιτούτο αναφέρθηκε στην διαχείριση του νερού άρδευσης στην Κρήτη και τις δυνατότητες εξοικονόμησης νερού με σωστή άρδευση. Ο καθηγητής το Ανοικτού Πανεπιστημίου του Schrobenhausen της Γερμανία κ. B. Bickel τόνισε ότι το νερό είναι κοινωνικό αγαθό και δεν πρέπει να γίνεται αντικείμενο οικονομικής εκμετάλλευσης και αναφέρθηκε στις αντικρουόμενες απόψεις που συζητούνται στην Γερμανία για την ιδιωτικοποίηση ή μη του νερού δίνοντας ως παραδείγματα την αποτυχία τέτοιων προγραμμάτων στην Αγγλία, το Παρίσι, αλλά την Αργεντινή. Ο καθηγητής του Πανεπιστημίου της Granada τη Ισπανίας τόνισε ότι πάνω από το 78% του νερού καταναλώνει ο αγροτικός τομέας και τα τελευταία χρόνια έχει γίνει μεγάλη οικονομία νερού λόγω της εφαρμογής των διαχειριστικών σχεδίων ανά περιοχή. Ο σύμβουλος του Δήμου Αγίου Αθανασίου της Κύπρου τόνισε ότι η Κύπρος λόγω ανεξέλεγκτης διαχείρισης έχει προβλήματα αναπλήρωσης του υπόγειου υδροφορέα, και για αυτό έχει κατασκευάσει πολλά φράγματα, που όμως λόγω κλιματικών αλλαγών δεν γεμίζουν. Για να λύσει το πρόβλημα επάρκειας έχει κατασκευάσει 4 εργοστάσια αφαλάτωσης, με αυξημένο κόστος παραγωγής.

Ο κ. Ε. Μαυράκης από την Δ/νση Υδάτων της Περιφέρειας Κρήτης αναφέρθηκε στα προβλήματα που δημιουργεί στην διαχείριση του νερού στη Κρήτη η καθυστέρηση εφαρμογής της Οδηγίας 60/2000 για το Νερό και η πολυδιάσπαση αρμοδιοτήτων ενώ ο κ. Μ. Δρετάκης από το Μουσείο Φυσικής Ιστορίας αναφέρθηκε στο ρόλο του νερού στη διατήρηση των φυσικών οικοσυστημάτων της βιοποικιλότητας. Τέλος ο Δρ. Γ. Ψαρράς αναφέρθηκες στις δυνατότητες επαναχρησιμοποίησης των υγρών επεξεργασμένων εκροών για άρδευση των καλλιεργειών και τόνισε ότι όταν χρησιμοποιηθούν σύμφωνα με τις υπάρχουσες προδιαγραφές μπορεί να παράγονται καλής ποιότητας και ασφαλή αγροτικά προϊόντα, εξοικονομώντας νερό καλής ποιότητας για άλλες χρήσεις

Μοιράστε το

Παρασκευή, 02 Νοεμβρίου 2012 17:33

Η σωστή διαχείριση θα λύσει το πρόβλημα του νερού στην Κρήτη

Ημερίδα για τη διαχείριση του νερού και την ευαισθητοποίηση του κοινού πραγματοποιήθηκε χτες στο Ινστιτούτο Ελιάς και Υποτροπικών Φυτών στα πλαίσια της 4ης συνάντησης του έργου *Water and Life* του προγράμματος δια βίου μάθηση Grundtvig. Στο έργο συμμετέχουν πανεπιστήμια, ερευνητικά ινστιτούτα, φορείς διαχείρισης νερού και δήμοι από την Γερμανία, Ισπανία, Γαλλία, Ελλάδα και Κύπρο. Την ημερίδα παρακολούθησαν εκπρόσωποι των Δήμων, των ΔΕΥΑ, του ΟΑΔΥΚ, του ΜΑΙΧ, του ΤΕΙ Κρήτης και των ΤΟΕΒ.

Ο Δ/ντής του Ινστιτούτου Δρ. Κ. Χαρτζουλάκης καλωσορίζοντας τους συμμετέχοντες τόνισε ότι το νερό είναι ζωτικής σημασίας για όλες τις μορφές ζωή και αν λάβουμε υπόψη την τάση αύξησης του πληθυσμού της γης και τις κλιματικές αλλαγές, η επάρκεια νερού, τόσο σε επίπεδο ποιότητας όσο και ποσότητας, θα είναι σε κρίσιμο σημείο στο μέλλον για τις περισσότερες χώρες.

Η αειφορική διαχείριση του νερού και η ευαισθητοποίηση των χρηστών στην ορθολογική χρήση του είναι ένα παγκόσμιο ζητούμενο. Το πρόγραμμα στοχεύει στην ανάπτυξη και εφαρμογή δράσεων για την ευαισθητοποίηση των χρηστών σε θέματα διαχείρισης του νερού, ενισχύοντας την επικοινωνία μεταξύ των φορέων διαχείρισης και του κοινού και ενημερώνοντας για τις ορθές πρακτικές χρήσης (στην ύδρευση, την γεωργία και το περιβάλλον) ώστε να αντιμετωπιστούν οι προκλήσεις του μέλλοντος σχετικά με το νερό (ποιότητα, διαθεσιμότητα, χρήση).

Στην ημερίδα η γεωπόνος Μ. Μπερτάκη από το Ινστιτούτο αναφέρθηκε στην διαχείριση του νερού άρδευσης στην Κρήτη και τις δυνατότητες εξοικονόμησης νερού

με σωστή άρδευση. Ο καθηγητής το Ανοικτού Πανεπιστημίου του Schrobenhausen της Γερμανία κ. B. Bickel τόνισε ότι το νερό είναι κοινωνικό αγαθό και δεν πρέπει να γίνεται αντικείμενο οικονομικής εκμετάλλευσης και αναφέρθηκε στις αντικρουόμενες απόψεις που συζητούνται στην Γερμανία για την ιδιωτικοποίηση ή μη του νερού δίνοντας ως παραδείγματα την αποτυχία τέτοιων προγραμμάτων στην Αγγλία, το Παρίσι, αλλά την Αργεντινή.

Ο καθηγητής του Πανεπιστημίου της Granada τη Ισπανίας τόνισε ότι πάνω από το 78% του νερού καταναλώνει ο αγροτικός τομέας και τα τελευταία χρόνια έχει γίνει μεγάλη οικονομία νερού λόγω της εφαρμογής των διαχειριστικών σχεδίων ανά περιοχή. Ο σύμβουλος του Δήμου Αγίου Αθανασίου της Κύπρου τόνισε ότι η Κύπρος λόγω ανεξέλεγκτης διαχείρισης έχει προβλήματα αναπλήρωσης του υπόγειου υδροφορέα, και για αυτό έχει κατασκευάσει πολλά φράγματα, που όμως λόγω κλιματικών αλλαγών δεν γεμίζουν. Για να λύσει το πρόβλημα επάρκειας έχει κατασκευάσει 4 εργοστάσια αφαλάτωσης, με αυξημένο κόστος παραγωγής.

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Σχολιάστε

Προσθήκη κοινωνικής δικτύωσης Facebook

Σημαντικά συμπεράσματα για τη διαχείριση των υδάτινων πόρων σε ημερίδα του Ινστιτούτου Ελιάς και Υποτροπικών Φυτών Χανίων (2/11/2012 17:37)

Σημαντικά συμπεράσματα, για την διαχείριση των υδάτινων πόρων μεταξύ των οποίων και τις δυνατότητες επαναχρησιμοποίησης των υγρών επεξεργασμένων εκροών για άρδευση των καλλιεργειών, αναφέρθηκαν κατά την διάρκεια ημερίδας για τη διαχείριση του νερού και την ευαισθητοποίηση του κοινού, έγινε στο Ινστιτούτο Ελιάς και Υποτροπικών Φυτών την Πέμπτη 1/11/2012.

Η ημερίδα διοργανώθηκε στα πλαίσια της 4ης συνάντησης του έργου 'Water and Life' του προγράμματος δια βίου μάθηση Grundtvig. Στο έργο συμμετέχουν πανεπιστήμια, ερευνητικά ινστιτούτα, φορείς διαχείρισης νερού και δήμοι από την Γερμανία, Ισπανία, Γαλλία, Ελλάδα και Κύπρο. Την ημερίδα παρακολούθησαν εκπρόσωποι των Δήμων, των ΔΕΥΑ, του ΟΑΔΥΚ, του ΜΑΙΧ, του ΤΕΙ Κρήτης και των ΤΟΕΒ.

Ο Δ/ντής του Ινστιτούτου Δρ. Κ. Χαρτζουλάκης καλωσορίζοντας τους συμμετέχοντες τόνισε ότι το νερό είναι ζωτικής σημασίας για όλες τις μορφές ζωή και αν λάβουμε υπόψη την τάση αύξησης του πληθυσμού της γης και τις κλιματικές αλλαγές, η επάρκεια νερού, τόσο σε επίπεδο ποιότητας όσο και ποσότητας, θα είναι σε κρίσιμο σημείο στο μέλλον για τις περισσότερες χώρες. Η αειφορική διαχείριση του νερού και η ευαισθητοποίηση των χρηστών στην ορθολογική χρήση του είναι ένα παγκόσμιο ζητούμενο. Το πρόγραμμα στοχεύει στην ανάπτυξη και εφαρμογή δράσεων για την ευαισθητοποίηση των χρηστών σε θέματα διαχείρισης του νερού, ενισχύοντας την επικοινωνία μεταξύ των φορέων διαχείρισης και του κοινού και ενημερώνοντας για τις ορθές πρακτικές χρήσης (στην ύδρευση, την γεωργία και το περιβάλλον) ώστε να αντιμετωπιστούν οι προκλήσεις του μέλλοντος σχετικά με το νερό (ποιότητα, διαθεσιμότητα, χρήση).

Στην ημερίδα η γεωπόνος Μ. Μπερτάκη από το Ινστιτούτο αναφέρθηκε στην διαχείριση του νερού άρδευσης στην Κρήτη και τις δυνατότητες εξοικονόμησης νερού με σωστή άρδευση. Ο καθηγητής το Ανοικτού Πανεπιστημίου του Schrobenhausen της Γερμανία κ. B. Bickel τόνισε ότι το νερό είναι κοινωνικό αγαθό και δεν πρέπει να γίνεται αντικείμενο οικονομικής εκμετάλλευσης και αναφέρθηκε στις αντικρουόμενες απόψεις που συζητούνται στην Γερμανία για την ιδιωτικοποίηση ή μη του νερού δίνοντας ως παραδείγματα την αποτυχία τέτοιων προγραμμάτων στην Αγγλία, το Παρίσι, αλλά την Αργεντινή. Ο καθηγητής του Πανεπιστημίου της Granada τη Ισπανίας τόνισε ότι πάνω από το 78% του νερού καταναλώνει ο αγροτικός τομέας και τα τελευταία χρόνια έχει γίνει μεγάλη οικονομία νερού λόγω της εφαρμογής των διαχειριστικών σχεδίων ανά περιοχή. Ο σύμβουλος του Δήμου Αγίου Αθανασίου της Κύπρου τόνισε ότι η Κύπρος λόγω ανεξέλεγκτης διαχείρισης έχει προβλήματα αναπλήρωσης του υπόγειου υδροφορέα, και για αυτό έχει κατασκευάσει πολλά φράγματα, που όμως λόγω κλιματικών αλλαγών δεν γεμίζουν. Για να λύσει το πρόβλημα επάρκειας έχει κατασκευάσει 4 εργοστάσια αφαλάτωσης, με αυξημένο κόστος παραγωγής.

Ο κ. Ε. Μαυράκης από την Δ/νση Υδάτων της Περιφέρειας Κρήτης αναφέρθηκε στα προβλήματα που δημιουργεί στην διαχείριση του νερού στη Κρήτη η καθυστέρηση εφαρμογής της Οδηγίας 60/2000 για το Νερό και η πολυδιάσπαση αρμοδιοτήτων ενώ ο κ. Μ. Δρετάκης από το Μουσείο Φυσικής Ιστορίας αναφέρθηκε στο ρόλο του νερού στη διατήρηση των φυσικών οικοσυστημάτων της βιοποικιλότητας. Τέλος ο Δρ. Γ. Ψαρράς αναφέρθηκες στις δυνατότητες επαναχρησιμοποίησης των υγρών επεξεργασμένων εκροών για άρδευση των καλλιεργειών και τόνισε ότι όταν χρησιμοποιηθούν σύμφωνα με τις υπάρχουσες προδιαγραφές μπορεί να παράγονται καλής ποιότητας και ασφαλή αγροτικά προϊόντα, εξοικονομώντας νερό καλής ποιότητας για άλλες χρήσεις.

Επιστροφή

ΜΕ ΣΩΣΤΗ ΔΙΑΧΕΙΡΙΣΗ

Μεγάλες δυνατότητες εξοικονόμησης νερού

» Παρουσίαση προτάσεων σε ημερίδα του Ινστιτούτου Ελιάς και Υποτροπικών Φυτών

ΔΗΜΗΤΡΗΣ ΜΑΡΙΔΑΚΗΣ
dmaridakis@yahoo.gr

Πάνω από 12 εκατ. κυβικά μέτρα νερού, που ισοδυναμούν με δύο φράγματα Βαλσαμιώτη, μπορούν να εξοικονομηθούν με ελάχιστα χρήματα μέσα από εφαρμογές ορθολογικής διαχείρισης των υδάτινων πόρων που αξιοποιούνται για την άρδευση.

Στιγμιότυπο από τη συνάντηση που πραγματοποιήθηκε χθες στο Ινστιτούτο Ελιάς και Υποτροπικών Φυτών.

Μάλιστα, σύμφωνα με πειραματικές εφαρμογές που έχει υλοποιήσει το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών σε υδροβόρες καλλιέργειες, όπως το αβοκάντο, η εξοικονόμηση νερού που χρησιμοποιείται για πότισμα μπορεί να αγγίξει έως και το 20%.

Τα παραπάνω επισημάνθηκαν, μεταξύ άλλων, στην ημερίδα που διοργανώθηκε στο πλαίσιο του ευρωπαϊκού προγράμματος Grundtvig με τίτλο "Νερό και Ζωή", η οποία πραγματοποιήθηκε στις εγκαταστάσεις του Ινστιτούτου Ελιάς και Υποτροπικών Φυτών.

Στο πρόγραμμα, που συμμετέχουν εκτός από το Ινστιτούτο, το Ανοιχτό Πανεπιστήμιο της Γερμανίας, το Πανεπιστήμιο Γρανάδας της Ισπανίας, το Πανεπιστήμιο της Κορσικής Pascal Paoli και ο Δήμος Άγιος Αθανάσιος από την Κύπρο, ανταλλάσσονται απόψεις και τεχνογνωσία γύρω από την αντιμετώπιση των προβλημάτων που σχετίζονται με το νερό, με απώτερο στόχο την ευαισθητοποίηση των χρηστών του νερού.

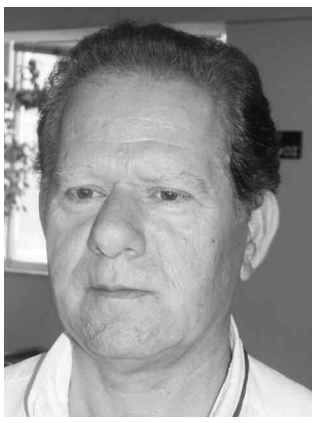
ΑΠΛΕΣ ΠΡΑΚΤΙΚΕΣ - ΣΗΜΑΝΤΙΚΑ ΑΠΟΤΕΛΕΣΜΑΤΑ

Ιδιαίτερη αίσθηση πάντως προκαλούν τα ερευνητικά αποτελέσματα του Ινστιτούτου Ελιάς και Υποτροπικών Φυτών τα οποία επικεντρώθηκαν στο θέμα της διαχείρισης του νερού για άρδευση, καθώς προέκυψε ότι μπορούν να εξοικονομηθούν πολύ μεγάλες ποσότητες με ελάχιστο κόστος.

Ειδικότερα, όπως ανέφερε ο διευθυντής του Ινστιτούτου Ελιάς και Υποτροπικών Φυτών Κώστας Χαρτζουλάκης μιλώντας στα "Χ.Ν.", τα Χανιά έχουν υπερεπάρκεια υδατικών πόρων αλλά το πρόβλημα εντοπίζεται στη διαχείρισή του ειδικά στη γεωργία, η οποία καταναλώνει πάνω από το 80% των συνολικών ποσοτήτων νερού που αξιοποιείται.

«Από τις μελέτες που έχουμε κάνει σε πραγματικό επίπεδο και όχι θεωρητικά, όπως για παράδειγμα στο πρόγραμμα "Beware" στο οποίο εφαρμόσαμε συμβουλευτική άρδευση στην περιοχή Βαρυπέτρου αλλά και στη Μεσαρά, που είναι μια περιοχή ελλειμματική σε νερό, είδαμε ότι αν συμβουλεύουμε τον αγρότη το πώς και πότε πρέπει να ποτίσει, μπορούμε να εξοικονομήσουμε 9,5% σε καλλιέργειες όπως η ελιά η οποία δεν θέλει πολύ νερό, αλλά μέχρι και 20% σε καλλιέργειες υδροβόρες όπως το αβοκάντο», σημείωσε σχετικά ο κ. Χαρτζουλάκης και πρόσθεσε: «Αυτό σημαίνει ότι δεδομένου ότι ο Νομός Χανίων καταναλώνει 110 - 120 εκατ. κυβικά νερό τον χρόνο για άρδευση, αν εμείς πετύχουμε με συμβουλευτική άρδευση να εξοικονομήσουμε μόνο το 10% για παράδειγμα, τότε 10 με 12 εκατ. κυβικά μέτρα νερό καλής ποιότητας που πηγαίνει ετησίως στη γεωργία, θα μπορεί να αξιοποιηθεί για άλλες ανάγκες. Δηλαδή θα εξοικονομήσουμε ποσότητες όσο δύο φράγματα Βαλσαμιώτη με πολύ ελάχιστα χρήματα».

Μάλιστα ο κ. Χαρτζουλάκης επεσήμανε ότι σε περίπτωση που οι ορθολογικές πρακτικές άρδευσης εφαρμοστούν σε παγκρήτιο επίπεδο τότε τα οφέλη θα είναι πολύ μεγάλα, αφού από τα περίπου 320 - 340 εκατ. κυβικά μέτρα νερού που καταναλώνονται για άρδευση (επί συνόλου 420 εκατ. κυβικών μέτρων νερού που υπολογίζεται η κατανάλωση μαζί την ύδρευση και άλλες χρήσεις) είναι δυνατόν να εξοικονομηθούν περίπου 35 εκατ. κυβικά μέτρα νερού με ελάχιστα χρήματα.



Στις δυνατότητες εξοικονόμησης μεγάλων ποσοτήτων νερού από την ορθολογική διαχείριση στον τομέα της άρδευσης, αναφέρθηκε ο διευθυντής του Ινστιτούτου Κώστας Χαρτζουλάκης.

«Αυτό πρέπει να καταλάβουν αυτοί που παίρνουν αποφάσεις. Αντιλαμβάνεστε τι περιθώρια εξοικονόμησης νερού έχουμε για να πάει για άλλες χρήσεις ιδιαίτερα τις κρίσιμες περιόδους», τόνισε ο διευθυντής του Ινστιτούτου και σχολίασε: «Βέβαια αυτό δεν πουλάει. Δεν έχει εγκαίνια κ.λπ. αλλά έχει όμως πρακτική εφαρμογή. Και για να μην παρεξηγηθώ δεν είμαι αντίθετος με τα φράγματα και σίγουρα πρέπει να γίνουν εκεί που πρέπει και υπάρχουν ανάγκες. Αλλά σήμερα παγκοσμίως στα μεγάλα φράγματα, λόγω του μεγάλου οικονομικού και περιβαλλοντικού κόστους, δεν ενδιαφέρεται κανείς πλέον ακόμα και ιδιωτικές εταιρείες να επενδύσουν σε τέτοια έργα. Αυτό λοιπόν που χρειάζεται είναι να σταματήσουμε να ψάχνουμε πολύ εξελιγμένες πρακτικές και να εφαρμόσουμε στο χωράφι την ήδη υπάρχουσα γνώση. Να εκπαιδεύσουμε τον αγρότη και τους φορείς που διαχειρίζονται το νερό τι σημαίνει ορθολογική διαχείριση και αφετέρου να στηρίξουμε αυτούς τους ανθρώπους».

ANASTASAKIS TRAVEL
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ΓΙΑ ΚΥΠΡΟ
25/11 ΜΕ 29/11
ΑΠΕΥΘΕΙΑΣ ΧΑΝΙΑ-ΠΑΦΟ
ΓΥΡΟΣ ΤΟΥ ΝΗΣΙΟΥ
ΗΜΙΔΙΑΤΡΟΦΗ, ΕΙΣΙΤΗΡΙΑ, ΞΕΝΑΓΗΣΕΙΣ
ΠΛΗΡΟΦΟΡΙΕΣ
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ΕΚΔΡΟΜΕΣ
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2. 4/11 Ημερήσια μονή Αγ. ΑΝΑΣΤΑΣΙΑΣ, ΠΑΤΣΟΣ, ΦΡΑΓΜΑ ΠΟΤΑΜΩΝ
3. 12-18/11 ΚΑΡΠΕΝΗΣΙ, ΙΩΑΝΝΙΝΑ, ΖΑΓΟΡΟΧΩΡΙΑ, ΛΕΥΚΑΔΑ 300€ ημιδιατροφή-δεκτά δελτία ΟΓΑ
4. 8/11 Ημερήσια ΑΡΑΔΑΙΝΑ Μιχαήλ Αρχαγγέλου
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Α.Σ. ΠΡΩΗΝ ΔΗΜΟΥ ΑΡΜΕΝΩΝ

"Οχι" ιδιώτες στο νερό

"Οχι" στην ιδιωτικοποίηση των νερών λέει με χθεσινή ανακοίνωσή του ο Αγροτικός Σύλλογος πρώην Δήμου Αρμένων. Αφορμή για την ανακοίνωση ήταν η εσπερίδα για την ορθολογική διαχείριση του νερού άρδευσης που οργάνωσε ο Δήμος Χανίων σε συνεργασία με το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών. Χθες, ο Αγροτικός Σύλλογος πρώην Δήμου Αρμένων κοινοποίησε το κείμενο της παρέμβασής του στην εσπερίδα και μεταξύ άλλων υπογράμμισε: «Η οδηγία 60/2000 της Ε.Ε., που πέρασε και στην ελληνική νομοθεσία, βάζει σε προτεραιότητα την εξοικονόμηση της ζήτησης νερού σε αντιπαράθεση με τη μεγιστοποίηση της προσφοράς. Ετσι, δεν εστιάζει σε νέα τεχνικά έργα και στις πολιτικές εμπλουτισμού των υπόγειων και επίγειων υδροφορέων, ούτε στην αναγκαιότητα προστασίας των δασών που συγκρατούν το νερό». Προσθέτει δε ότι «με το πρόσχημα της προστασίας του υδατικού περιβάλλοντος μεθοδεύεται αύξηση της τιμής του νερού, ιδιαίτερα στον αγροτικό τομέα. Αυτό απαιτούν οι μεγαλοκεφαλαιούχοι για να "βάλουν στο χέρι" και το νερό».

ΧΑΝΙΩΤΙΚΑ ΝΕΑ | Παρασκευή 9 Νοεμβρίου 2012

Τ.Ο.Ε.Β. ΒΑΡΥΠΕΤΡΟΥ: "Οχι" στην ιδιωτικοποίηση των νερών

Την αντίθεσή του με το ενδεχόμενο ιδιωτικοποίησης της διαχείρισης των νερών, εκφράζει με χθεσινή ανακοίνωσή του ο Τοπικός Οργανισμός Εγγείων Βελτιώσεων (ΤΟΕΒ) Βαρυπέτρου.

Παράλληλα κάνει αναφορά σε πρόσφατες δράσεις και συζητήσεις σε τοπικό αλλά και διεθνές επίπεδο, αναφορικά με το σημαντικό θέμα της διαχείρισης των νερών. Αναλυτικά στην ανακοίνωση του ο Τ.Ο.Ε.Β. Βαρυπέτρου αναφέρει:

«Στις 30/10/2012, κλιμάκιο από αντιπροσωπίες 4 ευρωπαϊκών χωρών, με διακεκριμένους καθηγητές πανεπιστημίων, επισκέφθηκε τον Τ.Ο.Ε.Β Βαρύπετρου στην Αγιά στο πλαίσιο του ευρωπαϊκού προγράμματος "Νερό και Ζωή".

Ο Πρόεδρος του Οργανισμού Παύλος Γιαννικάκης, ενημέρωσε την αντιπροσωπία για τον τρόπο λειτουργίας του Οργανισμού, τονίζοντας ότι οι παραγωγοί χρησιμοποιούν στάγδην άρδευση εξοικονομώντας έτσι το 50% του νερού, ότι είναι ένα κοινωνικό αγαθό και όχι προϊόν προς εκμετάλλευση και κερδοσκοπίας, διατίθοντας το σε χαμηλές τιμές.

Θα θέλαμε να ευχαριστήσουμε δια του Τύπου, το Ινστιτούτο Ελιάς & Υποτροπικών Φυτών Χανίων και ειδικότερα τον διευθυντή κ. Χαρτζουλάκη και τους συνεργάτες του, για την διοργάνωση της ημερίδας.

Επίσης την Πέμπτη 01/11/2012, στην ημερίδα παρουσιάστηκαν οι δραστηριότητες του προγράμματος, στην Κρήτη, στη Γερμανία, στην Κορσική, στην Ισπανία, την διαχείριση του νερού στην Κύπρο και διατυπώθηκαν προβληματισμοί και προοπτικές για την εφαρμογή της οδηγίας για το νερό 60/2000 στην Περιφέρεια Κρήτης, όπως και επαναχρησιμοποίηση επεξεργασμένων υγρών αποβλήτων για άρδευση.

Σύμφωνα με τις δραστηριότητες του προγράμματος στην Γερμανία, με ομιλητή τον καθηγητή του ανοιχτού πανεπιστημίου B. Bickel (διδάσκει 600 θεματικές ενότητες που αφορούν το περιβάλλον και την οικολογία) ανέφερε ότι κατά ποσοστό 49% η διαχείριση του νερού στο Βερολίνο ιδιωτικοποιήθηκε, που είχε σαν αποτέλεσμα να αυξηθούν οι τιμές του νερού κατά 30%, να χαθούν 2.000 θέσεις εργασίας και να μειωθεί η ποιότητά του και οι παρεχόμενες υπηρεσίες να υποβαθμιστούν. Επεσήμανε επίσης ότι το Διεθνές Νομισματικό Ταμείο και η Παγκόσμια Τράπεζα ενθαρρύνουν τα κράτη να προχωρήσουν σε ιδιωτικοποιήσεις των υπηρεσιών του Δημοσίου (νερό, μεταφορές, τηλεπικοινωνίες) προβάλλοντας τα διαβόητα προγράμματα αναδιάρθρωσης, φέρνοντας στην πραγματικότητα αντίθετα αποτελέσματα από αυτά που υπόσχονταν, όπως οικονομικά οφέλη, ότι ο ιδιωτικός τομέας είναι πιο ανταγωνιστικός και πιο αποτελεσματικός, ότι θα υπάρχουν καλύτερες παρεχόμενες υπηρεσίες και ότι η χρηματοδότηση του ιδιωτικού φορέα θα έχει σαν αποτέλεσμα την παροχή καθαρού νερού σε προσιτή τιμή για τους περισσότερους ανθρώπους, φέρνοντας παραδείγματα και εκτός συνόρων της Γερμανίας, Μπουένος Αϊρες, Μανίλα, Τζακάρτα, Ατλάντα Ηνωμένων Πολιτειών, Λονδίνο και Μεγάλη Βρετανία που απέτυχε παταγωδώς.

Στο Βερολίνο 600.000 κάτοικοι, αντιτιθέμενοι στην ιδιωτικοποίηση συμμετείχαν σε ένα δημοψήφισμα για διαφάνεια στη διαχείριση του νερού.

Ανοίγεται ένα μεγάλο θέμα, προς συζήτηση και εξεύρεση λύσεων, γνωρίζοντας τις συνέπειες που θα είχε και στην Ελλάδα και ιδιαίτερα στον αγροτικό πληθυσμό, αγνοώντας παντελώς τον ανθρώπινο παράγοντα.

Στο σημείο αυτό επισημαίνουμε ότι όντως, και υπάρχουν κάποιες πληροφορίες από το Υπουργείο Διοικητικής Μεταρρύθμισης και Ηλεκτρονικής Διακυβέρνησης, ότι ετοιμάζεται σχέδιο Νόμου για ιδιωτικοποίηση στη διαχείριση των υδάτων.

Οι Τοπικοί Οργανισμοί Εγγείων Βελτιώσεων ως Κοινωφελείς Οργανισμοί, αυτοσυντήρητοι χωρίς να βαρύνουμε τον κρατικό προϋπολογισμό ούτε ένα ευρώ, είμαστε κάθετα αντίθετοι για τις επιπτώσεις που θα επιφέρει η ιδιωτικοποίηση, αφού είναι ένα αγαθό που θα πρέπει να απολαμβάνεται από όλους και με περισσότερες αρνητικές επιπτώσεις στον αγροτικό πληθυσμό, που τα αγροτικά προϊόντα διατίθενται σε εξευτελιστικές τιμές αν και τις περισσότερες φορές μένουν αδιάθετα, με όλα τα εφόδια να έχουν συνεχείς αυξήσεις. Για τους παραπάνω λόγους προγραμματίζομε σύσκεψη με τους Τ.Ο.Ε.Β του Νομού, αποτρέποντας τη σχεδιαζομένη κατάσταση, έχοντας ως γνώμονα το κοινωνικό συμφέρον και έχοντας συμμάχους και άλλους αρμόδιους φορείς και την κοινωνία».

ΕΛΓΟ ΔΗΜΗΤΡΑ
ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ & ΥΠΟΤΡΟΠΙΚΩΝ ΦΥΤΩΝ

Δήμος Κισάμου

ΓΔ Εκπαίδευση και πολιτισμός
Πρόγραμμα διά βίου μάθηση

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Water and Life

ΕΣΠΕΡΙΔΑ
Ορθολογική Διαχείριση του Νερού Άρδευσης στις Καλλιέργειες

Ο.Α.ΔΥ.Κ
ΟΡΓΑΝΙΣΜΟΣ ΑΝΑΠΤΥΞΗΣ ΔΥΤΙΚΗΣ ΚΡΗΤΗΣ
Πρόγραμμα Εταιρικής Κοινωνικής Ευθύνης

Τετάρτη 22 Μαΐου 2013, 19:00

Αίθουσα Εκδηλώσεων Δήμου Κισσάμου

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17.07.2013 12:08:44

Αναζήτηση

17 ΤΕΤ
Μαρίνα, Μαρίνος, Αλεξάνδρα, Αλέκα, Αλίκη

ΑΡΧΙΚΗ ΕΠΙΚΑΙΡΟΤΗΤΑ ΚΡΗΤΗ ΠΟΛΙΤΕΣ ΕΛΛΑΔΑ ΟΙΚΟΝΟΜΙΑ ΚΟΣΜΟΣ ΑΘΛΗΤΙΣΜΟΣ ΠΟΛΙΤΙΣΜΟΣ ΥΓΕΙΑ ΑΠΟΨΕΙΣ ΕΙΔΑ ΑΚΟΥΣΑ

Απόδημοι Ανάπτυξη / Απασχόληση

Στο επίκεντρο η ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες

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Εκδήλωση πραγματοποιήθηκε στο Δήμο Κισσάμου

Εσπερίδα με θέμα 'Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες' οργάνωσε ο Δήμος Κισάμου, το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων και ο ΟΑΔΥΚ την περασμένη Τετάρτη. Την εσπερίδα χαιρέτησε ο δήμαρχος Κισάμου κ. Γ. Μυλωνάκης τονίζοντας την στήριξη του Δήμου στο πρωτογενή τομέα, ο εκπρόσωπος του ΟΑΔΥΚ κ. Ε. Κοπάσης που τόνισε την συμβολή του ΟΑΔΥΚ στην αξιοποίηση του υδατικού δυναμικού της περιοχής.

Στην εσπερίδα συμμετείχαν δημοτικοί σύμβουλοι, οι πρόεδροι των ΤΟΕΒ Κισάμου και Χρυοσκαλίτισσας και αγρότες.

Στην εσπερίδα ο αντιδήμαρχος Κισάμου κ. Ν. Κουμάκης αναφέρθηκε στις προτεραιότητες και τα έργα που απαιτούνται για την επάρκεια νερού στο Δ. Κισάμου και τόνισε την ανάγκη για ορθολογική διαχείρισή. Ο Δ/ντής του Ινστιτούτου κ. Κ. Χαρτζουλάκης τόνισε ότι το Ινστιτούτο έχει την τεχνογνωσία και μπορεί να συμβάλει στην ορθολογική χρήση του νερού στην γεωργία.

Αναφέρθηκε στα προβλήματα που προκαλεί η υπερ-κατανάλωση νερού, τις ανάγκες σε νερό των κυριότερων καλλιεργειών της περιοχής σε νερό και την αναγκαιότητα σωστής άρδευσης, αφού η κατανάλωση νερού για την παραγωγή ενός προϊόντος αποτελεί στοιχείο ποιότητας μέσω του 'υδατικού αποτυπώματος'.

Η γεωπόνος του Ινστιτούτου κ. Μ. Μπερτάκη αναφέρθηκε στην αναγκαιότητα εγκατάστασης και σωστής λειτουργίας του συστήματος άρδευσης με σταγόνες, και τόνισε ότι η αποτελεσματικότητα χρήσης του νερού μπορεί να φτάσει πάνω από 95%.

Τέλος ο ερευνητής του Ινστιτούτου Δρ. Γ. Ψαρράς αναφέρθηκε στην δυνατότητα χρήσης για άρδευση των καλλιεργειών των επεξεργασμένων υγρών αποβλήτων και παρουσίασε τα αποτελέσματα πειραμάτων του Ινστιτούτου αλλά και της διεθνούς πρακτικής για την παραγωγή ασφαλών και καλής ποιότητας προϊόντων.

Ακολούθησε διαλογική συζήτηση με τους συμμετέχοντες και διάθεση ενημερωτικών φυλλαδίων για την 'Ορθή Αρδευτική Πρακτική' που έχει εκδώσει το Ινστιτούτο..

Κρήτη
Δημοσίευση 26.05.2013 | 20:32 Αναγνώσεις

ΔΕΙΤΕ ΕΠΙΣΗΣ

Επιστολή στον Κυριάκο Μητσοτάκη από το Οικονομικό Επιμελητήριο

«Να σταματήσει ο εμπαιγμός της κυβέρνησης απέναντι στους μαθητές ΕΠΑΛ - ΕΠΑΣ!»

Κοινωνική βοήθεια από τη Λέσχη Lions Ηρακλείου

Εξόρμηση στο Φαράγγι της Σαρακίνας

ΣΧΕΤΙΚΑ ΑΡΘΡΑ

06.07.2013 ▶ Ημερίδα για τις αγροτικές καλλιέργειες

24.06.2013 ▶ Οι επιπτώσεις της κλιματικής αλλαγής

18.06.2013 ▶ «Αποζημιώνονται άμεσα οι αγρότες της Βιάννου για τις καταστροφές από την περσινή πυρκαγιά – Έρχονται και αποζημιώσεις»

17.06.2013 ▶ Χιλιάδες Ελληνόπουλα στράφηκαν στη γεωργία

ΡΟΗ ΕΙΔΗΣΕΩΝ ΔΗΜΟΦΙΛΕΙΣ

Κρήτη : Επιστολή στον Κυριάκο Μητσοτάκη από το Οικονομικό Επιμελητήριο 12:00

Ελλάδα : Οι βρύσες τρέχουν... σκουλήκια! 11:55

Κρήτη : «Να σταματήσει ο εμπαιγμός της κυβέρνησης απέναντι στους μαθητές ΕΠΑΛ - ΕΠΑΣ!» 11:48

Πολιτισμός : Στις Γωνιές Μαλεβιζίου ο Χρήστος Θηβαίος 11:40

Τεχνολογία : Η φύση μας καλεί: Ουρήστε και φορτίστε! 11:37

Αθλητισμός : Σαρρής:«Σταδιακά πρέπει να γίνει μείωση των ομάδων» 11:33

Ελλάδα : Συνελήφθη -ξανά- ο Λάκης Γαβαλάς 11:33

Κρήτη : Αεροδιάδρομος ... με προοπτική στο Καστέλλι - Ζωηρό ενδιαφέρον από πέντε ξένες εταιρείες 11:32

Πλατανιάς : Κοντά σε συμφωνία με Ντολάνο ο Πλατανιάς 11:25

Κρήτη : Κοινωνική βοήθεια από τη Λέσχη Lions Ηρακλείου 11:16

Η ΚΡΗΤΗ ΣΗΜΕΡΑ

Περίπτερο
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ΕΣΠΕΡΙΔΑ ΟΡΘΟΛΟΓΙΚΗΣ ΔΙΑΧΕΙΡΙΣΗΣ ΝΕΡΟΥ ΑΡΔΕΥΣΗΣ

Πραγματοποιήθηκε την Τετάρτη 22/5/2013 στην αίθουσα εκδηλώσεων του Δ. Κισάμου η εσπερίδα 'Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες' που οργάνωσε ο Δήμος Κισάμου, το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων και ο ΟΑΔΥΚ. Την εσπερίδα χαιρέτησε ο δήμαρχος Κισάμου κ. Γ. Μυλωνάκης τονίζοντας την στήριξη του Δήμου στο πρωτογενή τομέα, ο εκπρόσωπος του ΟΑΔΥΚ κ. Ε. Κοπάσης που τόνισε την συμβολή του ΟΑΔΥΚ στην αξιοποίηση του υδατικού δυναμικού της περιοχής. Στην εσπερίδα συμμετείχαν δημοτικοί σύμβουλοι, οι πρόεδροι των ΤΟΕΒ Κισάμου και Χρυοσκαλίτισσας και αγρότες.

Στην εσπερίδα ο αντιδήμαρχος Κισάμου κ. Ν. Κουμάκης αναφέρθηκε στις προτεραιότητες και τα έργα ..
.. που απαιτούνται για την επάρκεια νερού στο Δ. Κισάμου και τόνισε την ανάγκη για ορθολογική διαχείρισή. Ο Δ/ντής του Ινστιτούτου κ. Κ. Χαρτζουλάκης τόνισε ότι το Ινστιτούτο έχει την τεχνογνωσία και μπορεί να συμβάλει στην ορθολογική χρήση του νερού στην γεωργία. Αναφέρθηκε στα προβλήματα που προκαλεί η υπερ-κατανάλωση νερού, τις ανάγκες σε νερό των κυριότερων καλλιεργειών της περιοχής σε νερό και την αναγκαιότητα σωστής άρδευσης, αφού η κατανάλωση νερού για την παραγωγή ενός προϊόντος αποτελεί στοιχείο ποιότητας μέσω του 'υδατικού αποτυπώματος'. Η γεωπόνος του Ινστιτούτου κ. Μ. Μπερτάκη αναφέρθηκε στην αναγκαιότητα εγκατάστασης και σωστής λειτουργίας του συστήματος άρδευσης με σταγόνες, και τόνισε ότι η αποτελεσματικότητα χρήσης του νερού μπορεί να φτάσει πάνω από 95%. Τέλος ο ερευνητής του Ινστιτούτου Δρ. Γ. Ψαρράς αναφέρθηκε στην δυνατότητα χρήσης για άρδευση των καλλιεργειών των επεξεργασμένων υγρών αποβλήτων και παρουσίασε τα αποτελέσματα πειραμάτων του Ινστιτούτου αλλά και της διεθνούς πρακτικής για την παραγωγή ασφαλών και καλής ποιότητας προϊόντων. Ακολούθησε διαλογική συζήτηση με τους συμμετέχοντες και διάθεση ενημερωτικών φυλλαδίων για την 'Ορθή Αρδευτική Πρακτική' που έχει εκδώσει το Ινστιτούτο..

ΚΡΗΤΙΚΑ ΓΛΕΝΤΙΑ! ΠΟΥ ΠΑΙΖΕΙ ΚΑΙ ΠΟΙΟΣ

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Ο ΒΙΑΣΜΟΣ ΤΗΣ ΠΑΡΑΔΟΣΗΣ
. .... στο όνομα του φολκλόρ!!! Αρθρογράφος: Ελένη-Ρεβέκκα Στάιου Το σημερινό θέμα είναι λίγο εξειδικευμένο και ας με συγχωρήσουν οι αν...

ΤΥΠΑΔΕΣ....
Χανιά, 9 Ιουλίου 2013. Στον δρόμο για το Καστέλι αναρωτιόμουνα τι πάω να δω. Το έργο το είχα ξαναδεί πριν από τριάντα τόσα χρόνι...

Ή ΦΕΥΓΕΙΣ Ή ΦΕΡΝΕΙΣ ΤΟ ΔΝΤ Ή ΣΕ ΣΚΟΤΩΝΟΥΜΕ
Συντάχθηκε από τον Κωνσταντίνος Κρανίτης Το έγγραφο 1782/19 Αυγούστου 2009 της Ε.Υ.Π., που αναφέρεται στο περιοδικό Επίκαιρα, επιβεβαιώνει...

Ο ΑΝΤΙΠΡΟΕΔΡΟΣ ΜΑΣ ΤΙΜΗΣΕ....
Εγώ σας το ΄λεγα ότι στο μόνο μέρος που θα μπορούσε να φάει με την ησυχία του (την κακαβιά του) θα ήταν το Καστέλλι ...Έτσι λοιπόν το Σαββα...

ΦΑΛΑΣΑΡΝΑ ΠΑΡΕΛΘΟΝ ΚΑΙ ΜΕΛΛΟΝ
Ο σύλλογος Φίλων Αρχαίας Φαλάσαρνας "Νίκος Κακαουνάκης" σας καλεί στις 10 Ιουλίου και ωρα 21.00 στο πολιτιστικό κέντρο Πλατάνου σ...

ΣΣΣΣΣΣΣ ΚΑΚΙΕΣ.....
Επίθεση Γκούμπλια στον Κισσαμικό! Επίθεση προς τα μέλη της τωρινής διοίκησης του Κισαμικού εξαπέλυσε ο πρώην τεχνικός της ομάδας, Βασίλης ...

ΜΑΥΡΟ ΜΩΛΟΣ
Το λιμάνι της αρχαίας Κισσάμου βρισκόταν δυτικά της σύγχρονης πόλης, στη σημερινή τοποθεσία του Μαύρου Μώλου. Άγνωστο πότε τοποθετήθηκαν οι...

ΤΑ 15 ΩΡΑΙΟΤΕΡΑ ΧΩΡΙΑ ΤΗΣ ΚΡΗΤΗΣ
Στα πρότυπα των γαλλικών και ισπανικών συνδέσμων η Κρήτη αποκτά τα δικά της... όμορφα χωριά! Με κοινή

ΧΑΝΙΩΤΙΚΑ ΝΕΑ | Τρίτη 21 Μαΐου 2013

ΑΠΟ ΤΟ ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ ΧΑΝΙΩΝ

Δελτίο αναγκών νερού άρδευσης των καλλιεργειών

«Δελτίο αναγκών σε νερό άρδευσης των καλλιεργειών» άρχισε να εκδίδει από χθες το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων «προκειμένου να συμβάλει στην ορθολογική χρήση του νερού για την άρδευση των καλλιεργειών». Οπως εξηγεί σε ανακοίνωσή του, το δελτίο θα εκδίδεται κάθε Δευτέρα μέχρι το τέλος της αρδευτικής περιόδου 2013. Στο δελτίο αναφέρονται οι ανάγκες σε νερό των κυριοτέρων καλλιεργειών (ελιά, εσπεριδοειδή και αβοκάντο) για την τρέχουσα εβδομάδα (κ.μ. ανά στρέμμα) στις διάφορες περιοχές του Ν. Χανίων, που το Ινστιτούτο διαθέτει μετεωρολογικούς σταθμούς. Η εκτίμηση των αναγκών γίνεται με τα κλιματικά δεδομένα και τον φυτικό συντελεστή της καλλιέργειας και ο αριθμός δόσεων καθορίζεται από τον τύπο του εδάφους.

Για την περιοχή π.χ. Νεροκούρου οι ανάγκες σε νερό της πορτοκαλιάς είναι 23 κ.μ./στρέμμα και πρέπει να δοθεί σε δύο αρδεύσεις μέσα στην τρέχουσα εβδομάδα (12 κ.μ/στρέμμα) γιατί η υδατοϊκανότητα του εδάφους στο βάθος του ριζικού συστήματος είναι μικρότερη από τα 18 κ.μ./στρέμμα. Αντίθετα για την ελιά στην ίδια περιοχή, που οι ανάγκες είναι 10 κ.μ./στρέμμα, η ποσότητα μπορεί να δοθεί σε μια (1) άρδευση (δόση).

Επισημαίνεται ότι η προτεινόμενες ανάγκες είναι ενδεικτικές και δεν αντικαθιστούν τις ανάγκες που εκτιμούνται σε συγκεκριμένους αγρούς με πραγματικά στοιχεία (σύσταση εδάφους, μικροκλίμα της περιοχής κ.λπ.). Περισσότερες πληροφορίες για τον τρόπο χρήσης της πληροφορίας του δελτίου οι αγρότες μπορούν να επικοινωνούν στα τηλέφωνα 2821083442 και 2821083443 τις εργάσιμες ώρες.

ΠΕΡΙΟΧΗ	ΕΔΑΦΟΣ	ΚΑΛΛΙΕΡΓΕΙΑ								
		ΕΛΙΑ			ΕΣΠΕΡΙΔΟΕΙΔΗ			ΑΒΟΚΑΝΤΟ		
		ΕΛΑΦΡΥ	ΜΕΣΟ	ΒΑΡΥ	ΕΛΑΦΡΥ	ΜΕΣΟ	ΒΑΡΥ	ΕΛΑΦΡΥ	ΜΕΣΟ	ΒΑΡΥ
Δ. ΧΑΝΙΩΝ Νεροκούρου Μουρνιές Περιβόλια	Ανάγκες σε νερό (κ.μ./στρ)	10	10	10	23	23	23	22	22	22
	Αριθμός αρδεύσεων	1	1	1	2	2	2	2	2	2
	Δόση άρδευσης (κ.μ./στρ)	10	10	10	12	12	12	11	11	11
Βαμβακόπουλο Αλικιανός Αντά	Ανάγκες σε νερό (κ.μ./στρ)	8	8	8	19	19	19	18	18	18
	Αριθμός αρδεύσεων	1	1	1	2	1	1	2	1	1
	Δόση άρδευσης (κ.μ./στρ)	8	8	8	10	19	19	9	18	18
Δ. ΠΛΑΤΑΝΙΑ Πλατανιάς Γεράνι Μάλεμε Τσικριτής Κολυμπάρι	Ανάγκες σε νερό (κ.μ./στρ)	8	8	8	20	20	20	19	19	19
	Αριθμός αρδεύσεων	1	1	1	2	1	1	2	1	1
	Δόση άρδευσης (κ.μ./στρ)	8	8	8	10	20	20	10	19	19
Δ. ΚΙΣΣΑΜΟΥ Δραπανιάς Κίσσαμος Φολίσσαρνα Πλάτανος	Ανάγκες σε νερό (κ.μ./στρ)	8	8	8	21	21	21	19	19	19
	Αριθμός αρδεύσεων	1	1	1	2	2	2	2	1	1
	Δόση άρδευσης (κ.μ./στρ)	8	8	8	11	11	11	10	19	19
Δ. ΑΠΟΚΟΡΩΝΑ Στύλος Αρμένοι Κολύβες Βρύσσες Γεωργιούπολη	Ανάγκες σε νερό (κ.μ./στρ)	10	10	10	24	24	24	22	22	22
	Αριθμός αρδεύσεων	1	1	1	2	2	2	2	2	2
	Δόση άρδευσης (κ.μ./στρ)	10	10	10	12	12	12	11	11	11

Οι παραπάνω τιμές είναι ενδεικτικές για κάθε περιοχή.

ΕΣΠΕΡΙΔΑ ΣΤΗΝ ΚΙΣΑΜΟ

"Ορθολογική διαχείριση νερού άρδευσης"

Εσπερίδα για την "Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες" θα πραγματοποιηθεί αύριο, στις 7 μ.μ., στην αίθουσα εκδηλώσεων του Δήμου Κισάμου. Την εσπερίδα οργανώνουν ο Δήμος Κισάμου και το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων.

ΣΤΟ ΝΕΡΟ ΑΡΔΕΥΣΗΣ

Ανάγκη ορθολογικής διαχείρισης

Η ανάγκη ορθολογικής διαχείρισης του νερού άρδευσης στις καλλιέργειες τονίστηκε σε εσπερίδα που πραγματοποιήθηκε στην αίθουσα εκδηλώσεων του Δ. Κισάμου.

Την εσπερίδα οργάνωσαν ο Δήμος Κισάμου, το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων και ο Ο.Α.ΔΥ.Κ.

Οπως αναφέρεται σε ανακοίνωση του Ινστιτούτου Ελιάς, «την εσπερίδα χαιρέτησε ο δήμαρχος Κισάμου κ. Γ. Μυλωνάκης τονίζοντας τη στήριξη του Δήμου στον πρωτογενή τομέα, ο εκπρόσωπος του Ο.Α.ΔΥ.Κ. κ. Ε. Κοπάσης, που τόνισε τη συμβολή του Ο.Α.ΔΥ.Κ. στην αξιοποίηση του υδατικού δυναμικού της περιοχής. Στην εσπερίδα συμμετείχαν δημοτικοί σύμβουλοι, οι πρόεδροι των Τ.Ο.Ε.Β. Κισάμου και Χρυσοσκαλίτισσας και αγρότες.

Στην εσπερίδα ο αντιδήμαρχος Κισάμου κ. Ν. Κουμάκης αναφέρθηκε στις προτεραιότητες και τα έργα που απαιτούνται για την επάρκεια νερού στον Δ. Κισάμου και τόνισε την ανάγκη για ορθολογική διαχείριση. Ο δ/ντής του Ινστιτούτου κ. Κ. Χαρτζουλάκης τόνισε ότι το Ινστιτούτο έχει την τεχνογνωσία και μπορεί να συμβάλει στην ορθολογική χρήση του νερού στη γεωργία. Αναφέρθηκε στα προβλήματα που προκαλεί η υπερ-κατανάλωση νερού, τις ανάγκες σε νερό των κυριότερων καλλιεργειών της περιοχής σε νερό και την αναγκαιότητα σωστής άρδευσης, αφού η κατανάλωση νερού για την παραγωγή ενός προϊόντος αποτελεί στοιχείο ποιότητας μέσω του "υδατικού αποτυπώματος". Η γεωπόνος του Ινστιτούτου κα Μ. Μπερτάκη αναφέρθηκε στην αναγκαιότητα εγκατάστασης και σωστής λειτουργίας του συστήματος άρδευσης με σταγόνες και τόνισε ότι η αποτελεσματικότητα χρήσης του νερού μπορεί να φτάσει πάνω από 95%. Τέλος, ο ερευνητής του Ινστιτούτου δρ Γ. Ψαρράς αναφέρθηκε στη δυνατότητα χρήσης για άρδευση των καλλιεργειών των επεξεργασμένων υγρών αποβλήτων και παρουσίασε τα αποτελέσματα πειραμάτων του Ινστιτούτου, αλλά και της διεθνούς πρακτικής για την παραγωγή ασφαλών και καλής ποιότητας προϊόντων. Ακολούθησε διαλογική συζήτηση με τους συμμετέχοντες και διάθεση ενημερωτικών φυλλαδίων για την "Ορθή Αρδευτική Πρακτική" που έχει εκδώσει το Ινστιτούτο».

ΕΛΓΟ ΔΗΜΗΤΡΑ
ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ & ΥΠΟΤΡΟΠΙΚΩΝ ΦΥΤΩΝ

Δήμος Πλατανιά

Κοινωφελής Επιχείρηση Δ. Πλατανιά

Δ.Ε.Υ.Α.Β.Α.

ΓΔ Εκπαίδευση και πολιτισμός
Πρόγραμμα διά βίου μάθηση

Grundtvig-Project
Water and Life

ΕΣΠΕΡΙΔΑ
Ορθολογική Διαχείριση του Νερού Άρδευσης στις Καλλιέργειες

Ο.Α.ΔΥ.Κ
ΟΡΓΑΝΙΣΜΟΣ ΑΝΑΠΤΥΞΗΣ ΔΥΤΙΚΗΣ ΚΡΗΤΗΣ
Πρόγραμμα Εταιρικής Κοινωνικής Ευθύνης

Ορθόδοξος Ακαδημία Κρήτης
Ινστιτούτο Οικολογίας & Θεολογίας

Τετάρτη 24 Απριλίου 2013, 19:00

Ορθόδοξος Ακαδημία Κρήτης, Κολυμβάρι

Δήμος Πλατανιά

Κοινωφελής
Επιχείρηση
Δ. Πλατανιά

ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ &
ΥΠΟΤΡΟΠΙΚΩΝ ΦΥΤΩΝ

ΠΡΟΣΚΛΗΣΗ

Ο Δήμος Πλατανιά και το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων
σας προσκαλούν στην Εσπερίδα για την
"Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες",
η οποία θα πραγματοποιηθεί την Τετάρτη 24 Απριλίου 2013, στις 19:00
στην Ορθοδοξο Ακαδημία Κρήτης στο Κολυμβάρι

Grundtvig-Project
Water and Life

Ο Δήμαρχος Πλατανιά

Ιωάννης Μαλανδράκης

Ο Δ/ντής του Ινστιτούτου

Δρ. Κων/νος Χαριτζουλάκης

ΧΑΝΙΩΤΙΚΑ ΝΕΑ | Τρίτη 23 Απριλίου 2013

ΜΕ ΤΗΝ ΟΡΘΟΛΟΓΙΚΗ ΔΙΑΧΕΙΡΙΣΗ

Εφικτή η εξοικονόμηση νερού

» Επισημάνσεις με αφορμή εσπερίδα στο Κολυμπάρι

Εφικτή είναι η εξοικονόμηση νερού μέχρι και 20%, εφόσον ακολουθηθούν οι κατάλληλες πρακτικές.

Στιγμιότυπο από τη συνέντευξη Τύπου που παραχώρησαν χθες οι διοργανωτές της αυριανής εσπερίδας.

Η επισήμανση αυτή έγινε χθες σε συνέντευξη Τύπου με αφορμή την αυριανή εσπερίδα, στις 7 μ.μ., στην Ορθόδοξο Ακαδημία Κρήτης, στο Κολυμπάρι, στο επίκεντρο της οποίας θα βρεθούν οι πρακτικές ορθολογικής διαχείρισης του νερού άρδευσης στις καλλιέργειες.

Την εσπερίδα διοργανώνουν ο Δήμος Πλατανιά και η Κοινωφελής Επιχείρηση του Δήμου, το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών, ο Ο.Α.ΔΥ.Κ. και η Ορθόδοξη Ακαδημία.

Στη χθεσινή συνέντευξη, ο δήμαρχος Πλατανιά, Γιάννης Μαλανδράκης, τόνισε ότι η εσπερίδα εντάσσεται στο πλαίσιο της συνεργασίας του Δήμου με το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών για την ορθολογικότερη διαχείριση των υδατικών πόρων από τον πρωτογενή τομέα, όπως επίσης και της προσπάθειας για την καλύτερη δυνατή ενημέρωση των αγροτών σε ό,τι αφορά την καλλιεργητική φροντίδα και την ολοκληρωμένη διαχείριση.

«Επειδή η χρονιά θα είναι μία πολύ ξηρή χρονιά, όπως και γενικότερα -φοβάμαι- τα χρόνια που θα ακολουθήσουν, πρέπει να διαμορφωθεί μία διαφορετική νοοτροπία από αυτή που υπάρχει. Πρέπει να συνειδητοποιήσουν όλοι ότι οι πόροι δεν είναι άπλετοι και ότι ο Δήμος δεν μπορεί να υποστηρίζει κάθε αίτημα για νερό ανεξαρτήτως όγκου και περιόδου. Θέλουμε, λοιπόν, να ευαισθητοποιήσουμε και να ενημερώσουμε τον κόσμο γι' αυτά τα θέματα και πάνω από όλα να υπάρχει ένα πρακτικό αποτέλεσμα για τους αγρότες και για δική τους οικονομία και για τον περιορισμό της σπατάλης των φυσικών πόρων», σημείωσε ο κ. Μαλανδράκης.

Ο διευθυντής του Ινστιτούτου Ελιάς και Υποτροπικών Φυτών κ. Κώστας Χαρτζουλάκης τόνισε ότι με τις κατάλληλες πρακτικές η εξοικονόμηση που μπορεί να επιτευχθεί μπορεί να κυμανθεί από 8 έως 20% ανάλογα με το αν η καλλιέργεια είναι υδροβόρα ή μη.

«Τα στοιχεία δείχνουν ότι θα έχουμε μία δύσκολη χρονιά και κανείς δεν ξέρει πως θα είναι η επόμενη, επομένως πρέπει να υπάρξει μία νέα τακτική στην εφαρμογή των αρδεύσεων», τόνισε ο κ. Χαρτζουλάκης και πρόσθεσε ότι μέσα από τη σωστή χρησιμοποίηση του συστήματος άρδευσης με κλειστούς αγωγούς που εφαρμόζεται υπάρχουν πολύ μεγάλες δυνατότητες αποτελεσματικής αξιοποίησης του νερού που αγγίζουν ακόμα και το 95%.

«Υπάρχουν δηλαδή τεράστιες δυνατότητες με πάρα πολύ λίγα χρήματα», ανέφερε ο κ. Χαρτζουλάκης και συμπλήρωσε ότι παράλληλα στην εσπερίδα θα γίνει, μεταξύ άλλων, και ειδική αναφορά στους τρόπους εκμετάλλευσης των νερών από τους βιολογικούς καθαρισμούς, νερά τα οποία, όπως είπε, πρέπει να αξιοποιηθούν καθώς εντείνονται τα φαινόμενα ξηρασίας.

Από την πλευρά του ο πρόεδρος της Κοινωφελούς Επιχείρησης Δήμου Πλατανιά, Αντώνης Καπνισάκης, αφού αναφέρθηκε στο πρόγραμμα κάλεσε όλους τους γεωργούς - παραγωγούς να δώσουν το "παρών" στην εσπερίδα προκειμένου να ενημερωθούν για τις δυνατότητες ορθολογικής διαχείρισης του νερού άρδευσης στις καλλιέργειες.

ΤΟ ΠΡΟΓΡΑΜΜΑ

Το πρόγραμμα της εσπερίδας έχει ως εξής: Προεδρείο: Ε. Κοπάσης, Κ. Χαρτζουλάκης, Α. Καπνισάκης.

7 μ.μ.: Χαιρετισμοί: δήμαρχος Πλατανιά, δ/ντής Ινστιτούτου, γεν. δ/ντής Ο.Α.ΔΥ.Κ., Ορθόδοξος Ακαδημία Κρήτης.

7.20 μ.μ.: Αρδευση: Εργα υποδομής - Κόστος διαχείρισης, Γιάννης Μπατζέλης, γενικός διευθυντής Ο.Α.ΔΥ.Κ.

7.40 μ.μ.: Αρδευση των καλλιεργειών - Ανάγκες σε νερό, Κ. Χαρτζουλάκης, Ινστιτούτο Ελιάς & Υποτροπικών Φυτών.

8 μ.μ.: Σχεδιασμός - λειτουργία συστημάτων τοπικής άρδευσης, Μ. Μπερτάκη, Ινστιτούτο Ελιάς & Υποτροπικών Φυτών.

8.20 μ.μ.: Χρήση υποβαθμισμένων νερών στη γεωργία, Γ. Ψαρράς, Ινστιτούτο Ελιάς & Υποτροπικών Φυτών.

8.40 μ.μ.: Ερωτήσεις - Συζήτηση.

ΔΗΜ. ΜΑΡ.

Συνάντηση στον Αποκόρωνα

Συνάντηση για το θέμα της έλλειψης νερού διοργανώνει ο Δήμος Αποκορώνου σε συνεργασία με το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών την Τετάρτη 8 Μαΐου, στις 7 μ.μ., στην αίθουσα του Δημοτικού Συμβουλίου στις Βρύσες.

Παρασκευή, 26 Απριλίου, 2013 | 18:13

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Με επιτυχία η εσπερίδα στην ΟΑΚ για την 'Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες'

Πραγματοποιήθηκε με επιτυχία την Τετάρτη 24/4/2013 στην Ορθόδοξο Ακαδημία Κρήτης η εσπερίδα 'Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες' που οργάνωσε η Κοινωφελής Επιχείρηση του Δ. Πλατανιά, το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων, ο ΟΑΔΥΚ και το Ινστιτούτο Θεολογίας και Οικολογίας της ΟΑΚ.

Την εσπερίδα χαιρέτησε ο Δήμαρχος Πλατανιά κ. Ι. Μαλανδράκης τονίζοντας την στήριξη του Δήμου στο πρωτογενή τομέα και την αναγκαιότητα ορθολογικής χρήσης του νερού από όλους τους χρήστες, ο εκπρόσωπος του ΟΑΔΥΚ κ. Ε. Κοπάσης που τόνισε την συμβολή του ΟΑΔΥΚ στην αξιοποίηση του υδατικού δυναμικού της περιοχής και η Δ/τρια της ΟΑΚ κ Λαρενζάκη που τόνισε τη σχέση του νερού με την ζωή και το περιβάλλον.

Στην εσπερίδα συμμετείχαν δημοτικοί σύμβουλοι, ο πρόεδρος του ΤΟΕΒ Αγιάς-Κολυμβαρίου και πολλοί αγρότες.

Στην εσπερίδα ο πρόεδρος της ΚΕΔΗΠ κ. Α. Καπνισάκης αναφέρθηκε στις αλλαγές που έχουν γίνει τα τελευταία 50 χρόνια στην ζήτηση αλλά και τη διαχείριση του νερού ενώ ο κ. Ανδριανός τόνισε ότι το νερό είναι κοινωνικό αγαθό, όχι προϊόν αγοράς και η διαχείρισή του θα πρέπει να διέπεται από τους κανόνες της ηθικής. Ο Δ/ντής του Ινστιτούτου κ. Κ. Χαρτζουλάκης τόνισε ότι το Ινστιτούτο έχει την τεχνογνωσία και μπορεί να συμβάλει στην ορθολογική χρήση του νερού στην γεωργία.

Αναφέρθηκε στα προβλήματα που προκαλεί η υπερ-κατανάλωση νερού, τις ανάγκες σε νερό των κυριότερων καλλιεργειών της περιοχής σε νερό και την αναγκαιότητα σωστής άρδευσης, αφού η κατανάλωση νερού για την παραγωγή ενός προϊόντος αποτελεί στοιχείο ποιότητας μέσω του 'υδατικού αποτυπώματος'.

Η γεωπόνος του Ινστιτούτου κ. Μ. Μπερτάκη αναφέρθηκε στην αναγκαιότητα εγκατάστασης και σωστής λειτουργίας του συστήματος άρδευσης με σταγόνες, και τόνισε ότι η αποτελεσματικότητα χρήσης του νερού μπορεί να φτάσει πάνω από 95%. Τέλος ο ερευνητής του Ινστιτούτου Δρ. Γ. Ψαρράς αναφέρθηκε στην δυνατότητα χρήσης για άρδευση των καλλιεργειών των επεξεργασμένων υγρών αποβλήτων και παρουσίασε τα αποτελέσματα πειραμάτων του Ινστιτούτου αλλά και της διεθνούς πρακτικής για την παραγωγή ασφαλών και καλής ποιότητας προϊόντων. Ακολούθησε διαλογική συζήτηση με τους συμμετέχοντες και διάθεση ενημερωτικών φυλλαδίων για την 'Ορθή Αρδευτική Πρακτική' που έχει εκδώσει το Ινστιτούτο..

Μοιράστε το

AgroNews Καλλιεργεί ιδέες (/)

Ικανοποίησε η άρδευση με σταγόνα στα Χανιά

Λασηθιωτάκη Πέλλα | | 29/04/2013 - 10:47 πμ

Την ανάγκη εφαρμογής της μεθόδου άρδευσης με σταγόνες για την εξοικονόμηση του νερού επεσήμαναν οι επιστήμονες που πήραν μέρος σε εσπερίδα που έγινε στα Χανιά. Οι επιστήμονες παρουσίασαν μελέτες βάσει των οποίων η αποτελεσματικότητα της χρήσης του νερού με τη στάγδην άρδευση μπορεί να φθάσει το 95%.

Από την εκδήλωση με θέμα την άρδευση που έγινε στα Χανιά.

Την εκδήλωση που είχε ως θέμα 'Ορθολογική διαχείριση του νερού άρδευσης στις καλλιέργειες' και έγινε στην αίθουσα της Ορθοδόξου Ακαδημίας Κρήτης, οργάνωσαν η Κοινωφελής Επιχείρηση του Δ. Πλατανιά, το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων, ο ΟΑΔΥΚ και το Ινστιτούτο Θεολογίας και Οικολογίας της ΟΑΚ.

Χαιρετισμό απηύθυνε ο Δήμαρχος Πλατανιά κ. Ι. Μαλανδράκης ο οποίος επεσήμανε τη στήριξη του δήμου στον πρωτογενή τομέα και την αναγκαιότητα ορθολογικής χρήσης του νερού από όλους τους χρήστες. Επίσης ο εκπρόσωπος του ΟΑΔΥΚ κ. Ε. Κοπάσης που τόνισε τη συμβολή του Οργανισμού στην αξιοποίηση του υδατικού δυναμικού της περιοχής. Τις εργασίες της εσπερίδας χαιρέτισε και η διευθύντρια της ΟΑΚ κ Λαρενζάκη που τόνισε τη σχέση του νερού με την ζωή και το περιβάλλον. Στην εσπερίδα συμμετείχαν δημοτικοί σύμβουλοι, ο πρόεδρος του ΤΟΕΒ Αγιάς-Κολυμβαρίου και πολλοί αγρότες.

Στην εσπερίδα ο πρόεδρος της ΚΕΔΗΠ κ. Α. Καπνισάκης αναφέρθηκε στις αλλαγές που έχουν γίνει τα τελευταία 50 χρόνια στη ζήτηση αλλά και τη διαχείριση του νερού ενώ ο κ. Ανδριανός τόνισε ότι το νερό είναι κοινωνικό αγαθό, όχι προϊόν αγοράς και η διαχείρισή του θα πρέπει να διέπεται από τους κανόνες της ηθικής. Ο Δ/ντής του Ινστιτούτου κ. Κ. Χαρτζουλάκης τόνισε ότι το Ινστιτούτο έχει την τεχνογνωσία και μπορεί να συμβάλει στην ορθολογική χρήση του νερού στην γεωργία. Αναφέρθηκε στα προβλήματα που προκαλεί η υπερκατανάλωση νερού, τις ανάγκες σε νερό των κυριότερων καλλιεργειών της περιοχής σε νερό και την αναγκαιότητα σωστής άρδευσης, αφού η κατανάλωση νερού για την παραγωγή ενός προϊόντος αποτελεί στοιχείο ποιότητας μέσω του 'υδατικού αποτυπώματος'.

Η γεωπόνος του Ινστιτούτου κ. Μ. Μπερτάκη αναφέρθηκε στην αναγκαιότητα εγκατάστασης και σωστής λειτουργίας του συστήματος άρδευσης με σταγόνες, και τόνισε ότι η αποτελεσματικότητα χρήσης του νερού μπορεί να φτάσει πάνω από 95%. Τέλος ο ερευνητής του Ινστιτούτου Δρ. Γ. Ψαρράς αναφέρθηκε στην δυνατότητα χρήσης για άρδευση των καλλιεργειών των επεξεργασμένων υγρών αποβλήτων και παρουσίασε τα αποτελέσματα πειραμάτων του Ινστιτούτου αλλά και της διεθνούς πρακτικής για την παραγωγή ασφαλών και καλής ποιότητας προϊόντων. Ακολούθησε συζήτηση με τους συμμετέχοντες και διάθεση ενημερωτικών φυλλαδίων για την 'Ορθή Αρδευτική Πρακτική' που έχει εκδώσει το Ινστιτούτο.

Ινστιτούτο Ελιάς &
Υποτροπικών Φυτών Χανίων

ΓΔ Εκπαίδευση και πολιτισμός
Πρόγραμμα διά βίου μάθηση

Grundtvig-Project
Water and Life

Εσπερίδα

"Ορθολογική Διαχείριση του Νερού Άρδευσης στις καλλιέργειες"

ΠΡΟΓΡΑΜΜΑ:

19:00: Χαιρετισμοί
19:10: Άρδευση των Καλλιεργειών - Ανάγκες σε νερό
Κ. Χαριτουλάκης, Ερευνητής, Ινστιτούτο Ελιάς & Υποτροπικών
19:30: Χρήση Υποβαθμισμένων Νερών στη Γεωργία
Γ. Ψαρράς, Ερευνητής, Ινστιτούτο Ελιάς & Υποτροπικών
19:50: Σχεδιασμός Συστημάτων Τοπικής Άρδευσης
Μ. Μπεριάκη, Γεωπόνος ΕΤΕ, Ινστιτούτο Ελιάς & Υποτροπικών
20:10 Ερωτήσεις - Συζήτηση

Πληροφορίες:
28210-83443/ -442

Πέμπτη 20 Σεπτεμβρίου 2012
Αίθουσα Πολιτιστικού Συλλόγου Πλατάνου

ΚΕΝΤΡΟ ΠΕΡΙΒΑΛΛΟΝΤΙΚΗΣ ΕΚΠΑΙΔΕΥΣΗΣ ΒΑΜΟΥ

ΠΕΡΙΦΕΡΕΙΑΚΗ Δ/ΝΣΗ Π/ΘΜΙΑΣ & Δ/ΘΜΙΑΣ ΕΚΠ/ΣΗΣ ΚΡΗΤΗΣ

το Κ.Π.Ε. Βάμου

σε συνεργασία με τον ΟΑΔΥΚ, το Ινστιτούτο Ελιάς & Υποτροπικών Φυτών Χανίων και τους Υπευθύνους Σχολικών Δραστηριοτήτων ΠΕ & ΔΕ Ν.Χανίων

διοργανώνουν

Σεμινάριο:

"Μαθαίνοντας για το Νερό"

στις **9 Μαρτίου 2013**
ώρα έναρξης **9:00π.μ.**

στο κτίριο του **Κ.Π.Ε. Βάμου**
στον **Κεφαλά Αποκορώνου**

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Κοινωνικό Ταμείο

ΕΠΙΧΕΙΡΗΣΙΑΚΟ ΠΡΟΓΡΑΜΜΑ
ΕΚΠΑΙΔΕΥΣΗ ΚΑΙ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗ
επένδυση στην κοινωνία της γνώσης
ΥΠΟΥΡΓΕΙΟ ΠΑΙΔΕΙΑΣ & ΘΡΗΣΚΕΥΜΑΤΩΝ, ΠΟΛΙΤΙΣΜΟΥ & ΑΘΛΗΤΙΣΜΟΥ
ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ

ΕΣΠΑ 2007-2013
πρόγραμμα για την ανάπτυξη
ΕΥΡΩΠΑΪΚΟ ΚΟΙΝΩΝΙΚΟ ΤΑΜΕΙΟ

Grundtvig-Project
Water and Life

Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

ΙΔΡΥΜΑ ΝΕΟΛΑΙΑΣ ΚΑΙ ΔΙΑ ΒΙΟΥ ΜΑΘΗΣΗΣ

ΥΠΟΥΡΓΕΙΟ ΑΓΡΟΤΙΚΗΣ ΑΝΑΠΤΥΞΗΣ ΚΑΙ ΤΡΟΦΙΜΩΝ
ΕΛΛΗΝΙΚΟΣ ΓΕΩΡΓΙΚΟΣ ΟΡΓΑΝΙΣΜΟΣ "ΔΗΜΗΤΡΑ"

Σεμινάριο για εκπαιδευτικούς ΠΕ και ΔΕ Χανίων για το νερό

Σάββατο 9 Μαρτίου 2013

Το Κέντρο Εκπαίδευσης για την Αειφορία (ΚΠΕ) Βάμου, στα πλαίσια των Δράσεων του Επιχειρησιακού Προγράμματος «Εκπαίδευση & Δια Βίου Μάθηση», συνδιοργανώνει με το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων, και τον Οργανισμό Ανάπτυξης Δυτικής Κρήτης (ΟΑΔΥΚ), σεμινάριο για εκπαιδευτικούς της Περιφερειακής Ενότητας των Χανίων, το **Σάββατο 9 Μαρτίου 2013,** με τίτλο:

«Μαθαίνοντας για το νερό»

Η δράση αυτή γίνεται στα πλαίσια του Δικτύου «Υγρο-τροποποιώ τη συμπεριφορά μου» στο οποίο συμμετέχει το ΚΠΕ Βάμου και του προγράμματος **Grundtvig** '**Water and Life**' που συμμετέχει το Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων**.**

Στόχος της δράσης είναι η ενημέρωση και ευαισθητοποίηση των εκπαιδευτικών για το νερό, η στήριξή τους στην υλοποίηση δράσεων και προγραμμάτων Περιβαλλοντικής Εκπαίδευσης σχετικά με το νερό και η απάντηση ερωτημάτων όπως:

- Πώς γίνεται η διαχείριση του νερού στην Κρήτη**;**
- Πώς ελέγχεται η ποιότητα του νερού**;**
- Πώς γίνεται η διαχείριση του νερού στη γεωργία**;**
- Τι σχέδια διαχείρισης των υδατικών πόρων υπάρχουν;
- Τι έργα διαχείρισης νερού υλοποιούνται στην περιοχή μας;
- Τι προγράμματα και υλικό υπάρχει για τη στήριξη προγραμμάτων Περιβαλλοντικής Εκπαίδευσης στα σχολεία γι' αυτό το θέμα**;**

Στο σεμινάριο συμμετάσχουν πενήντα (**50)** εκπαιδευτικοί ΠΕ και ΔΕ Χανίων με προτεραιότητα α) όσοι εκπαιδευτικοί συμμετέχουν στο Δίκτυο «Υγρο**(**τροπο**)**ποιώ τη συμπεριφορά μου», β) οι εκπαιδευτικοί που υλοποιούν προγράμματα Π.Ε. στα σχολεία τους σχετικά με το νερό, γ) όσοι άλλοι εκπαιδευτικοί ενδιαφέρονται.

Το Σεμινάριο θα πραγματοποιηθεί στις εγκαταστάσεις του ΚΠΕ Βάμου στις **9** Μαρτίου **2013.**

ΠΡΟΓΡΑΜΜΑ ΣΕΜΙΝΑΡΙΟΥ

«Μαθαίνοντας για το νερό»

Σάββατο **9** Μαρτίου **2013**

Χώρος: Αίθουσα ΚΠΕ Βάμου

Ώρα	Τίτλος	Φορέας	Εισηγητής
9:00-9:30			
9:30-9:50	**Υδατικό Δυναμικό Ν. Χανίων και Διαχείρισή του**	Περιφέρεια Κρήτης ΠΕ Χανίων τμήμα Περιβάλλοντος και Υδροοικονομίας	Βοζινάκης Κων/νος
9:50-10:10	**Ποιότητα Πόσιμου Νερού**	Δημοτική Επιχείρηση Ύδρευσης και Αποχέτευσης Χανίων	Μάρακα Βούλα, Χημικός, ΔΕΥΑΧ
10:10-10:30	**Διαχείριση και ποιότητα νερού στην Γεωργία**	Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων	Χαρτζουλάκης Κων/νος**,** Μπερτάκη Μαρία
10:30-10:50	**Σχέδια Διαχείρισης Υδατικών Πόρων**	Τμήμα Μηχανικών Περιβάλλοντος Πολυτεχνείου Κρήτης	Νικολαΐδης Νίκος,
10:50-11:10	**Έργα Διαχείρισης Υδατικού δυναμικού**	Οργανισμός Ανάπτυξης Δυτικής Κρήτης	Πατρελάκης Μάρκος
11:10-11:30			
11:30-11:45			
11:45-12:00	**Το εκπαιδευτικό πρόγραμμα του ΚΠΕ Βάμου για το νερό**	ΚΠΕ Βάμου	Παιδαγωγική Ομάδα ΚΠΕ Βάμου
12:00-12:15	**Δίκτυο Περιβαλλοντικής Εκπαίδευσης «Υγρο(τροπο)ποιώ τη συμπεριφορά μου»**	ΚΠΕ Ιεράπετρας	Παύλος Δασκαλάκης, Υπεύθυνος του ΚΠΕ Ιεράπετρας
12:15-12:30	**Το νερό ως προϋπόθεση ανάπτυξης**	Οικολογική Πρωτοβουλία Χανίων	Νίκος Βακόνδιος
12:30-13:30	**Επίσκεψη στο υδροηλεκτρικό εργοστάσιο στη Γεωργιούπολη**		

Μαθαίνοντας για το νερό

Ημερομηνία δημοσίευσης: 12/03/2013, 14:00
Τελευταία ενημέρωση: 12/03/2013, 15:30

Το Κέντρο Εκπαίδευσης για την Αειφορία (ΚΠΕ) Βάμου, στα πλαίσια των Δράσεων του Επιχειρησιακού Προγράμματος «Εκπαίδευση & Δια Βίου Μάθηση», που αφορά τα Κέντρα Εκπαίδευσης για το Περιβάλλον και την Αειφορία και που χρηματοδοτείται από το Ευρωπαϊκό Κοινωνικό Ταμείο και από Εθνικούς πόρους, συνδιοργάνωσε με τους Υπεύθυνους Σχολικών Δραστηριοτήτων Π.Ε. και Δ.Ε. Χανίων και τον ΟΑΔΥΚ, Σεμινάριο για 50 εκπαιδευτικούς της Περιφερειακής Ενότητας των Χανίων, το Σάββατο 9 Μαρτίου 2013 στον Κεφαλά Αποκορώνου, με τίτλο: «Μαθαίνοντας για το νερό».

Η δράση αυτή γίνεται στα πλαίσια του Δικτύου «Υγροτροποποιώ τη Συμπεριφορά μου» στο οποίο συμμετέχει το ΚΠΕ Βάμου.

Στόχος της δράσης είναι η ενημέρωση και ευαισθητοποίηση των εκπαιδευτικών για το νερό, η στήριξή τους στην υλοποίηση δράσεων και προγραμμάτων Περιβαλλοντικής Εκπαίδευσης σχετικά με το νερό.

Στη διάρκεια του Σεμιναρίου έγιναν εισηγήσεις από τον Κώστα Βοζινάκη από την Περιφερειακή Ενότητα Χανίων για το Υδατικό Δυναμικό των Χανίων και τη διαχείρισή του, από τη χημικό Βούλα Μάρακα από τη ΔΕΥΑΧ για την Ποιότητα του πόσιμου νερού των Χανίων, από το διευθυντή του Ινστιτούτου Υποτροπικών Φυτών και Ελιάς Κώστα Χαρτζουλάκη για το Νερό στη Γεωργία, από την Ουρανία Τζωράκη από το Πολυτεχνείο Κρήτης για τα Σχέδια Διαχείρισης Υδατικών Πόρων και από το Μάρκο Πατρελάκη του ΟΑΔΥΚ που παρουσίασε τα Έργα Διαχείρισης Υδατικών Πόρων του ΟΑΔΥΚ.

Χαιρετισμός έγινε από το Γενικό Διευθυντή του ΟΑΔΥΚ Γιάννη Μπατζέλη, ενώ η Παιδαγωγική Ομάδα του ΚΠΕ Βάμου παρουσίασε τα εκπαιδευτικά προγράμματα του Κέντρου και ο Νίκος Βακόνδιος από την Οικολογική Πρωτοβουλία Χανίων παρουσίασε το εκπαιδευτικό υλικό «Ταραγμένα νερά - το νερό ως προϋπόθεση ανάπτυξης» που δημιουργήθηκε στα πλαίσια διεθνούς προγράμματος.

Το Σεμινάριο έληξε με εκπαιδευτικά παιχνίδια για το νερό, στην αυλή του Κέντρου Περιβαλλοντικής Εκπαίδευσης στον Κεφαλά.

22 ΜΑΡΤΙΟΥ 2013

Θεσμικό πλαίσιο διαχείρισης υδατικών πόρων

Μεγάλο Αρσενάλι, ώρα 18:30

Διοργανωτές:

ΤΕΕ ΤΔΚ , ΚΕΠΠΕΔΗΧ-ΚΑΜ

Προγραμμα Εταιρικης Κοινωνικης Ευθυνης

Ο.Α.ΔΥ.Κ

ΚΠΕ Βάμου

ΤΕΕ
ΤΜΗΜΑ ΔΥΤΙΚΗΣ ΚΡΗΤΗΣ

ΓεωΤΕΕ
ΠΑΡΑΡΤΗΜΑ ΚΡΗΤΗΣ

Πολυτεχνείο Κρήτης

Δ.Ε.Υ.Α.Χ.

ΥΠΟΥΡΓΕΙΟ ΑΓΡΟΤΙΚΗΣ ΑΝΑΠΤΥΞΗΣ ΚΑΙ ΤΡΟΦΙΜΩΝ
ΕΛΛΗΝΙΚΟΣ ΓΕΩΡΓΙΚΟΣ ΟΡΓΑΝΙΣΜΟΣ "ΔΗΜΗΤΡΑ"
ΙΝΣΤΙΤΟΥΤΟ ΕΛΙΑΣ & ΥΠΟΤΡΟΠΙΚΩΝ ΦΥΤΩΝ ΧΑΝΙΩΝ

ΔΗΜΟΣ ΧΑΝΙΩΝ
Κ.Ε.Π.ΠΕ.ΔΗ.Χ. - Κ.Α.Μ.

ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ
ΔΗΜΟΚΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΧΑΝΙΩΝ

21/3/2013

Ημερίδα για τη διαχείριση των υδατικών πόρων, αύριο στο Αρσενάλι

Like 0 Tweet 0 +1 0

Ημερίδα με θέμα το θεσμικό πλαίσιο διαχείρισης των υδατικών πόρων, πραγματοποιείται αύριο Παρασκευή 22 Μαρτίου, στις 6:30 το απόγευμα, στο Μεγάλο Αρσενάλι.

Την ημερίδα συνδιοργανώνουν ο ΟΑΔΥΚ, η ΚΕΠΠΕΔΗΧ-ΚΑΜ και το ΤΕΕ/ΤΔΚ και εντάσσεται στο πλαίσιο της εταιρικής κοινωνικής ευθύνης του ΟΑΔΥΚ.

Το πρόγραμμα είναι το ακόλουθο:

Προεδρείο: ΝΑΝΣΥ ΑΓΓΕΛΑΚΗ, ΛΕΥΤΕΡΗΣ ΚΟΠΑΣΗΣ , ΣΠΥΡΟΣ ΣΟΦΙΑΝΟΣ			
Ώρα	Τίτλος	Φορέας	Εισηγητής
18:30-19:00	Καλωσόρισμα Διοργανωτών - Χαιρετισμοί Επισήμων	Πρόεδρος ΚΕΠΠΕΔΗΧ-ΚΑΜ Γενικός Δ/ντης ΟΑΔΥΚ Πρόεδρος ΤΕΕ ΤΔΚ	Αγγελάκη Νάνσυ Μπατζέλης Γιάννης Στρογγυλός Γιάννης
19:00-19:15	Ειδική Μελέτη Διαχείρισης, Διοίκησης, Συντήρησης και Λειτουργίας Μεγάλων Υδροσυλλογών Έργων	ΤΕΕ ΤΔΚ	Παυλάκης Παύλος

3rd Project Meeting, 30/10-1/11/2012
Chania, Crete, Creece

SUSTAINABLE WATER MANAGEMENT IN AGRICULTURE

K. Chartzoulakis, M. Bertaki, G. Psarras

NAGREF, Institute for Olive Tree and Subtropical Plants
Department of Irrigation and Water Management
Agrokipio, 73100 Chania, Crete, Greece

Role of IOTSP in 'Water and Life'

- The Institute of Olive Tree and Subtropical Plants in cooperation with Local Water Boards in rural areas organize courses and lectures in order to increase farmers awareness for water saving.
- More specifically the role of the NAGREF-Institute for Olive Tree and Subtropical Plants in this project is:
- to suggest several methods and practices for water saving in agricultural sector
- to teach the farmers to use the innovative, water saving irrigation systems
- to produce informative material (leaflets, etc) for rational use of water
- report on water availability, crop needs and irrigation

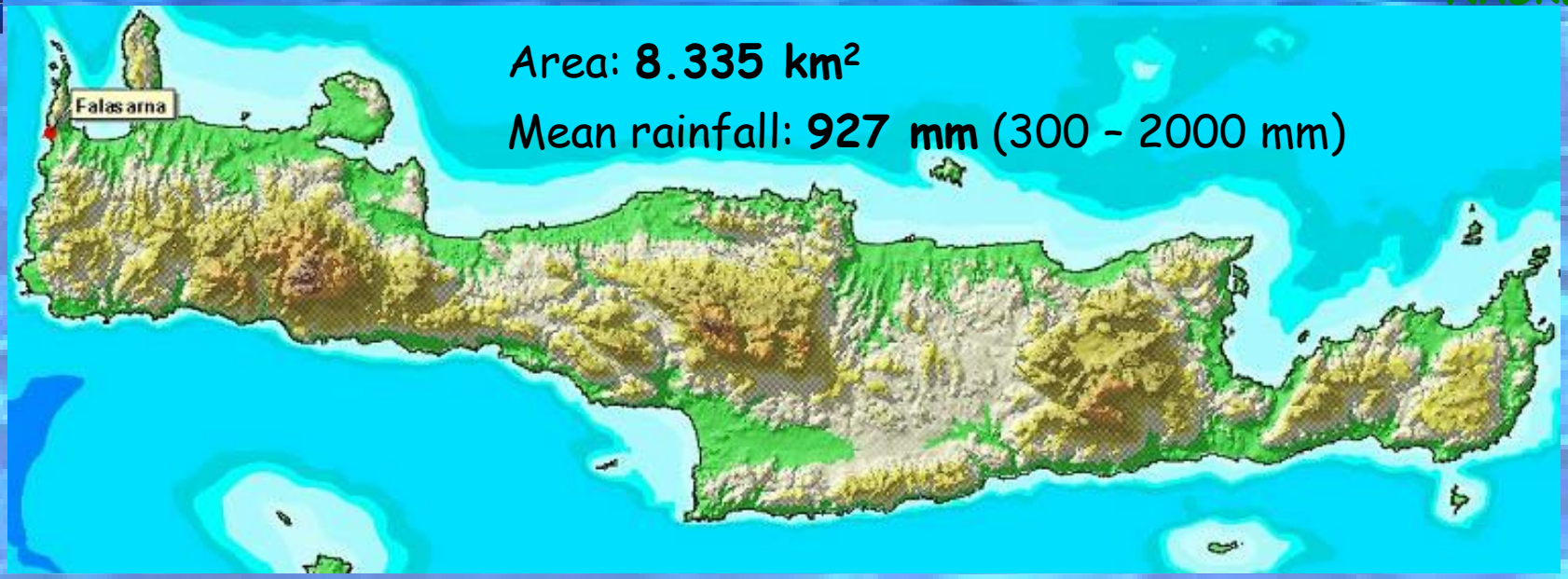
Water management in Greece

- Greece is considered as a rich country in water resources, with mean annual rainfall of 700 mm, which corresponds to 115 billion m^3.
- 50% are lost due to evapotranspiration process, 30% (35 billion m^3) due to surface runoff (reaching the sea) and only 20% goes for aquifer recharge.

- The uneven distribution of rainfall (900 mm in Epirus and N. Greece and 400 in Athens and Naxos),
- The extreme weather events
- The man-induced interventions

result in water shortage phenomena occurred in specific areas of the country. However, the ratio between the total water consumption and available water resources is estimated around of 12%, which is slightly higher than the average of OECD countries.

Water resources in Crete



Area: **8.335 km²**

Mean rainfall: **927 mm** (300 – 2000 mm)

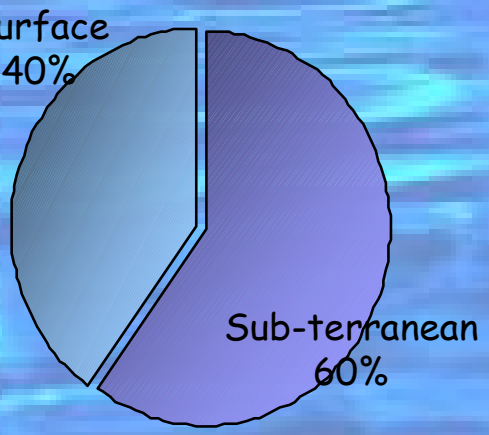
Annual water balance of Crete (Mm³)

Hydrological conditions	**Rainfall**	**Evapotranspiration**	**Surface runoff**	**Deep percolation**
Normal	7,69	4,83 (62,8%)	0,74 (9,6%)	2,12 (27,6%)
Wet	10,33	6,48 (62,7%)	0,99 (9,6%)	2,85 (27,6%)
Dry	5,07	3,18 (62,7%)	0,49 (9,7%)	1,40 (27,6%)

Water resources in Crete

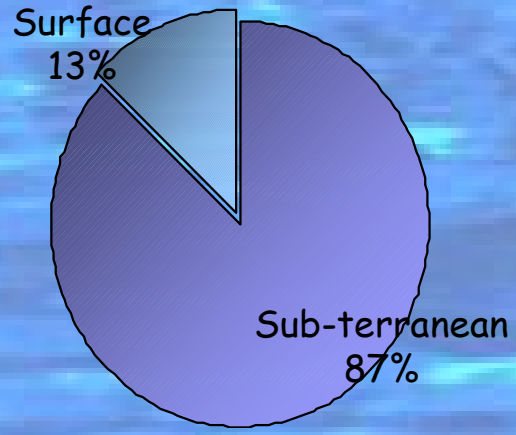
Potential

2,650 Mm^3/year

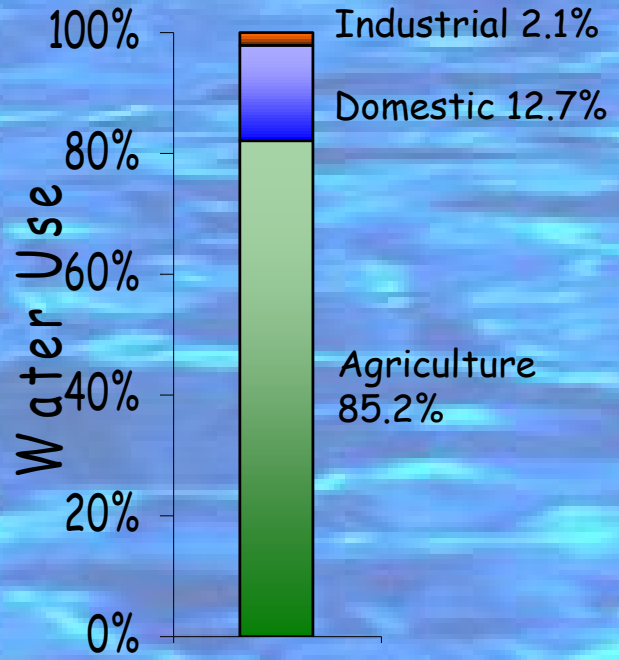


Used

372 Mm^3/year



Source: Region of Crete, 2002

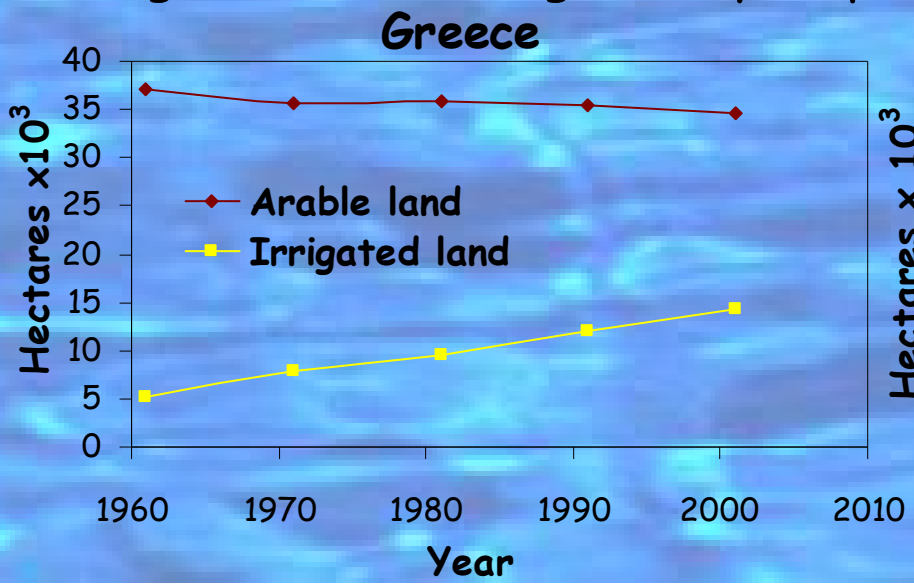


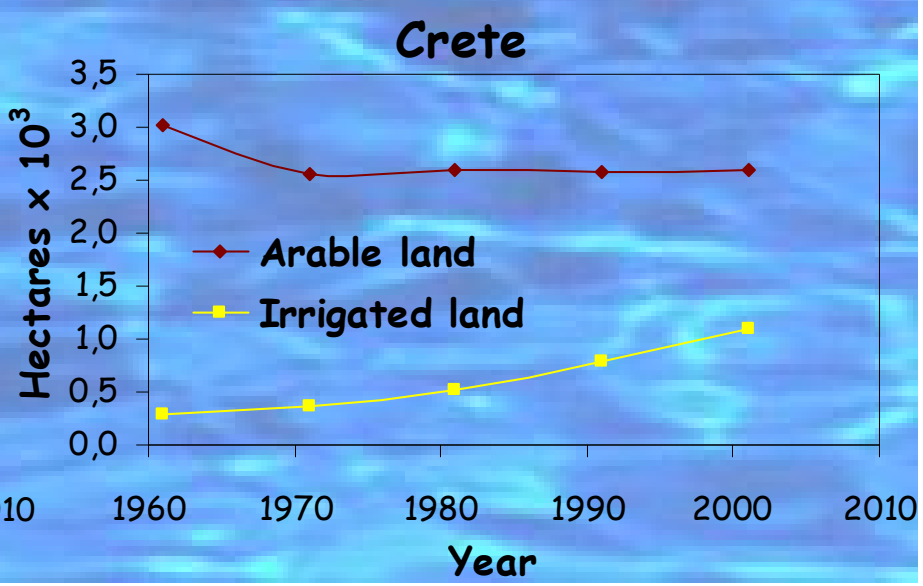
Water demand and deficit in Crete (RGC, 2002).

Water use	Consumption (Mm^3)	Deficit (Mm^3)	Cover percentage
Irrigation	302,06	156,31	65,9%
Domestic & other uses	69,75	7,59	90,2%
Total	371,81	163,90	72,2%

Irrigated areas

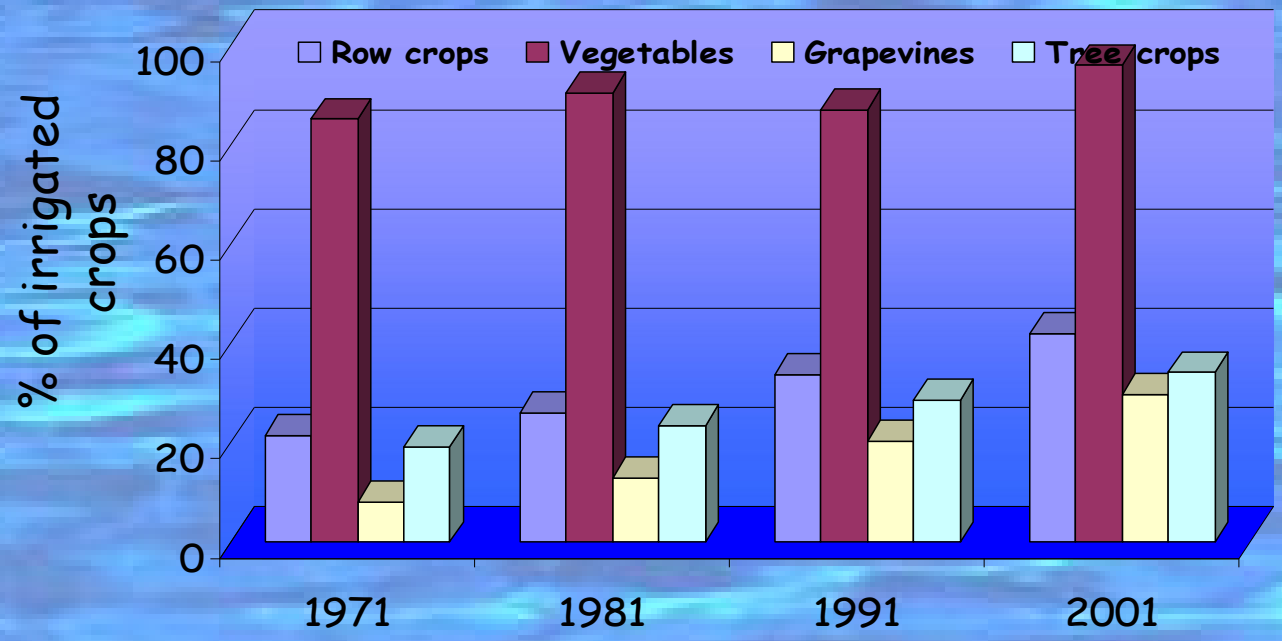
- The last 40 years the irrigated areas in Greece increased by 275% while in Crete the increase was 376%. At the same time the total agricultural land decreased by 6,7% and 13,7% respectively. The percentage of irrigated land in Crete is 42,3% (Region of Crete, 2002) while the respective % for Greece is 41,1% (NSSG, 2001).
- Main crops: olives, citrus, grapevines, field and greenhouse vegetables and avocado
- Methods of irrigation: drip (vegetables, grapevines, tree crops), sprinklers (forage crops, vegetables) and furrows (vegetables)
- Irrigation scheduling: mainly empirical

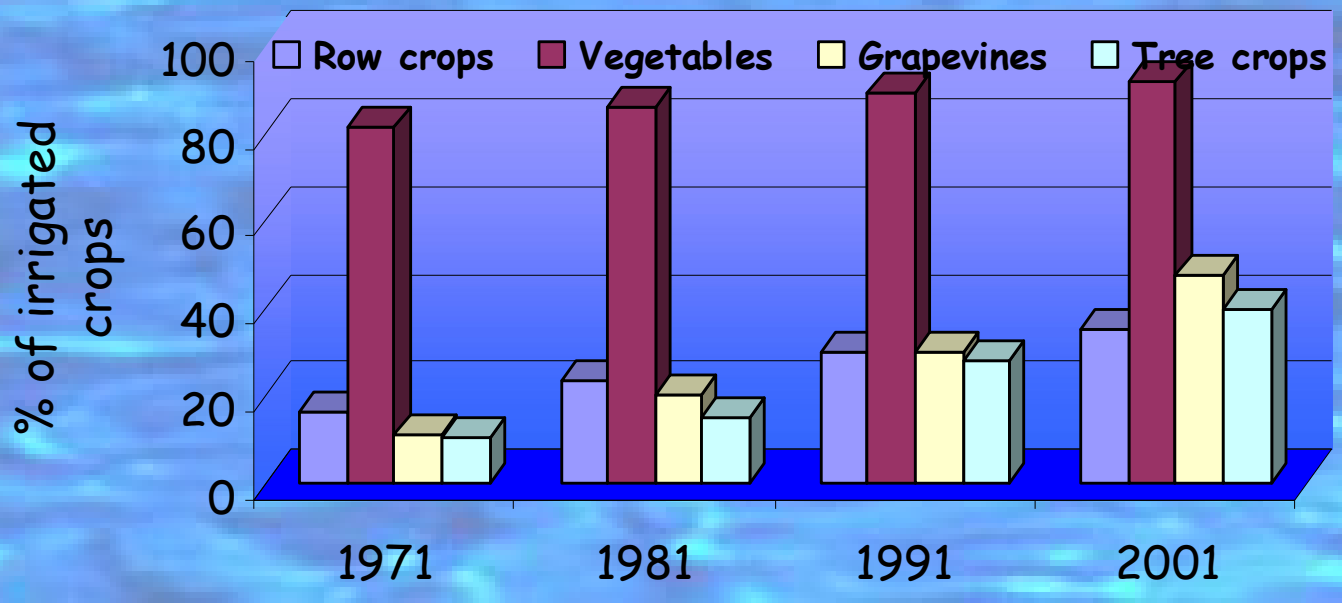




Evolution of irrigated crops

Evolution of main irrigated crops in the country





Evolution of main irrigated crops in Crete

Chania, Greece, 1-11-2012

Sustainable water management in agriculture

- Sustainable water management in agriculture aims to match water availability and water needs in quantity and quality, in space and time, at reasonable cost and with acceptable environmental impact.

- Its adoption involves:
  - technological problems
  - social behavior of rural communities
  - economic constrains
  - legal and institutional framework
  - agricultural practices

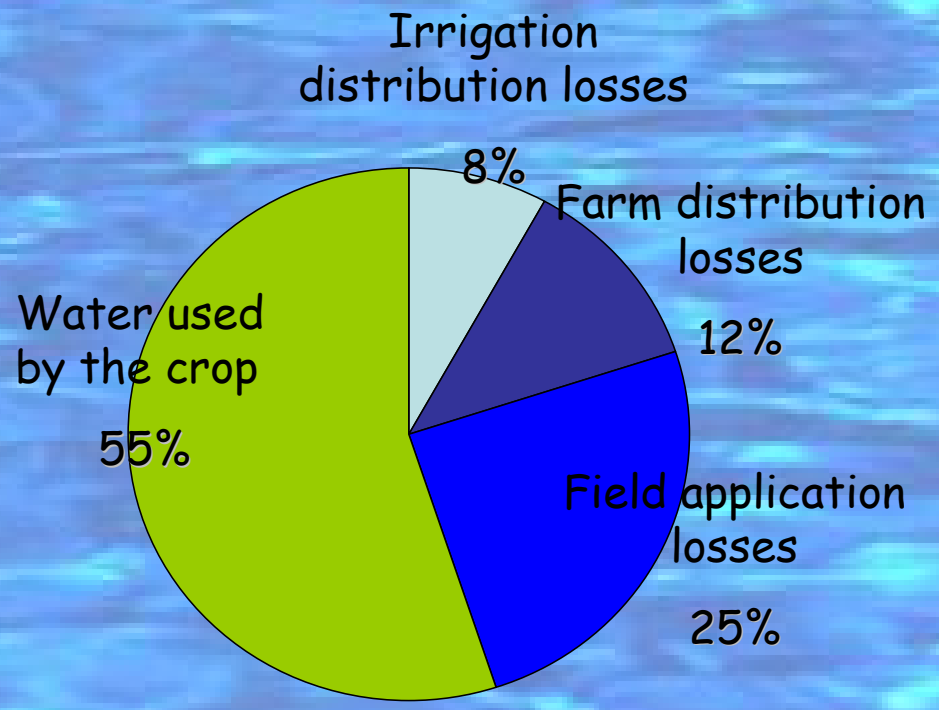
Sustainable water management in agriculture can be achieved by:

Sustainable water management in agriculture

Application of best irrigation practices

- Reduction of water losses

- Detect and eliminate any water leakage in the networks using up-today methods (GIS, remote sensing, etc).
- Repair and maintain the networks



Improve the efficiency or irrigation systems used

- surface irrigation systems: land leveling and use of short length furrows and basins
- sprinkler irrigation systems: use pressure regulators in sloping fields, monitor and adjust pressure, good system maintenance
- localized irrigation systems: use a single drip line for a double row crop, control of pressure, adjust the amount and the duration of irrigation according to soil characteristics

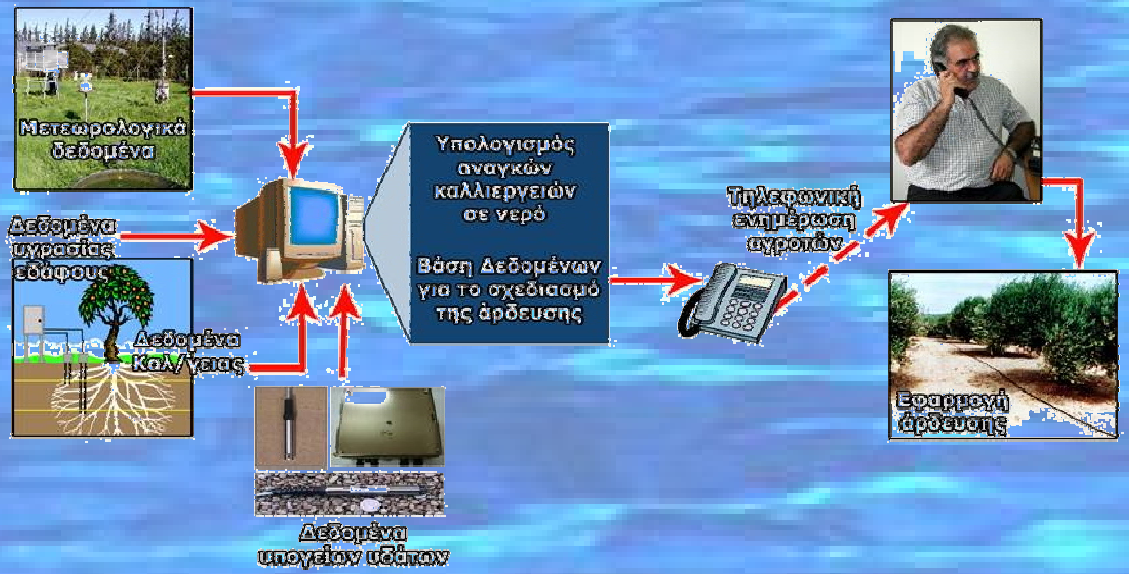
Sustainable water management in agriculture

- Increase water use efficiency

- obligatory use of localized irrigation systems (with or without subsides)
- apply proper irrigation scheduling based on soil and climatic conditions and the crop
- proper irrigation techniques to avoid soil salinisation
- adopt innovative irrigation techniques, which require reduced amount of water like regulated deficit irrigation (RDI), partial root drying (PRD) and subsurface irrigation in water scarce regions
- apply fertigation (application of fertilizers though the irrigation system)
- application of agrochemicals (herbicides, fungicides, etc)
- establish a local advisory system for advising the farmers for irrigation

Advisory system BEWARE

An advisory system to assist farmers for irrigation scheduling have been developed in Crete, Greece in the frame of CRINNO. The irrigation information is based in real-time data (climatic, soil, crop) and is given to the farmers through internet or phone call.



The purpose of the system is to improve irrigation efficiency at farm level.

Crop	Consultive irrigation (mm)	Empirical irrigation (mm)	Water saving (%)
Avocado	545	681	20,0
Orange	501	586	14,5
Olive	228	244	9,3
Grapevine	452	540	16,3

Sustainable water management in agriculture

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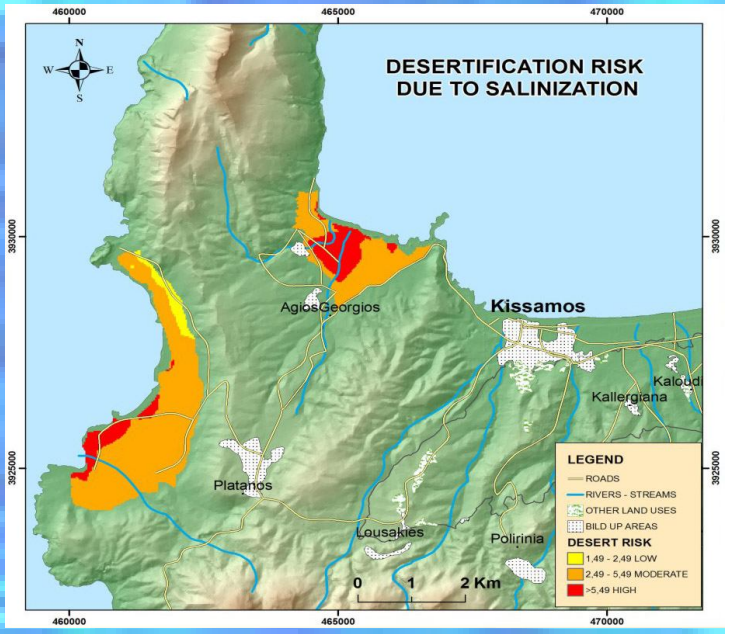
Chania, Greece, 1-11-2012

- **Water quality management:**

  It is important as much as the quantity management.

- Sources of water quality deterioration:
  - Use of agrochemicals (fertilizers, pesticides, etc)
  - Sea intrusion due to over-pumping (coastal aquifers)
  - Soil salinization (improper irrigation management)
- 35% of irrigated land is under high salinization risk while 49% is under moderate risk
- Protection measures:
  - Continous water quality monitoring
  - Rational use of agrochemicals (application of GAP)
  - Proper irrigation management
  - Artificial aquifer recharge (during the winter)



Sustainable water management in agriculture

Use of reclaimed waters for irrigation

The reuse of reclaimed water for irrigation of horticultural crops and recreational areas can ensure:

- ⇨avoiding the water quality deterioration of aquifers (minimize eutrophication)
- ⇨supply the soil with nutrients (mainly N, P and P) essential for plant growth minimizing the addition of fertilizers.
- ⇨an additional water source for water-deficient areas (in Crete will increase irrigated area by 5.3%)

- Development of guidelines for the reuse of reclaimed water for irrigation (in agreement with those of EU)
- The price of reclaimed water for irrigation must be lower than that of good quality
- For the use of marginal waters for irrigation it is necessary to follow an integrated management taking into account the crop (tolerance to salinity), the soil (proper tillage) and the irrigation method (drip, leaching, etc).

Water pricing

- Water pricing in agriculture is still open to debate
- Water pricing can play a key role in giving incentive to make water use in agriculture more efficient, thereby reducing pressure on the environment.
- Water pricing policy must promote the future sustainability of the resource, discourage the waste and induce the adoption of water saving technologies.

- Barriers to the application of a pricing mechanism are:
  - practical (water is often not metered)
  - legal-historical (existing water rights)
  - social (water is perceived as a public good).

- However appropriate pricing for wise water use has a central role to play in the transition to an era of scarcity.

Water pricing

<u>Irrigation water pricing in Crete</u>

- The price of irrigation water varies greatly among areas in the island or even among catchments due to different pricing structure, policies and managing organization. For example in Chania Prefecture the price of irrigation water is 0,07-0,12 €/m^3 in networks operated by TOEB, 0,10-0,17 €/m^3 operated by OADYK, 0,15 - 0,22 €/m^3 operated by Municipalities, whereas in some private projects it reaches 0.30–0.45 €/m^3.
- irrigation water tariffs must cover the O&M cost of water use and services
- volumetric water metering must be obligatory
- progressive, seasonal and over-consumption water tariffs (quotas) should be promoted
- an increasing block tariff charging system, for those exceeding crops' critical water requirements, must be established

Sustainable water management in agriculture

Strengthening capacity

- **Education and training** of professionals, technical staff and decision makers on subjects related to sustainable water management
- **Manpower build up.** Institutions to be staffed with qualified manpower (managers, engineers, technicians, social scientists)
- **Facilities and procedures.** Water authorities at all levels of management should be equipped with technologically advanced devices and programs e.g. computers, GIS, remote sensing etc.
- **Increase the farmers awareness. This implies:**

  Changes in education system

  Increased research

  Strong and effective Agricultural Extension Services

  Financial support by the State

  Wider and effective participation of farmers in water management

THANK YOU!

Grundtvig-Project
Water and Life

Education and Culture
Lifelong learning programme
GRUNDTVIG

Final Project Meeting, July 1-5, 2013
Schrobenhausen, Germany

Water and Life: activities by Greek partner NAGREF

K. Chartzoulakis, G. Psarras, M. Bertaki
A. Giannakaki

ELGO - DEMETER

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ISPOT in 'Water and Life'

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- ✓ The Institute of Olive Tree and Subtropical Plants in cooperation with Local Water Boards in rural areas organized courses and lectures in order to increase farmers awareness about water saving.
- ✓ More specifically, Institute aimed through this project to:
  - suggest several methods and practices for water saving in agricultural sector
  - train the farmers how to use the innovative, water saving irrigation systems
  - produce informative material (leaflets, online information, etc) for rational use of water
  - report on water availability, crop needs and irrigation.

Activities in the frame of 'Water and Life'

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Final Meeting, Schrobenhausen, 3-7-2013

1. Workshop on "Best Irrigation Practices" (for farmers)

- ✓ Platanos town, September 20th, 2012
- ✓ Attendants: about 80
- ✓ Main subjects addressed:
  - "Crop water requirements" (Dr. K. Chartzoulakis)
  - "Use of low quality waters for irrigation" (Dr. G. Psarras)
  - "Water saving and irrigation systems" (M. Bertaki)

Activities in the frame of 'Water and Life'

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2a. 4th Project meeting

✓Chania, October 30th – November 1st, 2012

✓The first two days of the meeting the participants visited:

- Organization for Development of Western Crete (OADYK)
- Local Organization of Irrigation Management (TOEV) of Varypetros
- Coastal Area of Platanos and Falasarna
- Agia Lake
- Dam of 'Potamoi', Amari, Rethimno
- Hersonisos' Wastwater treatment plant, Iraklio
- Knossos

Activities in the frame of 'Water and Life'

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2b. 4th Project meeting, workshop on 'Water issues'

- ✓ Agrokipio, Chania, November 1st, 2012
- ✓ Attendants: Project participants, local authorities
- ✓ Main subjects addressed:
  - "Partners activities in the project"
  - "Water resources management in Cyprus"
  - "Implementing the water framework Directive 60/2000 in the region of Crete: Problems and Perspectives"
  - "Reuse of low quality water for irrigation: Results of EU project SAFIR
  - "Biodiversity of Cretan wetlands".

Activities in the frame of 'Water and Life'

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3. Workshop on 'Learning about water' (for teachers)

- ✓ Kefalas, Vamos, March 9th, 2013
- ✓ Attendants: About 60 Elementary and High School Teachers
- ✓ Co-organized by: OADYK, ISPOT, Environmental Educational Center of Vamos
- ✓ Some of the subjects addressed were:
  - "Water resources management in Chania region"
  - "Quality and Management of irrigation water"
  - "Water quality control"
  - "Water resources infrastructure in Western Crete"
  - "Water: a precondition for life"
  - Presentation of 'water games'

Activities in the frame of 'Water and Life' - Learning about Water

Grundtvig-Project
Water and Life

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Final Meeting, Schrobenhausen, 3-7-2013

ΠΡΟΓΡΑΜΜΑ
ΣΕΜΙΝΑΡΙΟΥ
ΘΕΜΑ:

«Μαθαίνοντας για το νερό»

Σάββατο 9 Μαρτίου 2013
Χώρος: Αίθουσα ΚΠΕ Βάμου

Ώρα	Τίτλος	Φορέας	Εισηγητής
9:00-9:20	Προσέλευση-Χαιρετισμά		
9:30-9:50	Υδατικό Δυναμικό Ν. Χανίων και διαχείριση του	Περιφέρεια Κρήτης ΠΕ Χανίων τμήμα Περιβάλλοντος και Χδροσυκοιμίας	Βούλιάκης Κωνίνος
9:50-10:10	Ποιότητα Πόσιμου Νερού	Δημοτική Επιχείρηση Ύδρευσης και Αποχέτευσης Χανίων	Μάρκος Βούλα Χημικός Υπεύθυνη Εργαστηρίου ΔΕΥΑΧ
10:10-10:30	Διαχείριση και ποιότητα νερού στην Γεωργία	Ινστιτούτο Ελιάς και Υποτροπικών Φυτών Χανίων	Χαρτάλιαχος Κωνίνος
10:30-10:50	Σχέδιο Διαχείρισης Υδατικών Πόρων	Τμήμα Μηχανικών Περιβάλλοντος Πολυτεχνείου Κρήτης	Νικολαΐδης Νίκος
10:50-11:10	Έργα Διαχείρισης Υδατικού Δυναμικού	Οργανισμός Ανάπτυξης Δυτικής Κρήτης	Παρασκάκης Μάρκος
11:10-11:30	Ερωτήσεις-Συζήτηση		
11:30-11:45	Διάλειμμα - Κοφές		
11:45-12:00	Το εκπαιδευτικό πρόγραμμα του ΚΠΕ Βάμου για το νερό	ΚΠΕ Βάμου	Παιδαγωγική ομάδα ΚΠΕ Βάμου
12:00-12:15	Δίκτυο Περιβαλλοντικής Εκπαίδευσης «Ψυχοδιαστρεπτικώ τη συμπεριφορά μου»	ΚΠΕ Ιεράπετρας	Πάρκος Δασκαλάκης, Υπεύθυνος του ΚΠΕ Ιεράπετρας
12:15-12:30	Παρουσίαση εκπαιδευτικού υλικού «Ταραγμένο νερό – Το νερό ως προϋπόθεση ανάπτυξης»	Οικολογική Πρωτοβουλία Χανίων	Νίκος Εφκαλάκης
12:30-13:00	Επίσκεψη στο υδροηλεκτρικό εργοστάσιο στη Γεωργιούπολη		

Activities in the frame of 'Water and Life'

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Final Meeting, Schrobenhausen, 3-7-2013

4. **Workshop on 'Legal framework of water resources management' in the frame of Worlds' Water Day (local authorities, public)**

- ✓ Chania, March 22th, 2013
- ✓ Attendants: About 50 stakeholders and public
- ✓ Co-organized by: OADYK, ISPOT, Technical University of Crete, Region of Crete, Technical Chambers of Crete
- ✓ Some of the subjects addressed were:
  - "Management of large-scale water projects"
  - "Water potential in Chania Prefecture"
  - "Legal framework on water management"
  - "Water management in agriculture"
  - "Reclaiming energy from dams"
  - "Water management plan in Chania Prefecture in river basin scale

Activities in the frame of 'Water and Life'

Grundtvig-Project
Water and Life

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Final Meeting, Schrobenhausen, 3-7-2013

ΠΡΟΓΡΑΜΜΑ
ΕΤΑΙΡΙΚΗΣ ΚΟΙΝΩΝΙΚΗΣ ΕΥΘΥΝΗΣ

Ο.Α.Δ.Υ.Κ

Πολυτεχνείο Κρήτης · ΤΕΕ · ΤΕΕ ΤΔΚ · ΔΕΥΑΧ · ΚΠΕ Βάμου · ΔΗΜΟΣ ΧΑΝΙΩΝ · Κ.Ε.Π.Π.Ε.Δ.Η.Χ. - Κ.Α.Μ.

ΠΡΟΣΚΛΗΣΗ

Σας προσκαλούμε να παρευρεθείτε την Παρασκευή 22 Μαρτίου, ώρα 18.30, στο Μεγάλο Αρσενάλι στην εκδήλωση με θέμα "Θεσμικό πλαίσιο διαχείρισης υδατικών πόρων"

Η εκδήλωση πραγματοποιείται με αφορμή την Παγκόσμιο Ημέρα Νερού, στο πλαίσιο του Προγράμματος Εταιρικής Κοινωνικής Ευθύνης του ΟΑΔΥΚ με τους συνεργαζόμενους φορείς.

Συνδιοργανωτές : ΤΕΕ ΤΔΚ , ΚΕΠΠΕΔΗΧ-ΚΑΜ

ΠΡΟΓΡΑΜΜΑ ΕΚΔΗΛΩΣΗΣ
Προεδρείο: Νάνου Αγγελική, Λεπτάκη Κυπάρισσος, Σπύρος Σαρακάς

ΩΡΑ	ΤΙΤΛΟΣ	ΦΟΡΕΑΣ	ΕΙΣΗΓΗΤΗΣ
18.30-19.00	Καλωσόρισμα διοργανωτών Χαιρετισμοί επίσημων	Πρόεδρος ΚΕΠΠΕΔΗΧ-ΚΑΜ Γενικός Διευθυντής ΟΑΔΥΚ Πρόεδρος ΤΕΕ-ΤΔΚ	Νάνου Αγγελική Γιάννης Μπαλάζίας Γιάννης Σαρακάς
19.00-19.15	Ειδική μελέτη διαχείρισης διακίνησης, συντήρησης και λειτουργίας μηχανών υδρομάστευσης και ανύψωσης και διαχείρισης των διαθέσιμων υδατικών πόρων	ΤΕΕ - ΤΔΚ	Πολύς Παυλάκης
19.15-19.30	Υδατικό δυναμικό Ν. Χανίων και η διαχειριστική του	ΓΕΩΤΕΕ Περιφέρεια Κρήτης	Κώστας Βελιόλης
19.30-19.45	Το θεσμικό πλαίσιο της διαχείρισης νερού	Περιφέρεια Κρήτης ΠΕ Χανίων Τμήμα Περιβάλλοντος και Υδροοικονομίας	Ρωξάνη Μπαλαμπανάκη Ελένη Αγγελακοπούλου
19.45-20.00	Διαχείριση νερού στη κοιλάδα	ΕΥΦ Χανίων	Κωνάνος Χαρτζιδάκης
20.00-20.15	Ενεργειακή αξιοποίηση αρδευμένων	Ο.Α.Δ.Υ.Κ.	Λία Μανιάδακη
20.15-20.30	Διαχειριστικό σχέδιο Κρήτης, Λεκάνες απορροής ποταμών Χανίων	Τμήμα Περιβάλλοντος ΠΚ	Νίκος Νικολαΐδης
20.45-21.30	Ερωτήσεις - Συζήτηση		

Activities in the frame of 'Water and Life'

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Water and Life

Final Meeting, Schrobenhausen, 3-7-2013

5. Workshops on 'Sustainable use of irrigation water' in municipalities (local authorities, farmers)

- ✓ 5a. Kolibari, Municipality of Platanias, Aplil 24th, 2013
- ✓ 5b. Vrises, Municipality of Apokoronas, May 8th, 2013
- ✓ 5c. Kisamos, Municipality of Kisamos, May 22nd, 2013
- ✓ Attendants: More than 80 local authorities and farmers
- ✓ Co-organized by: ISPOT, OADYK, Municipalities
- ✓ The main subjects addressed were:

-"Crop water requirements – Sustainable water use for irrigation"

-"Localized irrigation systems: design, operation and maintenance"

-"Use of low quality waters for irrigation"

-"Water management projects in the Prefecture of Chania"

-"Ethics on water use".

Activities in the frame of 'Water and Life'

ELGO - DEMETER

Final Meeting, Schrobenhausen, 3-7-2013

ΗΜΕΡΙΔΑ
Ορθολογική Διαχείριση του Νερού Άρδευσης στις Καλλιέργειες

Τετάρτη 24 Απριλίου 2013, ώρα 19:00
Ορθόδοξος Ακαδημία Κρήτης, Κολυμβάρι

ΠΡΟΓΡΑΜΜΑ

Προεδρεία: Σ. Κρούσης, Κ. Χαρτζουλάκης, Α. Κατσιώτης

19:00. Χαιρετισμοί
Δήμαρχος Πλατανιά, Δ/ντής Ινστιτούτου Γεω. Δ/ντής ΟΑΔΥΚ, Ορθόδοξος Ακαδημία Κρήτης

19:20. Δράσεις: Έργα υποδομής - Κάτοχοι διαχείρισης
Γιάννης Μουτζάκης, Γενικός Διευθυντής ΟΑΔΥΚ

19:40. Δράσεις των καλλιεργειών - Ανάγκες σε νερό
Κ. Χαρτζουλάκης, Ινστιτούτο Ελιάς & Υποτροπικών

20:00. Τεχνολογία αποτελεσμάτων τεχνικής άρδευσης
Μ. Μπαρτάκος, Ινστιτούτο Ελιάς & Υποτροπικών

20:20. Χρήση υπολειμμάτων νερού στη γεωργία
Γ. Ψαρράς, Ινστιτούτο Ελιάς & Υποτροπικών

20:40. Ερωτήσεις - Συζήτηση

21:00. Περιβαλλοντικό Κέρασμα

Participation in project meetings - Mobility

ELGO - DEMETER

- ✓ 3rd meeting , June 18–22, 2012, Corsica.
- ✓ Participants of NAGREF: K. Chartzoulakis, G. Psarras.
  - NAGREF presented the Institute activities in a workshop.

Participation in project meetings - Mobility

ELGO - DEMETER

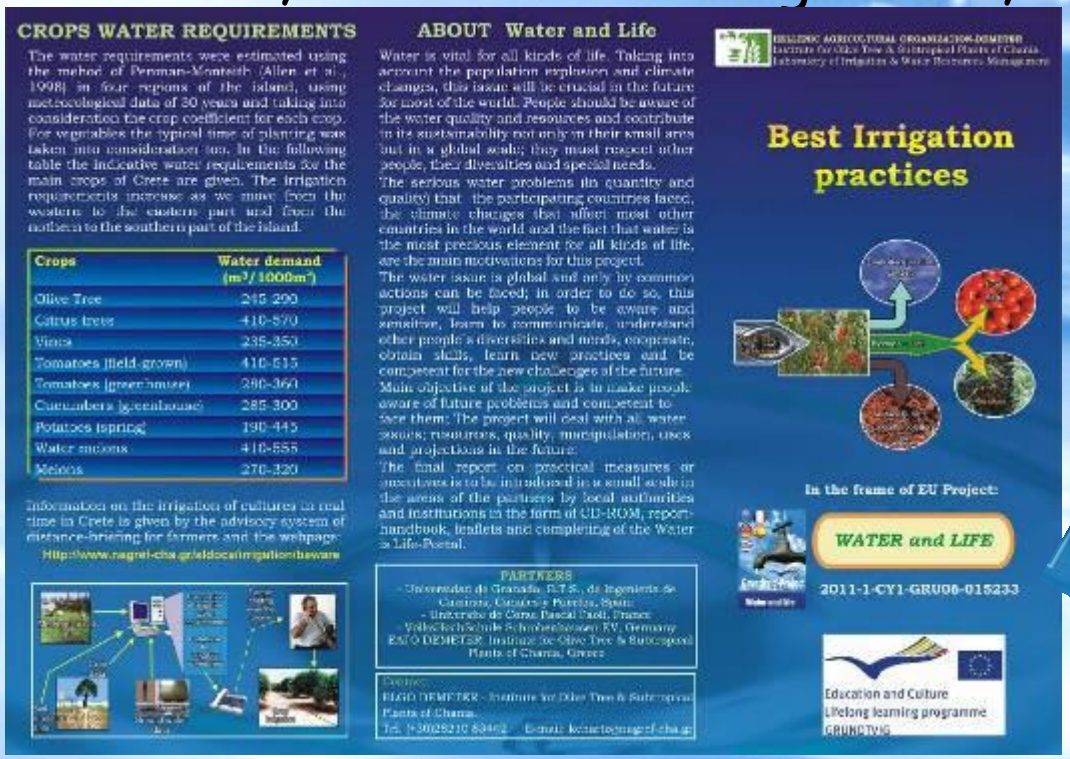
- 5th meeting, May 14 - 17, 2013, Granada, Spain.
- Participants of NAGREF:K. Chartzoulakis, M. Bertaki, A. Giannakaki .

Participation in project meetings - Mobility

- ✓ 6th meeting, June 17 - 18, 2013, Corsica, France.
- ✓ Participants of NAGREF: K. Chartzoulakis, G. Psarras, M. Bertaki.

Communication material

- ✓ A leaflet in Greek and English is designed and printed on '**Best Irrigation Practices**'
- ✓ The Greek version has been distributed either in printed or electronic form in all water-related entities (water authorities, cooperatives, municipalities, high schools, environmental agencies, etc) and farmers.



CROPS WATER REQUIREMENTS

The water requirements were estimated using the mehod of Penman-Monteith (Allen et al., 1998) in four regions of the island, using meteorological data of 30 years and taking into consideration the crop coefficient for each crop. For vegetables the typical time of planting was taken into consideration too. In the following table the indicative water requirements for the main crops of Crete are given. The irrigation requirements increase as we move from the western to the eastern part and from the northern to the southern part of the island.

Crops	Water demand (m^3/ 1000m^2)
Olive Tree	245-290
Citrus trees	410-570
Vines	235-350
Tomatoes (field-grown)	410-515
Tomatoes (greenhouse)	280-360
Cucumbers (greenhouse)	285-300
Potatoes (spring)	190-445
Water melons	410-555
Melons	270-320

Information on the irrigation of cultures in real time in Crete is given by the advisory system of distance-pricing for farmers and the webpage:
Http://www.nagrel-cha.gr/eldocairrigationbeware

ABOUT Water and Life

Water is vital for all kinds of life. Taking into account the population explosion and climate changes, this issue will be crucial in the future for most of the world. People should be aware of the water quality and resources and contribute in its sustainability not only in their small area but in a global scale; they must respect other people, their diversities and special needs.
The serious water problems (in quantity and quality) that the participating countries facee, the climate changes that affect most other countries in the world and the fact that water is the most precious element for all kinds of life, are the main motivations for this project.
The water issue is global and only by common actions can be faced; in order to do so, this project will help people to be aware and sensitive, learn to communicate, understand other people's diversities and needs, cooperate, obtain skills, learn new practices and be competent for the new challenges of the future.
Main objective of the project is to make people aware of future problems and competent to face them: The project will deal with all water issues: resources, quality, manipulation, uses and projections in the future.
The final report on practical measures or inventories is to be introduced in a small scale in the areas of the partners by local authorities and institutions in the form of CD-ROM, report-handbook, leaflets and completing of the Water in Life-Portal.

PARTNERS
- Universidad de Granada, E.T.S., de Ingeniería de Caminos, Canales y Puertos, Spain
- Université de Corse Pascal Paoli, France
Volkshochschule Schrobenhausen EV, Germany
ELGO DEMETER, Institute for Olive Tree & Subtropical Plants of Chania, Greece

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HELLENIC AGRICULTURAL ORGANIZATION-DEMETER
Institute for Olive Tree & Subtropical Plants of Chania
Laboratory of Irrigation & Water Resources Management

Best Irrigation practices

In the frame of EU Project:
WATER and LIFE
2011-1-CY1-GRU06-015233

Education and Culture
Lifelong learning programme
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Providing material for the Project calendar

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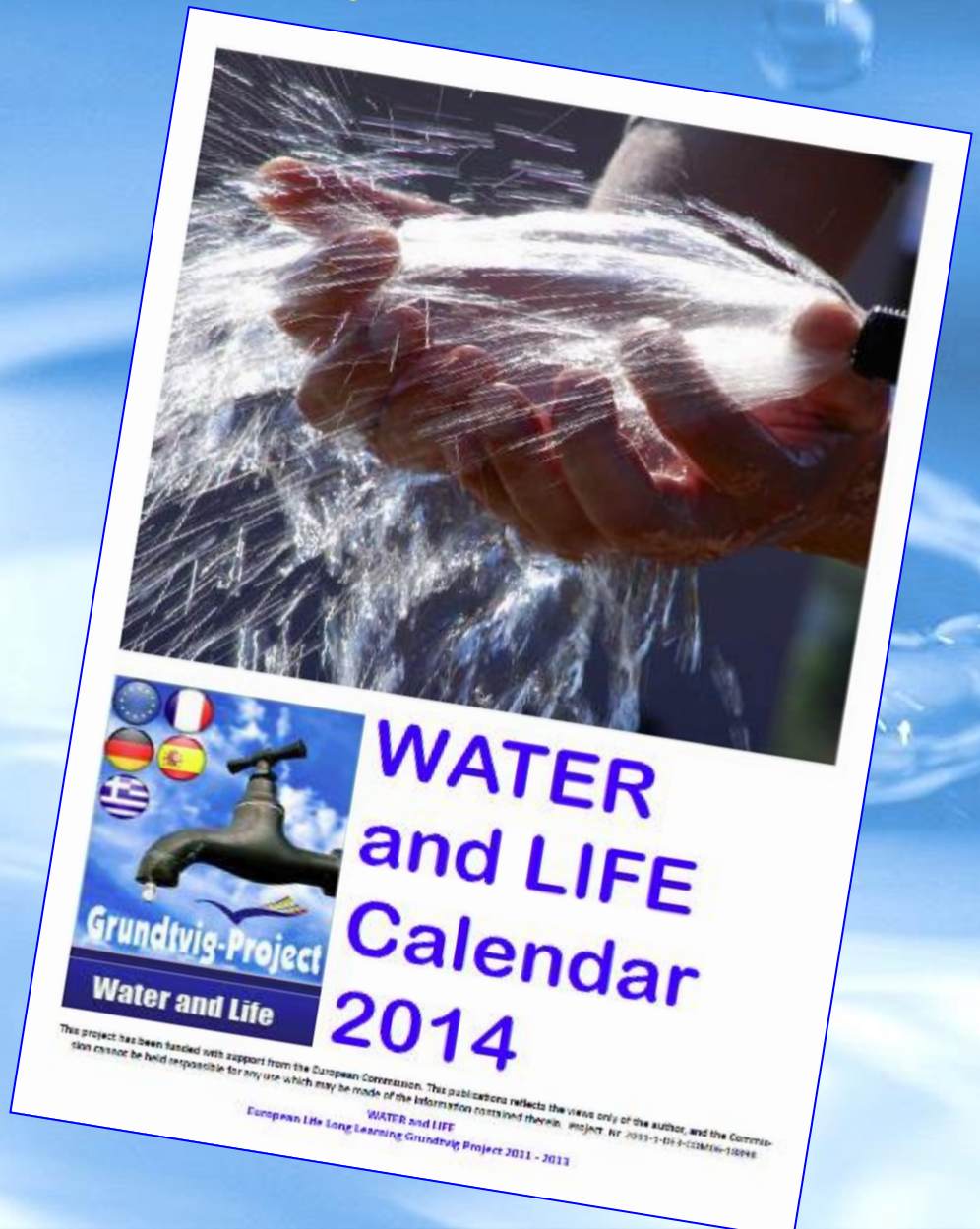

Deliverables

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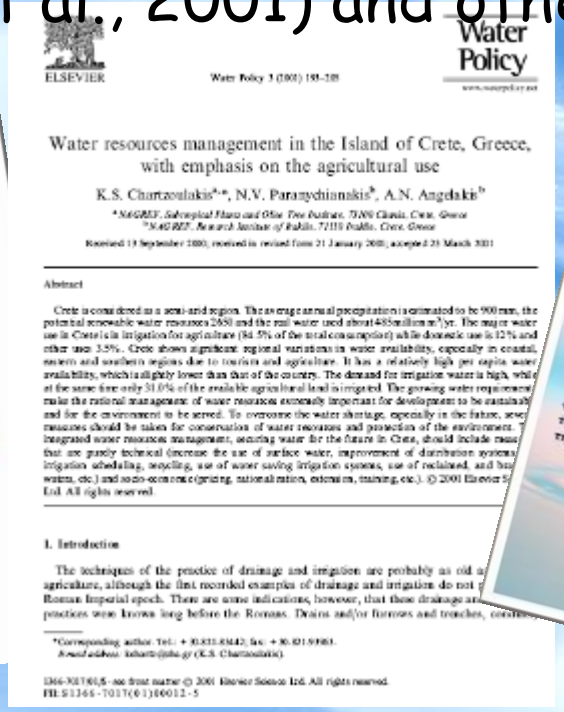
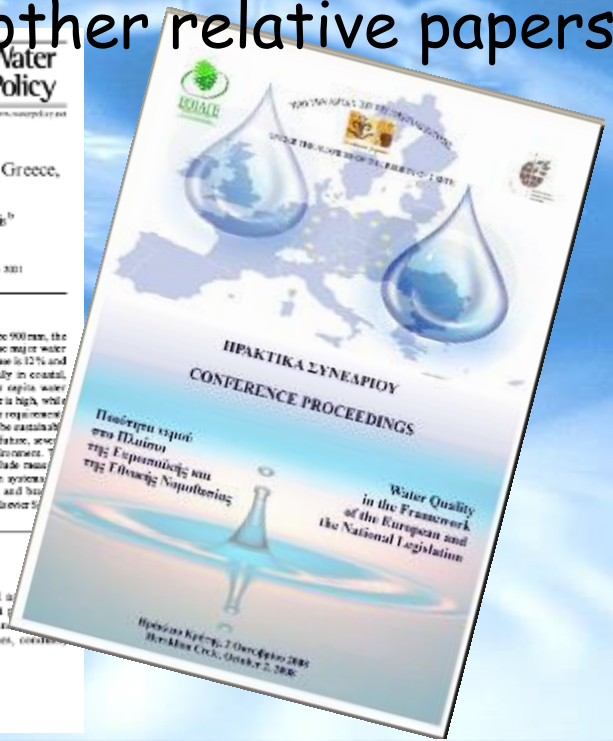
- ✓ "Report on Water Resources in Crete" (EU MEDIS project)
- ✓ "Water Quality in the Framework of the European and the National Legislation", Conference Proceedings
- ✓ "Water resources management in the Island of Crete, Greece, with emphasis on the agricultural use" (Chartzoulakis et al., 2001) and other relative papers





THANK YOU!

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Water Policy 3 (2001) 193–205

Water Policy

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Water resources management in the Island of Crete, Greece, with emphasis on the agricultural use

K.S. Chartzoulakis[a,*], N.V. Paranychianakis[b], A.N. Angelakis[b]

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Abstract

Crete is considered as a semi-arid region. The average annual precipitation is estimated to be 900 mm, the potential renewable water resources 2650 and the real water used about 485 million m^3/yr. The major water use in Crete is in irrigation for agriculture (84.5% of the total consumption) while domestic use is 12% and other uses 3.5%. Crete shows significant regional variations in water availability, especially in coastal, eastern and southern regions due to tourism and agriculture. It has a relatively high per capita water availability, which is slightly lower than that of the country. The demand for irrigation water is high, while at the same time only 31.0% of the available agricultural land is irrigated. The growing water requirements make the rational management of water resources extremely important for development to be sustainable and for the environment to be served. To overcome the water shortage, especially in the future, several measures should be taken for conservation of water resources and protection of the environment. The integrated water resources management, securing water for the future in Crete, should include measures that are purely technical (increase the use of surface water, improvement of distribution systems and irrigation scheduling, recycling, use of water saving irrigation systems, use of reclaimed, and brackish waters, etc.) and socio-economic (pricing, rationalization, extension, training, etc.). © 2001 Elsevier Science Ltd. All rights reserved.

1. Introduction

The techniques of the practice of drainage and irrigation are probably as old as those of agriculture, although the first recorded examples of drainage and irrigation do not precede the Roman Imperial epoch. There are some indications, however, that these drainage and irrigation practices were known long before the Romans. Drains and/or furrows and trenches, conduits,

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water-courses named *αμάραι* are mentioned in Homer (*Iliad*, 259). Thus, the names of the Cretan villages Αμάρι (Amari) and *Néo Αμάρι* (Neo Amari) in Rethymnon probably originated at a time when drainage and irrigation projects were constructed by the Minoans in that region. However, no traces of such projects have been found today, although Angelakis and Spyridakis (1996) believed that the Minoans had practiced irrigation. They assumed that the main region of agricultural production of that time was the Messara valley where irrigation and reclamation projects would have developed. In addition, according to Marinatos (1927), many of today's agricultural crops such as vegetables, cereals, olives, grapes and aromatic species were grown in Minoan Crete.

In the Neopalatial stage (ca. 1700–1450 BC), irrigation practices were of special significance. During periods of drought, people performed various invocations to the gods for rainfall and there is little doubt that farmers at that time had developed advanced irrigation systems. The best known of these are the so-called "Linies" (from the Latin *linea* = line), located in the Lasithi plateau. Here, numerous channels and ditches were joined to form a huge checker board pattern. This system, with proper maintenance and repair work, was used until modern times by succeeding civilizations on the island. It seems likely that the Minyans, another prehistoric people of Greece like the Minoans, introduced this technology to Orchomenos in central Greece. In fact, traces of it were observed there by British engineers during the reclamation project of Kopais lake in 1886. Thus, Minoan could be considered a pioneer of what we call today drainage and irrigation technologies (Angelakis & Spyridakis, 1996).

According to ancient mythology and other evidence handed down, repeated attempts were made at draining the plain and reclaiming arable land, as early as in prehistoric times and in antiquity. In particular, the legendary Minyans whose center was Orchomenos at the western edge of the plain are said to have been successful in doing so in the Mycenaean period (ca. 1600–1200 BC). In the 19th century, researchers collected such information and formed far-reaching theses but investigations of the historic hydraulic engineering remains on site started only gradually. The rapid development of mechanized agriculture and construction activities in the Kopais increasingly endangered what was left of old hydraulic installations (Lauffer, 1984).

In general, on the basis of our present-day knowledge and experience, the greatest respect must be paid to Minoan engineers for having had the courage to develop such a good water resource infrastructure 4500 yr ago with limited technological means and the scarce scientific knowledge.

Horticultural crops have always been the major agricultural activities in the small and medium-sized farms, especially in the Island of Crete. Usually they make the best use of the available agricultural resources and ensure an adequate income, especially in the small farms. Modern horticulture, based on new and sophisticated techniques, is quite different from that of the past and requires a rational use of its resources, especially of water. The major objective of any irrigation project is to make the required water available to the crops in view of eliminating, or at least reducing the unfavorable effects erratic climatic conditions might have on the crops.

An increasing demand for irrigation imposes a rational use of the increasingly limited water resources. This can be obtained through an advance in the knowledge about crop water requirements and irrigation technology and the diffusion of technical information to the farmers, necessary for obtaining high quality yields. This paper presents a historical development of the irrigation practices through the centuries with emphasis on Minoan civilization. In addition, the major irrigated crops, the crop water requirements, the irrigated areas, the potential for waste

water reclamation and reuse and the possibility for improvement of water use efficiency are presented. The overall objective of this paper is to describe briefly the existing conditions and problems of water resources management in Crete, as well as the different measures that should be applied to increase the availability of water and to reduce water pollution.

2. Climate

The impact of climate variations on water management and related socio-economical systems has long been the recipient of the interest of various researchers. In order to be able to predict impacts, once climate change occurs, the principle of "the past is the key to the future" has been adopted.

Although the total amount of water on the Earth is generally assumed to have remained virtually constant during recorded history, periods of flood and drought have challenged the intellect of man to develop the capacity to control the water resources available to him. Currently, the rapid growth of population, together with the extension of irrigation and industrial development, stress the quantity and quality aspects of the natural system. Because of the increasing problems, man has begun to realize that he can no longer follow a "use and discard" methodology either with water resources or any other natural resource. As a result, the need for a consistent policy of rational management of water resources has become evident.

2.1. Climate in the past

Several studies on climate variations in the Mediterranean region during the Holocene indicate that its climate was affected during summer by a subtropical high-pressure belt, which resulted in hot and rainless weather conditions. During winter the region is dominated by the mid-latitudinal depressions, connected with the westerlies regime which brings cold weather and rainfall. Studies based on fossil pollen analysis suggest that during the Chalcolithic and the Easrly Bronze Age the climate of Crete was more cold and humid than at present. The occurrence in the cores of numerous species characteristic of Central Europe, such as those of the genera *Betula*, *Fracinus*, *Cotylus*, *Carpinus*, and *Tila* which no longer grow naturally in Crete, provides evidence of a cold and humid period. On the other hand, at the end of the Chalcolithic (ca. 3000) and the Middle Bronze Age (ca. 2100–1600 BC), various pollen diagrams studied, reveal a marked decline in deciduous oak and in sensitive Central European tree pollen, such as those of the species of the genera *Betula* and *Tila* (Angelakis & Spyridakis, 1996).

Similar climatic change scenarios have been reported in Israel. Thus, a humid stage affected Palestine during the Early Bronze Age. This was proved by environmental data, such as ^{18}O and ^{13}C, as well as pollen of olive and oak trees in a core in the Sea of Galilee, records of Dead Sea levels and the level of the Nile, and of course the settlement of man in the desert. A humid stage in this region was indicated again during the end of the Late Minoan and the Iron Ages (Issar, 1995).

In this pattern, Paepe (1984), Issar and Makover-Levin (1996) and Issar (1995) concluded the followings: (a) A humid and, most probably, a cold period existed during the Chalcolithic Period (ca. 4500–3000 BC), except for its final year when the climate became warm and dry. (b) A short warm period of the Upper Chalcolithic prevailed around 3000 BC. (c) A cold and humid period

existed during most of the Early Bronze Period (ca. 3000–2200 BC). (d) A warm period commenced around 2200 BC (Middle Bronze VI) and extended to around 1500 BC. (e) From ca. 1500 to 600 BC (the Iron Age) there was another cold and humid period. (f) From ca. 600 to 300 BC (mainly during classical and Hellenistic times) the climate was rather warm and dry. (g) During the Roman period a colder and more humid period prevailed. (h) Finally, a warm and dry climate prevailed during the Arab period and reached a peak of high temperatures and drought ca. 800–1000 AD (Fig. 1).

Although little is known of the Early Minoan world, extant evidence points to a sustained cultural growth in this period of Crete's past. Notice that this cultural flowering occurred during cold and humid periods. Thus, the Minoan is universally considered to be one of the grandest and most brilliant of all ancient civilizations. Typical concerns in the construction of the principal Minoan centers appear to be the architectural and hydraulic function of stormwater and wastewater sewerage systems. These coincide with a cold and humid period prevalent at that time. Thus, it is not by chance that the main technical and hydraulic operations associated with catchment basins, surge chambers, manholes, urinals and toilets, laundry slabs and basins and sewerage systems, including disposal sites of the effluent, have been practiced in varying forms since ca. 3000 BC (Angelakis & Spyridakis, 1996).

2.2. Present climate

The present climate of Crete is sub-humid Mediterranean with humid and relatively cold winters and dry and warm summers. The annual rainfall ranges from 300 to 700 mm in the low areas and along the coast (Ierapetra 312 mm, Iraklio 512 mm, and Chania 665 mm), and from 700 to 1000 mm in the plains of the mainland, while in the mountainous areas it reaches up to 2000 mm. Such great climatological differences are due to the complex vertical and horizontal distribution of Crete. During winter that starts in November, the weather is instabilized due to frequent changes from low to high pressures. Precipitation was significantly decreased in the last 20 years in the Messara valley. A reduction in rainfall has occurred in the last two decades in the valley. However, long series rainfall data all over Crete does not show any significant change in precipitation (Markou-Iakovaki, 1979; Macheras & Koliva-Machera, 1990).

Despite considerable high precipitation (600 mm in the plains and 2000 mm in the mountains). It is estimated that from the total precipitation in plains per year about 65% is lost to evapotranspiration, 21% as runoff to sea and only 14% goes to recharging the groundwater. The rainfall is not uniformly distributed throughout the year, and it is mainly concentrated in the winter months while the drought period is extended to more than six months (May to October) with the Class A pan evaporation values ranging from 140 to more than 310 mm in the peak month (Fig. 2).

As noticed, more than one-third of the total precipitation occurs along the northern coast of the island in the three main mountainous terrains (White mountain, Idi, and Dikti). These three mountains extend over an area of 1900 km^2 and consist mainly of limestone masses intensely kasrtic as shown in Fig. 3.

Spring is short because of the cold fronts often affecting the region in March, whereas May is rather warm especially due to the appearance of the first south winds and the disappearance of the

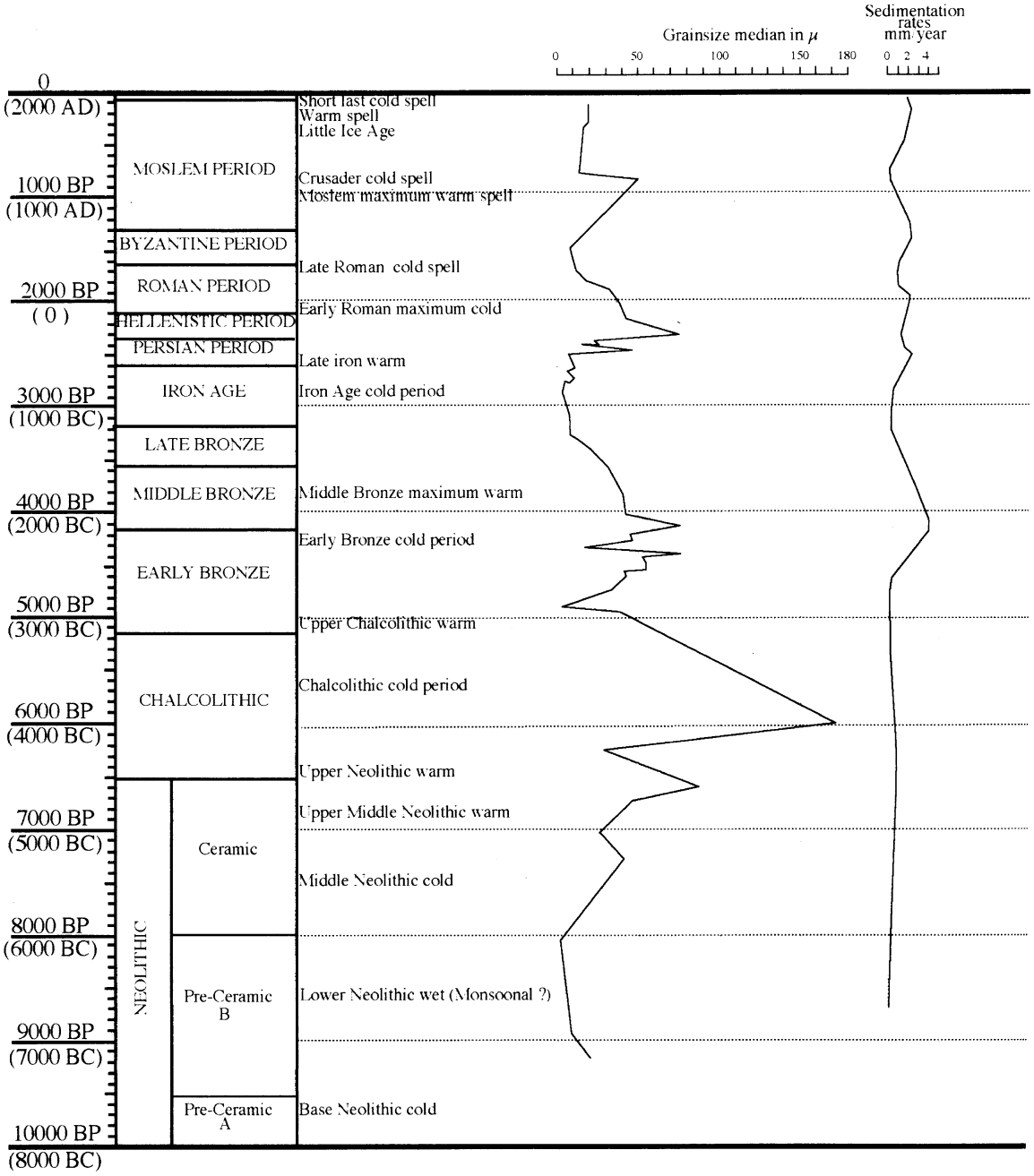

Fig. 1. Correlation between sedimentation sections in Greece (Paepe, 1984).

action of low pressures. North winds are dominant in the island. In summer, the north winds predominate creating very dry conditions, which are also enhanced by the diminishing of low pressures in the Eastern Mediterranean and is only interrupted by some local rainfall of tropical

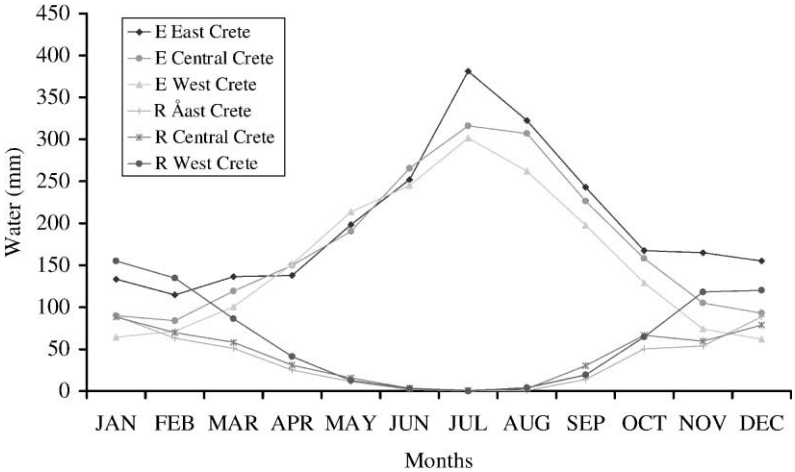

Fig. 2. Average rainfall and evaporation class a-pan in Crete (Chartzoulakis, Angelakis, & Skylourakis, 1997).

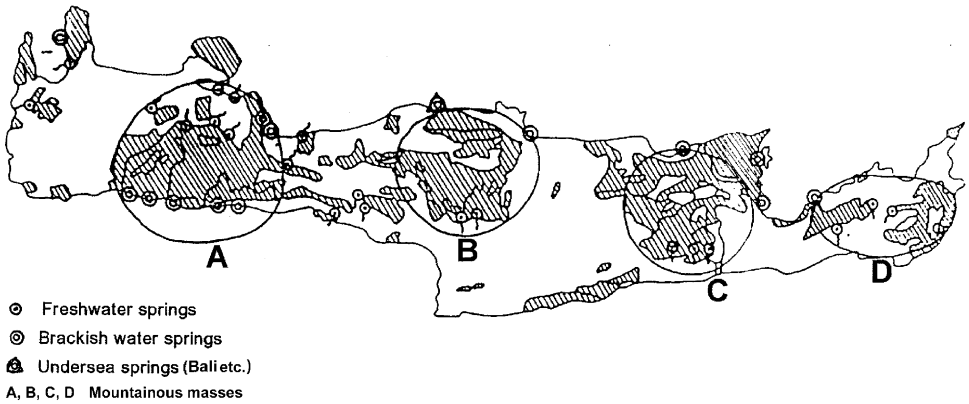

Fig. 3. Map of the main carbonate rocks of Crete with the main karstic springs (A = White Mountains, B = Idi, C = Dikti, and D = Sitia).

origin. Heat waves in the plains during summer may be rather lasting, affected by south winds blowing from Africa. The temperature of the area shows a great variation. Crete lies between the isotherms 18.5–19°C with an annual latitude of 14–15°C. The southern part of the island is warmer than the northern part and the warmest of Greece. During the cold period, temperature increases with decreasing latitude, whereas in the warm period and especially in the period from May to August, temperature increases from the coast to the mainland and particularly in the plains. In winter, the lowest temperatures scarcely fall below 0°C in the plains. During the summer, temperatures greater than 40°C may occur in the lowlands of Crete. The annual temperature has increased in the last two decades by 0.3°C (Angelakis, Cosmas, & Monopolis, 1997).

3. Water resources availability in Crete

The area of Crete is 8336 km^2, the mean altitude 460 m and the total population about 600,000 people. The average annual precipitation is estimated to be 7500, the potential renewable water resources 2650 and the real water used about 485 million m^3/yr (Department of Industry, Energy, and Technology, 1989). It is clear that water consumption constitute only a small percentage, less than 10 and 20% of the annual precipitation and water potential respectively. Although the contribution of the surface water to the potential water resources is about 40% (Fig. 4), the real contribution is about 13%, which means that almost all the water quantity used in Crete comes from subterranean sources (springs, wells, and boreholes).

The major water use in Crete is in irrigation for agriculture (84.5% of the total consumption) while domestic use is 12% and industrial use only 3.5% (mainly for olive extraction plants, packaging plants, livestock, and water bottling companies). Another sector related to water use is tourism (domestic and international), an important economic activity in Crete, which is still significantly increasing. The total number of tourists in Crete in 1999 exceeded two millions, and this number may double in 2025. The tourism industry requires huge quantities of water supply, with peak consumption during the high season and excess capacity in the low season. Furthermore, most of the tourists come from northern European humid cultures and are not prepared to encounter water scarcity.

It should be noted that water availability in average terms is not the limiting factor. Much more important are the significant regional and seasonal variations which Crete shows in water availability and demand. About 70–80% of annual rainfall occurs in three to four months, while summers are usually long and dry. This situation is further worsened by a seasonal and regional variation in water demand. Both agriculture and tourism require increased supplies in late spring, summer, and early autumn, when water is less abundant. Also, domestic use of water increases during dry and hot periods. On the average, Crete has a relatively high per capita water availability, i.e. around 4800 m^3/inh yr, which is lower than that of Greece (6700 m^3/inh yr). However, this value is much higher than that of other Mediterranean regions. For instance, there

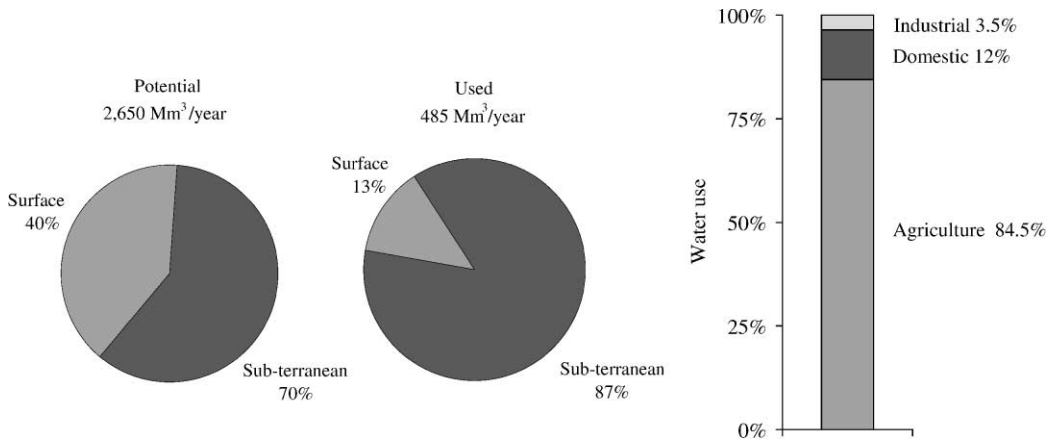

Fig. 4. Water availability and use in the Island of Crete.

are Mediterranean islands with a per capita availability of less than 1500 m^3/inh yr, such as: Cyprus 1285, Balearic islands 500 and Malta 85 m^3/inh yr (Marecos do Monte, Angelakis, & Asano, 1996).

The uneven atmospheric precipitation (spacially and regionally), the continued growth of the population, the rapid growth of the tourist industry and the periodic droughts have forced water services and other water agencies to search for new and reliable water sources. The use of reclaimed or recycled wastewater for various non-potable uses has proved to be the most reliable of sources, like in most Mediterranean countries (Angelakis & Diamadopoulos, 1995). In Crete, it is estimated that, at present, more than 100,000 m^3/d of secondary treated wastewater effluent is produced. Thus, it has been calculated that by reusing the treated effluent of today's existing plants, a 5.3% increase of irrigated area can be obtained (Tsagarakis, Tsoumanis, Chartzoulakis, & Angelakis, 2001). This is related to the availability of nearby agricultural areas and assumes that the relevant infrastructure, like storage reservoirs and distribution systems will be available.

4. Irrigation of horticultural crops

The main groups of crops and the surfaces covered in Crete are shown in the Table 1. The main vegetable crops grown in Crete are fresh tomatoes, cucumbers, potatoes, eggplants, onions, watermelons, melons, cabbages and peppers, while among fruit crops olive covers more than 89% followed by citrus 3.4%, almonds and avocados.

The demand for irrigation water is high, while at the same time only 31.0% of the available agricultural land is irrigated (Fig. 5), a percentage lower than that of Greece (36.3%). As shown in Fig. 5, there was an increase by more than 55% in the last 15 yr, while the average increase at the same time in the country was 25%. For vegetable crops, more than 91% of the cultivated area is irrigated, while the irrigated percentage in row crops was 34.0%, in fruit trees 36.3% and in vineyards 45.1%.

Depending on the size, irrigation projects are constructed by the government, the local authorities or private individuals. The large size irrigation schemes, which involve large hydraulic structures such as dams, conveyors, pumping stations, reservoirs and modern distribution systems are constructed by the governmental Water Resources Services and/or Agencies. The medium size

Table 1
Area and crops cultivated in Crete ($\times 10^3$ ha)[a]

Category	Cultivated area (10^3 ha)	Percentage of the total
Row crops	32.1	9.96
Vegetable crops	8.9	2.76
Vineyards	30.6	9.50
Fruit crops	182.6	56.70
Forage crops	14.2	4.50
Fallow fields	53.6	16.58
Arable land	322.0	100.00

[a] Source: Hellenic National Statistical Service, Preliminary data 1998.

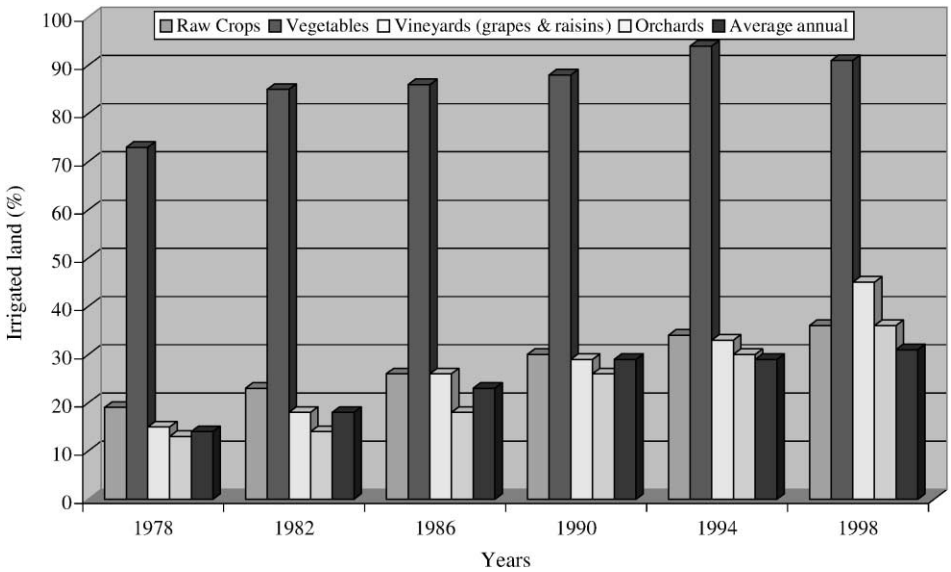

Fig. 5. Irrigated crops (percentage of the total cultivated area) in Crete during the last twenty years. Source: Hellenic National Statistical Service.

irrigation schemes of local importance, are constructed by the government on behalf of the Local Authority (Prefecture or Community) and usually comprise small dams or off stream ponds or boreholes and modern distribution systems. The cost of large and medium size irrigation schemes is financed by the government and farmers are charged per unit of water consumed. The small size irrigation schemes, comprising a single borehole, are constructed by individuals at their own cost and are found mostly in areas overlying aquifers.

The irrigation networks are of modern type made of pressurized distribution systems with delivery of water to the farm outlets. The delivery of water to the farm outlets is done on free or modified demand or on rotation with the appropriate pressure for direct use through modern on farm irrigation systems. Although in most cases irrigation water is distributed to fields through closed pipeline networks, there are major losses (seepage, evaporation, leakage, etc.) from water delivered to the agricultural sites for irrigation (Chartzoulakis, Angelakis, & Skylourakis, 1997). It is estimated that, on average, only 55% of water diverted or extracted for irrigation is effectively used by the crop (Fig. 6). In some cases, the losses are estimated to be as much as 50% of the delivered water (Dialynas, Diamadopoulos, & Angelakis, 1995).

The price of water per cubic meter varies greatly between catchment areas and even within the same catchment area, depending mainly on the managing agency. Cretan farmers operating in publicly developed irrigation projects still do not fully cover operation and maintenance (O&M) or capital replacement costs. So in the large irrigation project of West Crete the price is as low as 0.07–0.08 euros, whereas in community projects it reaches 0.10–0.12 euros and in some private projects it reaches 0.23–0.35 euros. These prices are much higher than in Portugal or in some regions in Spain (OECD, 1999). However, the implementation of a policy of approach between prices charged and real usage cost of water would set the course for achieving re-evaluation of this resource. This policy services as a financial instrument to offset the infrastructure cost and that of

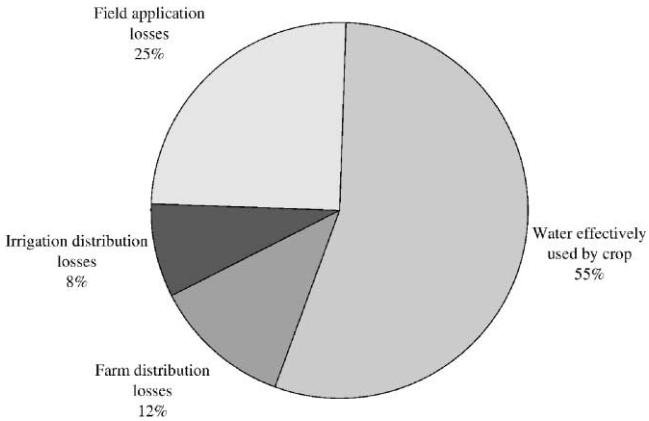

Fig. 6. Average irrigation water losses in the Island of Crete.

environmental restoration and it is a guarantee for rational water usage, with users becoming aware of its shortage. In addition, this policy will serve as a mechanism that automatically selects which production uses, in which areas, are the most important in the allocation of water.

Irrigation scheduling is another aspect of utmost importance for the appropriate irrigation of horticultural crops. It consists of a set of procedures which allow one, for a given crop, to find out when and how much to irrigate. Irrigation scheduling methods are based on environmental, physiological and soil parameters. The continuous technical progress in the irrigation scheduling methods using plant physiological indices (leaf water potential, stomatal opening, changes in diameter of selected organs, infrared thermometry, refractometry of the sap, etc.), although showing important innovations, involve measurements that are complex, time consuming and difficult to integrate and require highly qualified farmers. Since the average size of its irrigated field is half a hectare, the cost of such methods is very high, besides other difficulties, and our farmers do not use it at all.

For vegetables, especially in greenhouses, the analysis of soil moisture (by tensiometers, gypsum blocks or gravimetrically) is the most common method used for irrigation scheduling in Crete, since it assures low cost, simple operation and reliable estimation of soil water status. For tree crops, irrigation scheduling is mainly based on meteorological parameters (mainly Class A pan evaporation and Reference evapotranspiration ET_0). In Chania prefecture, thanks to the Irrigation Department of Subtropical Plants and Olive Tree Institute, information about irrigation to the farmers is given through a weekly bulletin, based on class A pan evaporation. Recently, thanks to new advances in communication, some assistance systems based on agrometeorological approach have been planned, which would permit an efficient exchange of information between Research Institutes, Extension Services and farmers.

Research in irrigation and water management for agriculture in Crete is carried out in the respective departments of two research institutes existing in Crete, the Subtropical Plants and Olive Tree Institute in Chania and the Research Institute for Viticulture, Floriculture and Vegetable Crops in Iraklio, both of which belong to the National Agricultural Research Foundation. Both institutes are involved in national and international projects, and with training

courses, seminars and conferences they try to help the farmers to assimilate the new technologies and techniques in the field of water management.

6. Conclusions and recommendations

The necessity for expanding and improving irrigation, in order to ensure sustainable agriculture, is increasing in Crete. Given the severe limitations of exploiting new water resources, the only solution in meeting water requirements is to use of water more efficiently.

Although several important advances have been made over the last several years, significant challenges still remain in the areas of technological, managerial, policy innovation and adaptation, human resources management, information transfer and social environmental considerations. These issues for the Island of Crete, but applicable to most Mediterranean countries, are:

(a) *Water conservation and efficient use*. Since agriculture is by far the largest water user, efficient irrigation management will undoubtedly be a major conservation option for the future. It can be achieved through irrigation requirements and irrigation scheduling techniques, use of localized irrigation systems, salinity management techniques, and reduction of losses from water conveyance systems.
(b) *Water sectorial use*. Any amelioration of conflict and competition among water users will have positive effects in improving efficiency and productivity. Greater efforts are urgently needed to integrate irrigation planning and management with other sectors of economy that impinge on water use.
(c) *Water pricing and cost recovery*. The most important recommendation we can make is the adoption of full-cost pricing of water use and services. It will be the basis for promoting conservation, reducing losses and mobilizing resources. Furthermore, it could affect cropping patterns, income distribution, efficiency of water management, and generation of additional revenue which could be used to operate and maintain water projects.
(d) *Wastewater reuse*. Water resources shortage and environmental concerns have already led to waste water reuse for irrigation. Since waste water reuse has multidisciplinary interlinkage with different sectors such as environment, health, agriculture, water resources, etc., it is necessary for the administrative responsibility of reuse activities to be well defined.
(e) *Water quality management and use of saline water*. It is becoming increasingly as important as water quantity, and is a far more complex task than quantity monitoring. Research has provided much knowledge on the specific interactions of saline waters on soil and plant and various strategies and criteria have been developed for the safe use of such waters for crop production.
(f) *Other cost-effective technologies*. Besides technologies, such as reclamation and reuse of marginal waters, other cost-effective technologies, such as artificial recharge of groundwater, should be considered.
(g) *Technology transfer*. The availability of improved technologies or techniques is however no guarantee for their application. The farmer will play a key role in adopting more efficient and sustainable water management practices. Factors that provide the favorable conditions under

which the farmers may accept and adopt better and more efficient water use practices are clear benefits for efficient water use, investment support, adequate legislation, simple, practical and cost-effective technologies, guidance and advice in introducing efficient technologies.

(h) *Education and training*. Extensive educational programs should be instituted at all levels of society to promote prudent use and conservation of water as one of the indispensable natural resources. The institutional framework for support services and the training of the staff involved in irrigation development, will be the key to the introduction of new technologies in irrigation.

(i) *Development of an integrated water resources plan*. The necessity for establishing an integrated water resources plan similar to that of California, Israel or other regions, with advanced water resources management should be considered. It is of high importance to apply a policy for water resources management which will cover the present requirements but also ensure the future needs.

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Water resources management in Crete (Greece) including water recycling and reuse and proposed quality criteria

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Abstract

In Crete, Greece despite having adequate atmospheric precipitation, water imbalance is often experienced, because of temporal and spatial variations in the precipitation, an increase in water demand during summer months and the difficulty of transporting water due to the mountainous terrain. Crete can be regarded as a representative mediterranean region with a relatively high potential for wastewater recycling and reuse. Preliminary estimates show that the implementation of wastewater recycling and reuse plans would lead to water savings of up to 5% of the total irrigation water. The basic aim of this paper is to present views on integrated water resources management in Crete, Greece including the potential for the recycling and reuse of treated wastewater. A preliminary inventory, distribution and mapping of wastewater treatment systems in Crete is also presented. Furthermore, the quality of treated effluents, disposal sites, irrigated areas, and environmental, social, economical, and agronomical impacts are considered. Finally, quality criteria for reuse of treated wastewater in Greece and maybe for other mediterranean countries are proposed.
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Keywords: Integrated water management; Quality criteria; Wastewater treatment; Water recycling

1. Introduction

The total annual precipitation in Greece and the total water potential are estimated to be $115,375 \times 10^6\,m^3$ per year and $69,000 \times 10^6\,m^3$ per year, respectively (including water inflows from countries to the north). At the beginning of the 1990s the total water consumption was estimated at $5,500 \times 10^6\,m^3$ per year, but by the end of the decade it was

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increased by about 30%. It is estimated that water consumption in Greece increases by more than 3% per year. The major water use category in Greece is irrigation, which varies among water regions from 17% (Attica) to 95% (East Peloponnese), while domestic use ranges from 3% (East Peloponnese) to 66% (Attika), and industrial use from 0.2% (West Central Greece) to 16.0% (Attica) of the total consumption (Tsagarakis et al., 2001). The increased water demand, for both urban and agricultural use, cannot always be met, despite adequate precipitation. Water imbalance is often experienced, especially in coastal and south-eastern regions, due to: (a) the temporal and spatial variations in the precipitation; (b) an increase in water demand during the summer months; and (c) the difficulty of transporting water due to the mountainous terrain. However, on average, there is a relatively high per capita water availability, i.e. around 5,800 m^3/inhabitants per year in year 2000.

Agriculture in Greece has undergone substantial development since 1980 but further development is limited by water availability. Although only one-third of agricultural land is irrigated, the estimated mean annual increase in agricultural water use is only 1–1.5%, consequently there is a great demand for irrigation water. In Crete, for example, only 36% of the available agricultural land was irrigated in 1997. Moreover, major water losses occur (seepage, evaporation, leakage, etc.) during the delivery of the water to irrigated sites and to municipal sites for domestic use (Chartzoulakis et al., 2001). Thus the potential for water recycling and reuse, particularly in south eastern parts of the country, is relatively high.

Greece, with a population of 10.9 million, has to comply with the 271/91/EC directive on urban wastewater treatment (EU, 1991). Today there are over 300 municipal wastewater treatment plants (MWTP) serving about 65% of the country's permanent population. For 21% of the remaining population, it is estimated that 1,800 MWTP will be needed. The remaining 14% of the population is in small villages and remote areas and on site sanitation technologies should be used. However, Greece, as a member of the EU, is required to connect all agglomerations at sensitive areas to sewerage networks with population equivalent (p.e.) $\geq$ 2,000 to MWTP by the end of 2005.

It is necessary that an integrated river basin water management scheme be adopted in response to 60/2000/EC directive (EU, 2000). Marginal waters and especially recycled water should also be considered in such a management scheme. The objectives of this study are to analyze the wastewater treatment status, to investigate the potential for water recycling and its considering as part of an integrated water resources scheme. Potential uses of recycled water are analyzed, particularly for agricultural irrigation on the island of Crete. In addition, quality criteria for the reuse of treated wastewater in Greece and perhaps other mediterranean regions are proposed.

2. Water resources management in Crete

The island of Crete has been characterized by a significant increase in urban and touristic activities, particularly over the past twenty years. As a result of this development the majority of the population has become concentrated in coastal areas. In many cases the infrastructure required to support this type of economical development is inadequate. Although underground water resources are estimated to be sufficient to cover all water needs, the lack of

Table 1
Available water resources and water uses for Crete

Area (km^2)	Precipitation (Mm^3 per year)	Water potential[a] (Mm^3 per year)			Water use[b] (Mm^3 per year)			Consumption index (%)
		Surface	Ground	Total	Agricultural	Domestic and industrial	Total	
8,335	7,690	1,300	1,300	2,600	446	69	515	19.8

[a] Tsagarakis et al. (2001).
[b] Region of Crete (2002).

proper organization and infrastructure has led to serious problems, due to increased water demand particularly during the dry periods.

Water consumption and use in Crete is less than 7% of the annual precipitation. However, in many cases there is a severe water imbalance due to temporal and regional distribution of precipitation. This situation is made worse during the summer months when water demand rises due to irrigated agriculture and increased water consumption as a result of tourism. Furthermore, high percentage of the annual precipitation occurs in the mountainous areas of western Crete and transport of water to the rest of the island exhibits technical, social, and economical limitations. An alternative plan should include integrated water resources management as well as the integration of recycled water originating from the MWTP effluents, into the water resources management. A such plant not only would provide additional water, particularly for irrigation, but also contribute significantly to public health protection to water availability increase, and to coastal pollution protection.

The available water resources and water uses for Crete are shown in Table 1. Note that water use is 515 Mm^3 per year. The total water potential is 2,600 Mm^3 per year, resulting in a consumption index of 19.8%.

3. Wastewater treatment in Crete

The coverage of municipal wastewater treatment in Crete has increased during the past two decades. In 1994 there were nine MWTP in operation but this figure had increased to 13 in 1998 (Tsagarakis, 1999). Today the number of MWTP in operation is 25 and it is estimated that by 2006 this number will have increased to 46. At present seven plants are under construction while other 14 are in the planning stage. There are also four plants which have failed. The failure of those plants is due to the old and not appropriate technology applied and to the scarcity of properly trained technical personnel at these facilities. The number of MWTP according to their status, their total design p.e. and population connected currently to the sewerage system, i.e. served population (s.p.), which reflects the current average flow rate in the hot season, are presented in Table 2. It is estimated that almost all Cretan municipalities with p.e. $\geq$ 2, 000 will be connected to MWTP providing at least secondary treatment by 2005. The locations of all existing and planed MWTP in Crete and their status are presented in Fig. 1. A higher concentration of plants in the eastern island is shown due to the decently populated area. Notice that 50 and 30% of the total population of the island is staying in the county of Iraklio and the metropolitan area of Iraklio city, respectively.

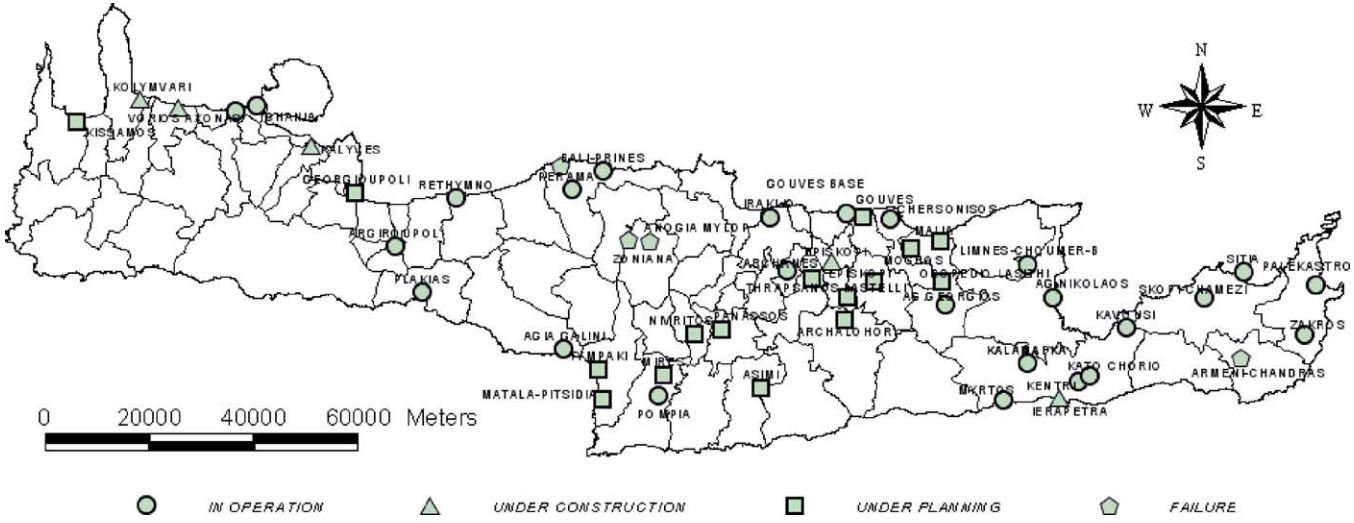

Fig. 1. Location of MWTP in Crete.

Table 2
Development of MWTP in Crete according to their number, p.e. and s.p.

Status	No				p.e.				s.p.		
	1994	1998	2002	2006	1994	1998	2002	2006	1994	1998	2002
In operation	9	13	25	46	49,300	356,250	471,550	712,650	n.d.	267,100	313,900
Under construction	n.d.	6	7	n.d.	n.d.	20,500	124,100	n.d.	n.d.	n.d.	n.d.
Under planning	n.d.	n.d.	14	n.d.	n.d.	n.d.	117,000	n.d.	n.d.	n.d.	n.d.

n.d.: no available data.

4. Effluent recycling, disposal and reuse in Crete

The operational status of MWTP, the quality of treated wastewater, the disposal sites, reuse case studies, and the potential for water recycling and reuse are mainly considered in the following text.

4.1. Operational status

Tsagarakis (1999) has classified the MWTP in operation according to their performance, taking into account effluent qualitative parameters and the effluent quality requirements. Out of 13 MWTP, 42% were operating properly, 41% moderately, and 17% poorly. Today, using the same criteria, out of 25 MWTP, 60% are operating properly, 20% moderately, and 20% poorly. Thus, a significant improvement in the performance of MWTP is indicated. This is mainly due to increased experience and the positive effect of the reforms that were achieved through the new local administrative structure, implemented under Law 2539/97 (Ministry of the Interior Public Administration and Decentralization, 1999).

4.2. Quality of treated wastewater

In general, the quality of the effluent in most of the MWTP appears to be satisfactory (Table 3). On an average basis the BOD_5, SS, and nutrient concentrations in the effluent appear to be on appropriate limits. Also EC maintains less than 2.7 dS/m, i.e. none severe potential irrigation problem (Tchobanoglous et al., 2003). Finally, inorganic constituents and especially heavy metals are in the range recommended for irrigation waters by Tchobanoglous et al. (2003). However, these concentrations do not create a problem because acid soils are very rare in Crete.

4.3. Disposal sites

In the early days of wastewater treatment, Crete, like the rest of the country, had not developed its own local knowledge on wastewater management, and therefore disposal practices were transferred from other countries, with different requirements for disposing of the effluent and water uses (Tsagarakis et al., 2001). Sea outfalls were used mostly at coastal areas for discharging treated effluent. Installations away from the sea usually dis-

Table 3
Qualitative and quantitative data from major MWTP of Crete

	Units	Sitia	Agios Nikolaos	Archanes	Chania	Hersonissos	Ierapetra	Iraklio	Pompia	Rethimno
s.p.		14,000–17,000	10,000–18,000	5,000–9,300	70,000	10,000–40,000	10,000	120,000–145,000	1,200	55,000–60,000
Q_e	m^3/day	2,600–3,000	1,000–2,000	600	17,000	500–3,400	1,800	21,000–24,000	144	7,500
BOD_5	mg/l	18–44	15.7	4–10	5–10	11	7–10	6–10	7.7	5–10
COD	mg/l	25–48	54.0	10–30	29	53	24–30	10–20	18.3	35–45
TDS	mg/l	–	–	–	–	–	–	1,300–1,600	–	1,400–1,600
SS	mg/l	15–28	20.0	5–15	8	4.5	–	5–10	5.6	10–15
NTU		–	–	–	–	–	–	5–8	–	5–10
EC	dS/m	0.65–1.23	1.4–1.9	2.7	1.2–1.9	2.6	1.3–2.2	2.0–2.5	1.5–1.9	2.2–2.5
pH		–	7.7	7.5–8.1	7.50	7.32	7.5–8.1	7.5–7.8	–	7.5–8.0
TKN	mg/l	1.6–3.1	–	–	4.50	2.37	11–16	15–25	17.8	2–3
NH_4–N	mg/l	0.01–0.17	2.1	0.5–4.0	0.40	0.52	0.1–0.5	3.0–6.0	–	0.3–1.0
NO_3–N	mg/l	–	0.9	0.7–5.0	7.10	5.49	11.2–15.1	4.0–8.0	–	0.3–1.0
NO_2–N	mg/l	–	–	–	0.47	–	–	–	–	0.1–0.2
Total P	mg/l	1.8–4.3	–	4.25	7.90	6.06	–	10–15	6.2	3–7
Total K	mg/l	–	–	–	–	27.51	–	–	–	–
Cl^-	mg/l	–	–	170.4	–	576	–	–	–	500
Cd	mg/l	–	–	–	–	0.0048	–	–	–	–
Cu	mg/l	–	–	0	0.013	0.014	–	–	–	–
Fe	mg/l	–	–	0.03	0.15	–	–	–	–	–
Pd	mg/l	–	–	–	–	0.0064	–	–	–	–
Mn	mg/l	–	–	0.02	0.02	–	–	–	–	–
FC	MPN/100 cm^3	90–1,050	–	25	50–500	0–2,100	40–300	0	–	10^6
TC	MPN/100 cm^3	250–1,400	1,000	120	–	0–8,600	90–750	0–30	–	2.3×10^7

Notes. Average values are presented; quantitative variation are due to seasonal tourism.; not all the plants operate disinfection at all times although it is installed.

Table 4
Disposal sites of MWTP at different times in Crete, according to their number, p.e. and s.p.

Disposal site	No			p.e.			s.p.	
	1998	2002	2006	1998	2002	2006	1998	2002
Sea	10	12	13	354,200	460,800	480,800	259,800	277,300
Ephemeral river	6	9	9	17,350	23,600	23,600	5,300	9,250
Irrigation agricultural	3	9	21	4,200	105,250	187,250	2,000	25,350
Irrigation landscape	–	2	3	–	6,000	21,000	–	2,000
Total	19	32	46	375,750	595,650	712,650	267,100	313,900

charged into ephemeral rivers. Other possible disposal sites include irrigation of agricultural and forested land. The number of MWTP falling into each category, their p.e. and s.p. at different years are shown in Table 4. It can be observed that there is a change in the disposal sites from the sea to that of irrigation use. In 1998, 53% of the plants (10/19) were designed to discharge into the sea, while this percentage is 38% (12/32) and 28% (13/46) for 2002 and 2006, respectively. In terms of p.e. these percentages are higher as the larger plants still dispose their effluents into the sea. On the other hand, the number of MWTP that recycle the treated effluent for agricultural and landscape irrigation has increased from 16% (3/19) in 1998 to 34% (11/32) in 2002 and is estimated to be 52% (24/46) in 2006.

4.4. Reuse case studies

Wastewater recycling and reuse in Crete has the potential: to provide new and low-cost sources of water, particularly for irrigation, to prevent coastal pollution, and to define a public policy emphasizing resources and nature conservation. At present the following MWTP are implementing recycling and reuse plans.

4.4.1. Palekastro

In this plant, 280 m^3 per day of treated effluent is used to irrigate olive trees after loading on a 20 m^3 storage reservoir. The irrigation method is trickle irrigation.

4.4.2. Zakros

In this plant, 210 m^3 per day of treated effluent is used to irrigate olive trees, without any storage. The irrigation method is trickle irrigation. During the non irrigation period, effluent is diverted to the adjoining ephemeral river.

4.4.3. Herssonisos

Treated effluent is stored in two reservoirs of total volume 1000 m^3. The main uses of recycled water are (Borboudaki et al., 2002):

- Irrigation of agricultural land: The whole system provides water for irrigation of olive trees covering an area of 2,200 ha. Water is applied to the irrigated land by trickle irrigation.

- Landscape irrigation: Two types of landscape irrigation are practiced: (a) irrigation of ornamental plants on the side slope of the new national road Iraklio–Ag. Nikolaos (6–7 km); and (b) irrigation of 5 ha land planted with ornamental trees and scrubs in the surrounding areas to the five star Creta Maris and 0.5 ha at the four star Silva Maris Hotels. Both of these hotels are located near the city of Hersonissos and are connected to the MWTP sewerage network.
- Fire protection: Water for fire protection is provided through the storage tanks used for agricultural irrigation. In these tanks water level should always maintain above 200 m^3 as this quantity is regarded as the minimum needed in case of fire at the surrounding area.

4.4.4. Archanes

In this MWTP there is planning for tertiary treatment of 40 m^3/h secondary effluent by filtration and UV disinfection and reuse it for irrigation originally of about 14 ha of olive trees and vineyards. An irrigation network of 5.1 km in length is going to be installed for irrigating two irritation zones at different latitudes. One storage tank is going to be installed in each zone of volume 150 and 100 m^3, respectively (Kounenaki, 2002).

4.5. Potential for water recycling and reuse

An analysis has been carried out to estimate the potential use of recycled water in three main irrigation categories given priority as follows: (a) irrigation of agricultural land; (b) irrigation of forested land and fire protection, and; (c) landscape irrigation. An average effluent production of 150 l/p.e.·day is used. The potential for effluent reuse in the years 2002 and 2006 are presented in Table 5. It can be concluded that by reusing the effluent of the existing MWTP, particularly for irrigation of agricultural land, irrigation water could be increased by 5.1% or fresh water used currently for irrigation could be saved. Utilization of the recycled water is related to the existence of nearby agricultural areas and assumes that the relevant infrastructure, like storage reservoirs and distribution systems, will be available. It is estimated that for, the year 2006 this will be 5.7%. For saving additional effluent it is necessary to implement new recycling and reuse projects.

Water consumption for domestic and industrial purposes was 69 Mm^3 per year in 2002, 65 of which is estimated to be for domestic use (Table 1). In addition, Table 5 indicates that more than 26 Mm^3 per year of it can be reused, i.e. about 40% of the water consumption.

Table 5
Potential for effluent reuse of MWTP for various purposes in cubic metre for the region of Crete

Year	Irrigation of agricultural land	Irrigation of forested land and fire protection	Landscape irrigation	Total water reuse potential	Total water use	Percentage of saving over water used
1998	16,490,700	4,026,863	0	20,517,563	458,000,000[a]	4.5%[a]
2002	22,016,070	4,048,763	262,800	26,327,633	515,000,000	5.1%
2006	28,687,229	4,286,925	870,525	34,102,612	597,000,000[a]	5.7%[a]

[a] Estimations based on 2002 data.

5. Proposed wastewater effluent quality criteria

Potential risks of water recycling, EU and WHO initiatives, and the recommended criteria for Greece are presented in the following text.

5.1. Potential risks

By using untreated or inadequately treated wastewater could adversely affect the environment and consequently human health. Thus, among the most important adverse effects on the environment, with the use of inadequately treated wastewater, are pollution of soil and water resources and consequently public health risks.

5.1.1. Effects to soil

On a long-term irrigation strategy, the total quantity of salts applied to the irrigated soil with the applied water should be equivalent to the salts uptaken by the crop plus the amount leaking from the soil. Soil salinitization is common in arid and semi-arid regions, where water could be saline and salt concentrations could be further increased through the wastewater treatment processes. Thus, in such areas additional criteria for EC and SAR must be applied.

In addition to the soil salinity and toxicity of both specific ions, such as Na^+, Cl^-, also B^{3+} should be considered as well as heavy metals. Also, by adding heavy metals in vedoze soil zone, their concentration and solubility in the soil solution under certain conditions will increase with time and following some years of irrigation, it is possible for toxic levels to develop in plant tissues (Angelakis, 2003). However, the water supply economy in Crete depends on the groundwater. Thus, water supply quality is very good with very low EC (<1 dS/m) resulting also in relatively low EC and TDS concentrations in the treated wastewater (Table 3).

5.1.2. Effects to water resources

Most pathogens present in wastewater and treated wastewater effluent are retained in the top few centimetres of the soil, particularly in fine textured soils (Tzanakakis et al., 2003), and the horizontal movement distances under uniform soil conditions, are normally less than 20 m. Also, the depth of groundwater table even during the winter period areas appears to be very deep. Thus, the potential contamination of soil and consequently of the groundwater is depending on the survival time of the specific pathogens during its residence time in the soil. However, the concentration of heavy metals in the treated wastewater is relatively low due to the existing of small to medium communities and without industrial facilities connected to the sewerage network (Table 3).

5.2. EU initiatives

In Greece no guidelines or criteria for wastewater recycling and reuse have yet been adopted. It should be mentioned that secondary effluent quality criteria are used for discharging purposes according to the Health Arrangement Action of 1963 (Ministries of Interior and Public Health, 1965) and are independent of the disposal, recycling, and reuse

practices. Moreover, no water recycling and reuse regulation exists at the European level. The only reference to it is in article 12 of the European Wastewater Directive 91/271/EEC (EU, 1991) stating: "Treated wastewater shall be reused whenever appropriate." To make this statement reality, common definitions of what is "appropriate" are needed. Thus, the need for establishing wastewater recycling and reuse standards at both the European and national level is obvious (Angelakis et al., 1999).

5.3. WHO initiatives

The WHO guidelines were derived from the review of epidemiological studies of wastewater reuse, along with what was achievable by wastewater treatment processes (Havelaar et al., 2001). Studies are available on the disease risk from some pathogens and the illnesses risk on the exposure to raw wastewater and excreta, and on the risk to farm workers in developing countries (Blumenthal et al., 2001). However, there is little data available on the effect of the use of treated wastewater on the general public, particularly in relation to consumption of vegetable crops. Where epidemiological evidence is not sufficient to allow the defining of a level (microbiological quality) at which no excess risk of infection would occur, data on pathogen removal by wastewater treatment processes, pathogen die-off in the field, and pervading guidelines for water quality are taken into account (Gerba and Rose, 2003). WHO (1989) guidelines are under revision. The first draft is expected to be published early of 2004.

5.4. Recommended criteria

More recently a group of experts in the water recycling area have proposed international guidelines for recycled water based on draft Australian guidelines (Anderson et al., 2001). These guidelines are based on the level of FC and treatment received by the wastewater. In Greece a preliminary study for establishing quality criteria has been undertaken. A summary of those criteria are given in Table 6. As indicated, these criteria are based on similar principles to those of Anderson et al. (2001) and Gerba and Rose (2003). Any application of the criteria (Table 6) should be associated with the following general comments:

(a) A minimum sample of four should be considered.
(b) Student's *t*-test should be met.
(c) Values for criteria indicated must be conformed at 80% of the samples per month, based on average values.
(d) Control of odor is required in cases of application to the soil surface in and/or closed to residential areas.
(e) Criteria for irrigation are not applicable in the cases of subsurface irrigation.
(f) For agricultural irrigation avoidance of using disinfection with Cl^- should be taken into account. In addition, the following should be considered: (i) integrated management of water resources; (ii) seasoned storage which improves water quality and; availability, and (iii) quality supervision of the sampling method, the frequency of sampling and the reliability of analyses.

Table 6
Proposed minimal microbiological and physical criteria for reusing of reclaimed wastewater in Greece

No	Water quality criteria	Recommended uses
1st	I.N.[a] $\leq$ 0.1 eggs/l FC $\leq$ 10 cfu/100 ml TSS $\leq$ 10 mg/l	(a) Residential areas with high public contact (b) Toilet flushing and air conditioning (c) Car washing
2nd	I.N. $\leq$ 1 eggs/l FC $\leq$ 100 cfu/100 ml TSS $\leq$ 20 mg/l	(a) Ponds, bodies of water, and streams with high public contact[b] (b) Fountains and other recreation places (c) Streets cleaning and fire-fighting
3rd	I.N. $\leq$ 1 eggs/l FC $\leq$ 1000 cfu/100 ml TSS $\leq$ 35 mg/l	(a) Irrigation of fodder crops for livestock[c], of crops for canning, of vegetables to be eaten cooked, of plant nurseries, etc. (b) Aquaculture
4th	I.N. $\leq$ 1 eggs/l FC $\leq$ 10,000 cfu/100 ml TSS $\leq$ 35 mg/l	(a) Irrigation of wooden areas, industrial wood areas, greenbelts and areas where the public is not allowed to enter (b) Industrial use (except for the food industry)[d] (c) Ponds, bodies of water and streams where public contact is not allowed
5th	I.N. $\leq$ 1 eggs/l FC $\leq$ 100 cfu/100 ml TSS $\leq$ 10 mg/l	(a) Groundwater recharge (direct injection and/or surface spreading)[b,e,f]

[a] I.N.: intestinal nematodes including the following families: *Strongyloides*, *Trichostrongylus*, *Toxacara*, *Enterobius*, and *Capillaria*. Limits are not applicable for most of the uses.

[b] Limits for NO_3^- should be required, such as TN $<$ 15 and $<$50 mg/l for groundwater recharge (direct injection and surface spreading, respectively)s and NO_3^-–N $<$ 100 mg/l for ponds and water streams.

[c] Limits for *Taenia* sp. ($<$1 eggs/l) should be required.

[d] Limits for industrial cooling for *Legionella phennophila* should be required.

[e] A minimal depth for the groundwater table of 5 m is required.

[f] In the case of direct injection particularly to a potable groundwater aquifer, the criteria for potable water should be applied.

(g) According to Greek legislation, recycled wastewater can be reused for irrigation except for the irrigation of plants used for human consumption.

As non potable reuse will long remain the goal of the large majority of reuse projects, the proposed criteria for municipal wastewater recycling and reuse for Greece and probably for mediterranean region are focused on microbiological hazards. Treated wastewater quality criteria should reflect the potential for regional variations in climate, water flow, and wastewater effluent characteristics and should be planned to protect individuals against realistic maximum exposures. Intestinal nematodes are of major concern in south mediterranean countries. For the northern (mainly EU member) countries only FC or *Eshcheria coli* should be considered. In addition proposed criteria should be: (a) realistic in relation to local conditions (epidemiological, social-cultural, and environmental factors), (b) affordable, (c) practical, (d) simple, (e) flexible, and (f) enforceable.

Establishing common mediterranean criteria for municipal wastewater effluent reuse is a challenge because of the absence of comprehensive international criteria and of a scientific consensus on the approach that should be adapted to issue such criteria. This has led to

inconsistencies between the criteria that are already implemented in some mediterranean countries.

6. Conclusions and recommendations

Greece is characterized by relatively high overall water availability. However, there are water regions under water stress. In the water region of Crete the water resources availability is limited due to temporal and spatial variations of precipitation. Also, the continued increase of domestic water and agricultural demand can only be met through an integrated water management scheme in which non conventional water resources (such as recycled water) should be included. This study reveals that by proper management and reuse of the effluents from the existing MWTP in Crete an overall water saving up to 5.1% should be achieved. This percentage will increase substantially as the number of MWTP is increased. Criteria for the safe use of treated wastewater particularly in agriculture are required to maximize public health benefits and at the same time allow for the beneficial use of scare resources. Effluent quality criteria for intestinal nematodes, FC, and TSS should be used for the safe application of water recycling and reuse, according to the recommended uses. These criteria directed to agricultural and landscape irrigation and groundwater recharge. Industrial reuse is very seldom practiced in Greece and in the most mediterranean countries. It is believed that proposed criteria are well balanced among the health and environmental protection and the feasibility to be implemented in the most mediterranean countries.

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Water Resources Status Including Wastewater Treatment and Reuse in Greece
Related Problems and Prospectives

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Abstract: *This paper presents an overview of regional water resources in Greece including water availability, water uses, wastewater reclamation, and reuse trends. Water demand has increased tremendously in recent decades. Despite adequate precipitation, several regions are under water stress due to temporal and regional variations of precipitation, the high rate of evapotranspiration and the high cost of transporting water over the mountainous terrain. To address the problem of water stress, integration of reclaimed wastewater into water resources management is proposed. Data about the current situation of municipal wastewater treatment and reuse options are presented, and regional and temporal trends for wastewater reclamation and reuse are summarized. It is revealed that by proper management and reuse of the effluent from existing municipal wastewater treatment plants, water availability can be increased by 3.2 percent.*

Keywords: *Effluent disposal sites, water resources, water availability, wastewater treatment, wastewater reuse.*

Introduction

Agricultural and landscape irrigation with domestic wastewater has been practiced in many parts of the world for centuries. One of the salient characteristics of Minoan civilization was the architectural and hydraulic function of its stormwater and sewerage systems in its palaces and cities. In the entire structures of most Minoan palaces and cities, nothing is more remarkable than the elaborate sewerage system, while indications for utilization of wastewater for agricultural irrigation extend back to *ca.* 3000–1100 B.C. (Angelakis and Spyridakis, 1996). Although irrigation with sewage effluents is, in itself, an effective way of wastewater treatment (such as in slow-rate land treatment), some degree of treatment must be achieved before the sewage can be used for agricultural or landscape irrigation. This level of pre-application treatment should be practiced for the protection of public health, the prevention of nuisance conditions during storage and application, and the prevention of damage to the crops and soils (Asano, 1998).

Greece is characterized by a severe water imbalance particularly in the summer months, due to low precipitation and, at the same time, increased demands for irrigation and water use due to tourism. The climate of Greece is sub-humid Mediterranean with humid and relatively cold winters and dry and warm summers with an average rainfall of 870 mm/year. Annual rainfall ranges from 300 to 500 mm in the southeast of Greece and from 800 to 1,200 mm in the north-western plains of the mainland, while in some mountainous areas it may be above 2,000 mm. Such great climatological differences are due to the complex vertical and horizontal distribution of the mountains and the great number of islands.

Despite high precipitation (of about 600 mm in the plains and more than 2,000 mm in the mountains), water consumption constitutes a relatively small portion of water availability due to unequal temporal and regional distribution and high evapotranspiration rates. About 45 percent of the total precipitation occurs during the period from December to January. It is estimated that about 65 percent of the annual precipitation occurring in the plains is returned by evapotranspiration, 10 percent returns as surface runoff to the sea, and only 25 percent represents groundwater recharge. In addition, transport of water from water-rich areas to where it is needed cannot be practiced, due to both environmental reasons and the high cost of transporting it across the mountainous terrain. An alternative water resource to be considered is treated effluents from municipal wastewater treatment plants (Angelakis and Diamadopoulos, 1996).

In this paper it is presented the current status of the water resources in Greece, in terms of water availability and use, and evaluated the possibility of treated wastewater reuse for irrigation. Also, cases of wastewater reclamation and reuse are presented and the potential for increase of irrigated area is estimated.

Water Resources Management, Availability, and Water Demand

Although precise estimates of the available water resources in Greece have not been made, most authorities agree that water consumption and use constitute only a small percentage, less than 10 and 15 percent of the annual precipitation and water potential, respectively (Table 1). The total annual precipitation is estimated to be 115,375xMm³ and the total water potential is estimated to be 69,000xMm³ (including water transported from countries to the north). By the beginning of the 1990s, the total water consumption was estimated at 5,500xMm³/year, while by the end of the decade it increased by about 30 percent. It is estimated that water consumption in Greece increases by more than 3 percent annually.

The major water use in Greece is irrigation (17 to 95 percent of total consumption within regions) while domestic use ranges among regions from 3 to 66 percent and industrial use from 0.2 to 16.0 percent. The increased demand for water, either for urban or agricultural use, cannot always be met despite adequate precipitation. Water imbalance is often experienced, especially in the coastal and south-eastern regions, due to temporal and spatial variations of the precipitation, the increased water demand during the summer months, and the difficulty of transporting water due to the mountainous terrain. However, on average, there is a relatively high per capita water availability (i.e., around 5,800 m³/inhabitat/year) Although this is lower than most European countries, it is much higher than that of other Mediterranean regions. For instance, there are regions in Spain (Balearic islands) with a per capita availability of less than 500 m³/year. (Marecos do Monte et al., 1996). In these Mediterranean regions wastewater reclamation and reuse may constitute an appropriate solution.

Greece's agriculture has been improved substantially since 1980 and additional agricultural development mainly depends on water availability. The demand for irrigation water is high, since it is estimated that the mean annual increase in agricultural water use is between 1.0 and 1.5 percent, while at the same time only 36 percent of the available agricultural land was irrigated in 1997 in Crete (Chartzoulakis et al., 1997). On the other hand, there are major losses (seepage, evaporation, leakage, etc.) from water delivered to the agricultural sites for irrigation and the municipal sites for domestic use. In some cases, these losses are estimated to be as much as 45 percent.

An alternative plan for water resources management should include the reclaimed wastewater originating from the wastewater treatment plant effluents. This plan may provide sufficient water for irrigation, while at the same time the pollution loads entering the sea or inland waters will be reduced (Angelakis and Diamadopoulos, 1995).

Wastewater Treatment Status

Greece, with an estimated population of 10.6 million, must comply with the EU 271/91 directive on urban wastewater treatment (EU, 1991). Thus, today 270 Municipal Wastewater Treatment Plants (MWTPs) can serve about 60 percent of the country's permanent population (Figure 1). For the remaining 26 percent, it is estimated that 2,000 MWTPs serving more than 500 population equivalent (P.E.)

Table 1. Available Water Resources and Water Uses by Water Region in Greece

Water Region	Area (km²)	Precipitation (Mm³/year)	Water Potential (Mm³/year)			Water Use (Mm³/year)				Consumption Index (%)
			Surface	Ground	Total	Agricultural	Domestic	Industrial	Total	
1. West Peloponnese	7,301	8,031	3,050	700	3,750	560.0	23	22.0	605.0	16.1
2. North Peloponnese	7,310	6,404	2,650	900	3,550	653.5	40	68.0	761.5	21.5
3. East Peloponnese	8,477	5,811	1,000	950	1,950	780.0	20	25.0	825.0	42.3
4. West Central Greece	10,199	13,592	9,750	850	10,600	260.0	21	0.5	281.5	2.7
5. Epirus	10,026	17,046	8,500	250	8,750	230.0	31	4.0	265.0	3.0
6. Attiki	3,207	1,642	200	200	400	70.0	270	65.0	405.0	101.3
7. Central Greece and Evia	12,341	9,516	1,900	1,050	2,950	380.0	36	5.5	421.5	14.3
8. Thessaly	13,377	10,426	3,250	1,350	4,600	1,060.0	65	46.0	1,171.0	25.5
9. West Macedonia	13,440	10,599	4,100	850	4,950	582.0	48	30.0	660.0	13.3
10. Central Macedonia	10,389	6,596	6,900	700	7,600	477.0	75	20.0	572.0	7.5
11. East Macedonia	7,280	4,422	4,200	550	4,750	439.0	23	9.5	471.5	9.9
12. Thrace	11,177	8,574	10,900	400	11,300	536.0	35	6.0	577.0	5.1
13. Crete	8,335	7,500	1,300	1,300	2,600	320.0	60	4.0	384.0	14.8
14. Aegean Islands	9,103	5,216	1,000	250	1,250	80.0	37	1.0	118.0	9.4
Total	131,962	115,375	58,700	10,300	69,000	6,427.5	784	306.5	7,518.0	10.9

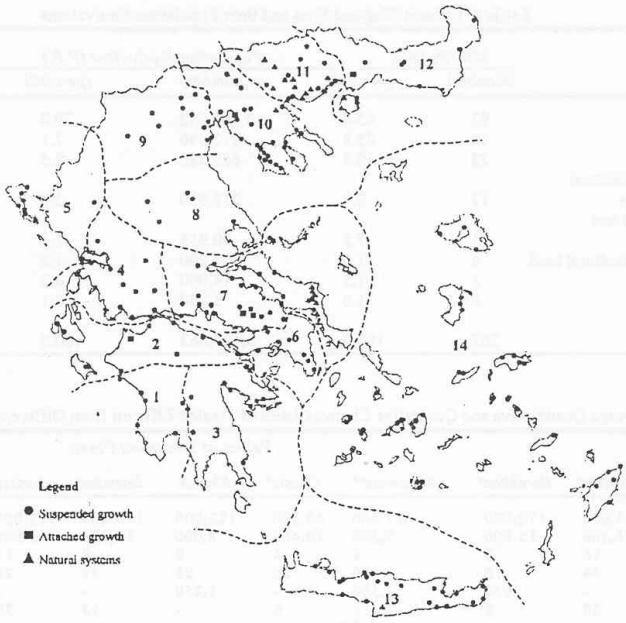

Figure 1. Water regions and MWTPs of Greece according to the treatment system they employ (Tsagarakis, 1999).

will be needed. Fourteen percent of the population is in villages of less than 500 P.E. for which on site sanitation technologies should be used (Tsagarakis, 1999). The following actions present and analyze the wastewater treatment technologies, disposal sites and effluent quality of the MWTPs. Also, the areas under water stress are shortly discussed, and a reuse evaluation in regional level is undertaken.

Wastewater Treatment Technologies

In Greece, specific technologies for municipal wastewater treatment have been developed. Among these systems, 88 percent are activated sludge systems, 10 percent are natural systems, and 2 percent are attached growth systems. Among the activated sludge systems 85 percent are extended aeration systems, 10 percent are conventional systems, and 5 percent are sequencing batch reactors. It is obvious that extended aeration is the dominant system, as it provides additional advantages for Mediterranean climatic conditions. Approximately 44 percent of the activated sludge systems have nitrogen removal, and 15 percent have considered phosphorous removal.

Disposal Sites

At the early stages of wastewater treatment, Greece had not developed its own local knowledge, and therefore, disposal methods were copied from other countries, which had different requirements for water reuse due to local climatic conditions. Sea outfalls were used mostly at MWTPs near the sea for discharging treated effluent. Installations away from the sea usually discharge to both permanent and ephemeral rivers. Other disposal sites are irrigation of agricultural and forested land, lake and land application. The number of MWTPs falling into each category, their total design P.E. and current P.E. (T.P.E.), which reflects the current average flow rate in the hot season are presented in Table 2. Excluded from this evaluation are the plants that have failed, and also natural wastewater systems because the effluent flow rate is very low compared to influent, or even non-existent. Effluent disposal sites in Greece are also described in Tsagarakis et al. (1998).

Effluent Quality

Tsagarakis (1999) has classified the MWTPs in operation according to their performance, taking into account effluent qualitative parameters and the effluent quality requirements. Of existing MWTPs, 42 percent were operating well, 41 percent moderately, and 17 percent poorly. In general, large plants tend to operate well. Qualitative and quantitative values from some large MWTPs of Greece are presented in Table 3.

Table 2. Effluent Disposal Sites and their Population Equivalents

Disposal Site	*MWTPs Sites* (number)	(percent)	*Population Equivalent (P.E.)* (number)	(percent)	*Current P.E.* (number)	(percent)
Sea	93	45.4	6,409,082	79.0	4,832,100	85.6
Ephemeral River	49	23.8	577,390	7.1	236,300	4.2
Permanent River	22	10.7	689,486	8.5	408,500	7.2
Indirect irrigation of agricultural land with prior dilution	17	8.3	238,950	2.8	51,500	0.9
Irrigation of forested land and fire protection	15	7.3	90,955	1.1	34,800	0.6
Directly irrigation of agricultural land	4	2.0	94,000	1.2	76,000	1.3
Lake	3	1.5	14,000	0.2	3,000	0.1
Land	2	1.0	3,700	0.1	500	0.1
Total	205	100.0	8,117,563	100.0	5,642,700	100.0

Table 3. Average Quantitative and Qualitative Characteristics of Treated Effluent from Different MTWPs in Greece

Parameters	*Values at Treatment Plants*								
	Agios Nikolaos[a]	*Heraklion*[a]	*Rethimnon*[a,b]	*Chania*[b]	*Rhodes*	*Ioannina*[a]	*Larissa*	*Lamia*[a,b]	*Kavala*[b]
Current P.E.	14,000	110,000	57,500	40,500	120,000	110,000	113,000	50,000	70,000
Q_e (m^3/d)[c]	1,500	15,000	7,500	10,400	8,000	17,089	19,000	7,500	12,000
BOD_5 (mg/l)	16	8	8	4	9	8	11	21	18
COD (mg/l)	54	15	40	29	25	38	28	-	90
TDS (mg/l)	-	950	1,500	-	1,250	-	-	-	-
SS (mg/l)	20	8	13	8	-	13	20	6	23
NTU	-	-	7.5	-	-	-	-	10.0	-
EC (μS/cm)	-	1.55	2.35	-	-	0.95	-	0.80	1.00
pH	7.70	7.65	7.75	7.50	7.60	7.69	7.80	7.90	7.35
TKN (mg/l)	-	20.00	2.50	4.50	-	11.50	-	-	-
NH_4-N (mg/l)	2.10	4.50	0.65	0.40	0.50	9.65	3.00	5.10	1.50
NO_3-N (mg/l)	0.90	6.00	0.65	7.10	3.50	4.66	7.50	2.30	4.00
NO_2-N (mg/l)	-	-	0.15	0.47	-	0.30	-	-	0.65
Total P (mg/l)	-	12.50	5.00	7.90	7.60	4.28	8.00	8.00	4.00
Total K (mg/l)	-	25.00	-	-	-	-	-	-	-
Cl^- (mg/l)	-	-	500	-	800	-	-	-	-
Cu (mg/l)	-	-	-	0.013	-	-	-	-	-
Fe (mg/l)	-	-	-	0.15	-	-	-	-	-
Mn (mg/l)	-	-	-	0.02	-	-	-	-	-
FC (MPN/100 cm^3)	-	0	1,000,000	275	-	0	-	-	-
TC (MPN/100 cm^3)	1,000	15	23,000,000	-	-	25	-	-	-

[a]Average values for 1999; [b] Without disinfection; [c] Q_e: Effluent average daily flow rate.

Wastewater Reclamation and Reuse

Areas Under Water Stress

The main natural reason for causing the above mentioned negative water balance is the large number of small islands in the south-eastern part of the country where the precipitation is reduced, the groundwater tables of mainly carstic aquifers are open to the sea and discharge large quantities of water into the sea as brackish water, and where there is a large ratio of coastal areas to those of inland. At the same time, the structure and orientation of the economy (seasonality of use because of tourism) dexasperate the problem of water demand in these areas.

The majority of small Aegean islands, eastern Crete and particular southeastern coasts are the Greek areas which are affected by those conditions. A number of those areas, due to geological circumstances, the bad quality of water, and the lack of rational administrative policies, are confronted with a permanent negative water balance, whose continuous deterioration causes economic and social problems. Because their solutions appear to be very costly, wastewater reclamation and reuse need to be practiced.

Reuse

An investigation has been carried out to estimate the suitability for reuse of reclaimed water in three main categories of uses: agriculture, forestry and fire protection, and landscape irrigation. An average effluent production of 150 liters/inhabitant/day is used in the calculations. The results are presented in Table 4. It can be concluded that by reusing the effluent of the existing MWTPs water reuse, particularly for irrigation of agricultural land, can be

Table 4. Potential for Effluent Reuse of MWTPs for Various Purposes in m^3

Region	*Irrigation of Agricultural Land*	*Irrigation of Forested Land & Fire Protection*	*Landscape Irrigation*	*Total Reuse Potential*	*Percentage of Saving over Water used in Rural Areas*
1. West Peloponnese	1,660,896	278,240	0	605,000,000	0.3%
2. North Peloponnese	19,205,753	3,066,000	2,299,500	761,500,000	3.2%
3. East Peloponnese	9,863,213	3,339,750	0	825,000,000	1.6%
4. West Central Greece	5,674,838	766,500	1,095,000	281,500,000	2.7%
5. Epirus	7,599,300	1,450,875	3,816,075	265,000,000	4.9%
6. Attiki	2,896,275	3,394,500	29,565,000	405,000,000	8.9%
7. Central Greece and Evia	13,561,575	4,380,000	5,639,250	421,500,000	5.6%
8. Thessaly	8,924,250	3,558,750	0	1,171,000,000	1.1%
9. West Macedonia	17,421,450	0	0	660,000,000	2.6%
10. Central Macedonia	17,520,000	5,529,750	4,763,250	572,000,000	4.9%
11. East Macedonia	3,235,725	4,599,000	657,000	471,500,000	1.8%
12. Thrace	13,003,125	1,040,250	328,500	577,000,000	2.5%
13. Crete	16,490,700	4,026,863	0	384,000,000	5.3%
14. Aegean Islands	4,302,803	7,418,625	9,759,461	118,000,000	18.2%
Total	141,359,901	42,849,102	57,923,036	7,518,000,000	3.2%

increased by 242 Mm^3/year or 3.2 percent of the current total use of freshwater. Thus the freshwater that is currently used for irrigation can be saved. This is related to the availability of nearby agricultural areas and assumes that the relevant infrastructure like storage reservoirs and distribution systems will be available.

In Greece, no guidelines or criteria for wastewater reclamation and reuse have yet been adopted. Note that secondary effluent quality criteria are used for discharging purposes with a Health Arrangement Action of 1965 (Ministries of Interior and Public Health, 1965) and are independent of the disposal, reclamation, and reuse effort. Also, no regulation of wastewater reuse exists at European level. The only reference to it is the article 12 of the European Wastewater Directive (91/271/EEC) (EU, 1991) stating: "Treated wastewater shall be reused whenever appropriate." In order to make this statement a reality, common definitions of what is "appropriate" are needed. Thus, the need for establishing wastewater reclamation and reuse standards on both European and national level is obvious (Angelakis et al., 1999). In Greece, a preliminary study for establishing quality criteria is in progress (Angelakis et al., 2000). These criteria are summarized in Table 5.

Cases of Wastewater Reuse

Agricultural Reuse

There are only a few MWTPs where effluent is used for direct irrigation of agricultural land. These include:

- At Levadia, 3,500 m^3/d are used to irrigate cotton. Advanced treatment includes nutrients control (N-P). The irrigation method is closed pipe network.
- At Amfisa, 400 m^3/d are discharged into a 30,000 m^3 reservoir for the irrigation of olive trees.
- At Palecastro, 280 m^3/d are used to irrigate olive trees after loading on a 20 m^3 charge reservoir. The irrigation method is closed pipe network.
- At Ko, an installation of a small number of agricultural and other trees close to the installation is irrigated, but it is in the planning process to irrigate more in the future with the 4,000 m^3/d effluent that can be produced. Advanced treatment includes nutrient control (N-P).
- Effluent from some of the waste stabilization ponds in operation is used for agricultural irrigation by farmers. Local skin infections have been reported when the effluent comes in contact with farmers' hands (this should be expected as some of these systems are not properly designed or maintained).

The Pefkochori, Kolindros, Chaniotis, and Kalithea plants are in the process of changing the initial disposal site to irrigation of agricultural land. In addition plants that serve Perama, Nea Epidavros, Thermisia, Kranidi, Arahova, Nikita, Nea Kalikratia, Nea Potidea, and Thiva are planning to use treated effluent for irrigation of agricultural land.

It should be noted that there are plants that discharge to ephemeral rivers and after infiltration there is pumping through adjacent wells by farmers for irrigation. This is a way of indirect reuse for irrigation.

Forestry and Landscape Reuse

The effluents from four plants are used for the irrigation of forestry and other amenity purposes:

- At Kentarchos (Serifos), 100 m^3/d are used to irrigate trees after applying sand filtration.
- At Agios Konstantinos (Samos), 200 m^3/d are used to irrigate trees (mainly pine) using a sub-surface system.

Table 5. Proposed Minimal Microbiological and Physicochemical Criteria for Treated Wastewater Effluents Reuse in Greece

Wastewater Effluents Reuse[a]	*Quality Criteria*				
	Microbiological		*Physicochemical*		
	Nematodes eggs[b]	*Escherichia coli*	*SS*[d]	*Turbidity*	*Other Criteria*
Urban Use[f]					
a) Residential uses: Private garden watering, toilet flushing, home air conditioning systems, car washing.	<1 egg/10L	0 cfu/100ml.	<10 mg/L	<2 NTU	
b) Urban uses and facilities: Irrigation of areas with free admittance (parks, golf courses, sport fields,...), street cleaning, fire-lighting, fountaings, and other recreation places.	1 egg/L	<10 cfu/100mL	<20 mg/L	<5 NTU	
Agricultural Use[g]					
a) Irrigation of vegetables to be eaten uncooked. Sprinkler-irrigated fruit trees.	<1 egg/L	<10 cfu/100mL	<20 mg/L	<5 NTU	*Legionella pheumophila* 0 cfu/100mL
b) Irrigation of fodder crops for livestock (for milk or meat production)	<1 egg/L	<1,000 cfu/100mL	<35 mg/L	No limit established	*Taenia saginata* and *Taenia solium*
c) Irrigation of crops for: a) canning industry, b) vegetables to be eaten cooked, and c) fruit trees (except sprinkler-irrigated).	<1 egg/L	<1,000 cfu/100mL	<35 mg/L	No limit established	
d) Irrigation of industrial crops, plant nurseries, stored fodder, cereals, and oleaginous seeds.	<1 egg/L	<1,000 cfu/100mL	<35 mg/L	No limit established	
e) Irrigation of wooden areas, industrial wood areas, greenbelts or other areas where the general public is not allowed to enter.	<1 egg/L	<10,000 cfu/100mL	<35 mg/L	No limit established	
Aquaculture[c,g]					
a) Aquiculture (production of vegetal or animal biomass)	<1 egg/L	<1,000 cfu/100mL	<35 mg/L	No limit established	
Industrial Use					
a) Industrial cooling (except for food industry).	No limit established	<10,000 cfu/100mL	<35 mg/L established	No limit 0 cfu/100mL	*Legionella pheumophila*
Environmental Use and Entertainment					
a) Ponds, bodies of water and streams for recreational purposes, where the public is allowed contact (except for bathing purposes).	<1 egg/L	<200 cfu/100mL	<35 mg/L	No limit established	NO_3 <100 mg/L
b) Ponds, water bodies and ornamental streams, where the public is not allowed contact.	No limit established	<100 cfu/100 mL	<35 mg/L	No limit established	NO_3 <100 mg/L
Groundwater Recharge					
a) Groundwater recharge[e,c], surface spreading (through soils)	<1 egg/L	<1,000 cfu/100mL	<35 mg/L	No limit established	Total Nitrogen <50 mg/L
b) Groundwater recharge: direct injection[h]	<1 egg/10L	0 cfu/100mL	<10 mg/L	<2 NTU	Total Nitrogen <15 mg/L

[a] Minimal wastewater treatment level secondary or equivalent.
[b] Intestinal Nematodes (in eggs/L) include the following families: *Strongyloides, Trichostrongylus, Toxocara, Enterobius* and *Capillaria.*
[c] Control of odor is required.
[d] SS: Suspended Solids.
[e] Minimal depth of groundwater required at 5 m.
[f] Above values must be conformed at the 80 percent of the samples per month.
[g] Reclaimed wastewater can be reused for agricultural purposes, except for irrigation plants for human consumption, it is forbidden by the Greek law.
[h] The agricultural use also required additonal criteria for TDS, C1-, and various minerals, etc.
[i] Control of heavy metals in the source.
[j] Avoidance of using disinfection with C1-. Also, consider: i) Integrated management of water reesources; ii) seasonal storage, which improves the quality and the availability; iii) irrigation method: the sub-surface irrigation requires inferior quality effluents; and iv) quality supervision in point of the sampling method, the frequency reception and the reliability of analyses.

- At Karistos, 1,450 m³/d are used to irrigate 14,000 trees using nearly all the effluent with a closed pipe network.
- At Ierisos, 1,200 m³/d are discharged into a reservoir before irrigating forested land.
- At Chalkida, the disposal site to sea is being diverted to the surrounding area. In addition, at Serifos, Marpisa, Kini, Karterados, Chora (Samos), Nea Artaki, and Siviri there are plans to irrigate land for forestry and amenity.

Industrial Reuse

There is no industrial reuse of treated effluent apart from some installations that use filtration for treating further effluent that is going to be used in the installation. Industries that are heavy water consumers such as food processing will be increasingly interested in using reclaimed wastewater, particularly in areas under water stress.

Conclusions

Water resources are limited in Greece. The continued increase of potable water demand can only be met through an integrated water management scheme that includes the use of all sources including marginal waters. This study reveals that by proper management and reuse of the effluents from the existing MWTPs, the savings in water used can be increased by 3.2 percent. This percentage will be substantially increased as the number of MWTPs increase. Currently only at a few MWTPs are effluents reused for agriculture and forestry. However, this will increase in the near future due to more appropriate chooices of effluent disposal and the change of some MWTPs from sea or river disposal to irrigation.

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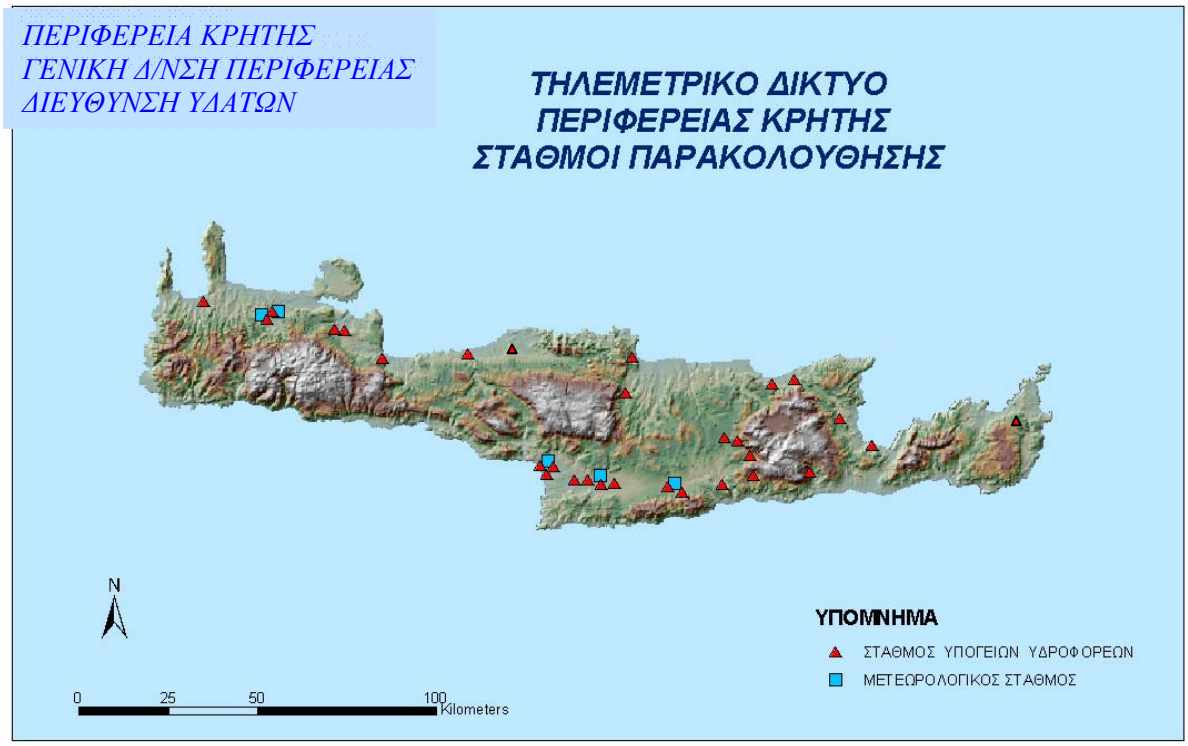
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ
ΓΕΝΙΚΗ Δ/ΝΣΗ ΠΕΡΙΦΕΡΕΙΑΣ
ΔΙΕΥΘΥΝΣΗ ΥΔΑΤΩΝ
ΤΜΗΜΑ ΠΑΡΑΚΟΛΟΥΘΗΣΗΣ ΚΑΙ ΕΛΕΓΧΟΥ ΤΗΣ ΠΟΙΟΤΗΤΑΣ ΚΑΙ ΠΟΣΟΤΗΤΑΣ ΤΩΝ ΥΔΑΤΩΝ

ΚΑΤΑΣΤΑΣΗ ΥΠΟΓΕΙΩΝ ΥΔΡΟΦΟΡΕΩΝ ΚΡΗΤΗΣ

Παρατηρήσεις για το τρέχον υδρολογικό έτος
(1η Νοεμβρίου 2007 έως 30η Απριλίου 2008)



Περιφέρεια Κρήτης

ΗΡΑΚΛΕΙΟ, ΙΟΥΝΙΟΣ 2008

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1 ΕΙΣΑΓΩΓΗ

Η Δ/νση Υδάτων της Περιφέρειας Κρήτης έχει αρχίσει μετά τη σύστασή της μια προσπάθεια ενημέρωσης των αρμόδιων φορέων, των χρηστών νερού αλλά και του κοινού για την κατάσταση των κύριων υδροφορέων του νησιού, στους οποίους έχουν εγκατασταθεί σταθμοί παρακολούθησης. Σε αυτά τα πλαίσια περιλαμβάνεται και η έκδοση αυτής της περιοδικής, ανά εξάμηνο, έκθεσης σχετικά με τη συμπεριφορά των υπόγειων υδροφορέων της Κρήτης.

Στα επόμενα κεφάλαια, περιγράφεται η κατάσταση των κύριων υδροφορέων του νησιού, μετά την αναπλήρωση από τις βροχοπτώσεις που πραγματοποιήθηκαν κατά τη χειμερινή περίοδο του τρέχοντος υδρολογικού έτους (2007-2008) και μετά από αξιολόγηση των δεδομένων του τηλεμετρικού συστήματος, που έχει αναπτυχθεί από την Υπηρεσία μας. Ειδικότερα στο κεφάλαιο 2 δίνονται γενικά στοιχεία για τις βροχοπτώσεις της φετινής χειμερινής περιόδου, στο κεφάλαιο 3 περιγράφεται η κατάσταση των καρστικών συστημάτων, στο κεφάλαιο 4 η κατάσταση των προσχωσιγενών λεκανών και στα κεφάλαια 5 και 6 τα συμπεράσματα και οι προτάσεις της υπηρεσίας μας για την τρέχουσα περίοδο.

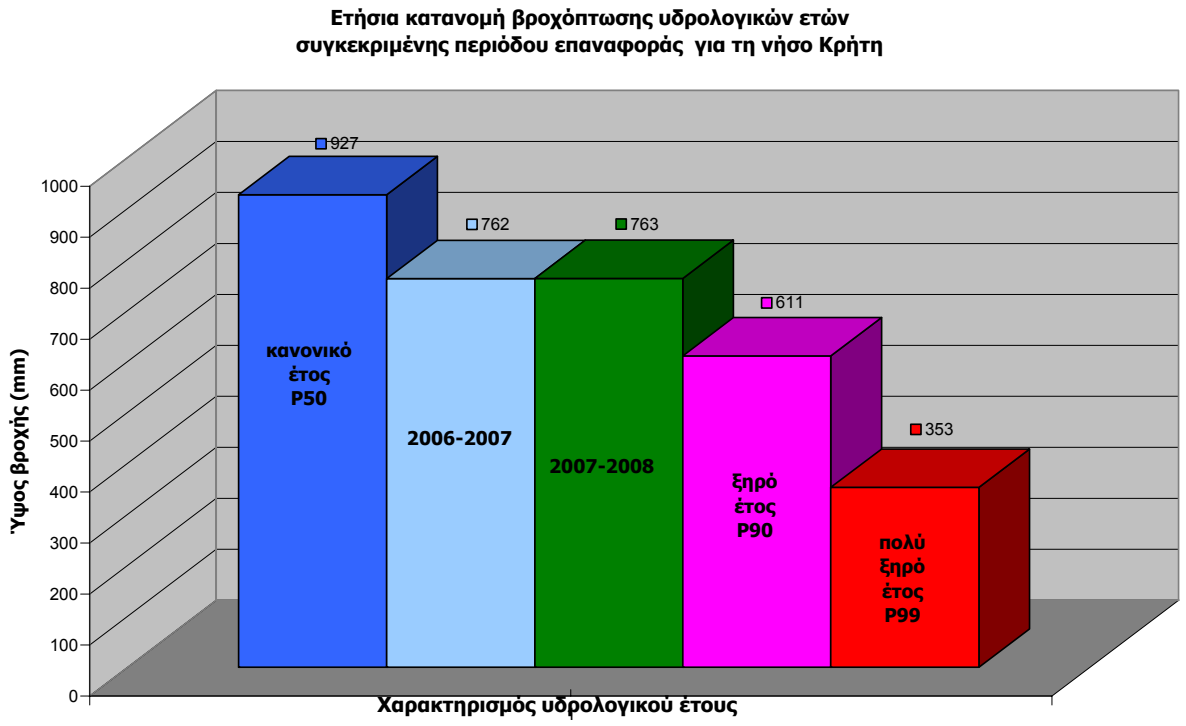
Τα δεδομένα που χρησιμοποιήθηκαν στην παρούσα έκθεση προέρχονται από το τηλεμετρικό σύστημα της υπηρεσίας μας*, που αποτελείται από 5 μετεωρολογικούς σταθμούς και 27 σταθμούς υπόγειων και επιφανειακών νερών, οι οποίοι έχουν εγκατασταθεί στους κύριους υδροφορείς του νησιού. Επίσης, χρησιμοποιήθηκαν δεδομένα του συστήματος παρακολούθησης του τμήματος Εγγείων Βελτιώσεων της Περιφέρειας Κρήτης, για τα οποία ευχαριστούμε πολύ, καθώς και τα αποτελέσματα της διαχειριστικής μελέτης Κρήτης.

Η επεξεργασία των δεδομένων και η σύνταξη της έκθεσης έγινε από την Αγγελική Μαρτίνου, Δρ. Χημικό Μηχανικό, στην αξιολόγηση των δεδομένων συνέβαλαν οι Μαρίνος Κριτσωτάκης, Γεωλόγος MSc και Στέργιος Κοκολάκης, υδρογεωλόγος, ενώ στη συντήρηση και καλή λειτουργία των σταθμών συνέβαλε ο Νίκος Τζωρακολευθεράκης, όλοι στελέχη της Δ/νσης Υδάτων της Περιφέρειας Κρήτης.

* Η εγκατάσταση του τηλεμετρικού δικτύου έγινε στα πλαίσια των ευρωπαϊκών προγραμμάτων INTERISK και BEWARE-CRINNO που υλοποίησε η Περιφέρεια Κρήτης. Η συμπλήρωση, λειτουργία και συντήρηση του τηλεμετρικού δικτύου γίνεται από το πρόγραμμα ΣΑΕΠ 002 της Περιφέρειας Κρήτης.

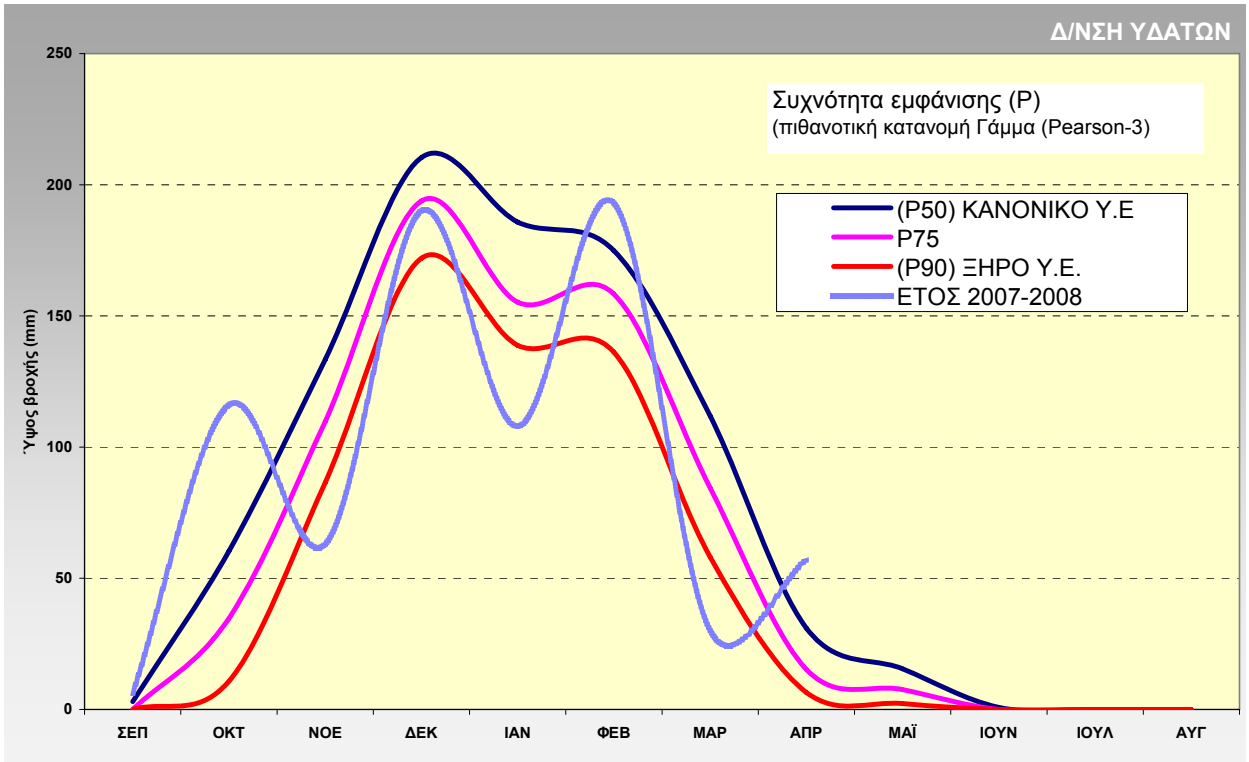
2 ΒΡΟΧΟΠΤΩΣΕΙΣ ΤΡΕΧΟΝΤΟΣ ΥΔΡΟΛΟΓΙΚΟΥ ΕΤΟΥΣ

Η ετήσια κατανομή βροχόπτωσης των υδρολογικών ετών για συγκεκριμένες περιόδους επαναφοράς φαίνονται στην Εικόνα 2-1. Παρατηρούμε ότι, για παράδειγμα, η μέση ετήσια επιφανειακή βροχόπτωση περιόδου επαναφοράς 2 ετών (ή αλλιώς, με πιθανότητα ετήσιας εμφάνισης 50%) σε όλη τη νήσο ανέρχεται σε 927 mm, τιμή που αντιπροσωπεύει το κανονικό υδρολογικό έτος. Από τα στοιχεία των βροχοπτώσεων του τρέχοντος υδρολογικού έτους, προκύπτει ότι η φετινή μέση ετήσια επιφανειακή βροχόπτωση ανέρχεται στα 763 mm, (ίδια με την αντίστοιχη τιμή για το υδρολογικό έτος 2006-2007, που ήταν 762 mm), τιμή που αντιστοιχεί σε συχνότητα εμφάνισης πολύ κοντά στο 75% (περίοδος επαναφοράς 1,33 έτη). Εάν επιλέξει κανείς τη συχνότητα εμφάνισης 90% για τον ορισμό του ξηρού υδρολογικού έτους (μέση ετήσια επιφανειακή βροχόπτωση 611 mm), τότε συμπεραίνουμε ότι η φετινή χρονιά μπορεί να χαρακτηριστεί σαν μια χρονιά μεταξύ του κανονικού και του ξηρού υδρολογικού έτους.



Εικόνα 2-1

Στο διάγραμμα της εικόνας 2-2 δίνεται η μηνιαία κατανομή της βροχόπτωσης για ένα «ξηρό» (P90), ένα «κανονικό» (P50), ένα ενδιάμεσο (P75), καθώς και για το τρέχον υδρολογικό έτος (2007-2008) για την Κρήτη. Από το διάγραμμα παρατηρούμε ότι το χαρακτηριστικό της φετινής χειμερινής περιόδου ήταν η διαφορετική από τη συνήθη μηνιαία κατανομή των βροχοπτώσεων. Ειδικότερα, η βροχόπτωση που πραγματοποιήθηκε το μήνα Οκτώβριο αντιστοιχεί στατιστικά στο διπλάσιο της τιμής του μήνα αυτού, κατά τη διάρκεια ενός «κανονικού» έτους. Το μήνα Νοέμβριο οι βροχοπτώσεις ήταν λιγότερες από αυτές που αντιστοιχούν στο μήνα αυτό κατά τη διάρκεια ενός «ξηρού» έτους, φαινόμενο που επαναλήφθηκε και τους μήνες Ιανουάριο και Μάρτιο. Το μήνα Δεκέμβριο, οι βροχοπτώσεις που πραγματοποιήθηκαν, ήταν ίδιες με αυτές ενός «ενδιάμεσου» υδρολογικού έτους. Τους μήνες Φεβρουάριο και Απρίλιο, οι βροχοπτώσεις που πραγματοποιήθηκαν, ήταν μεγαλύτερες από αυτές που αντιστοιχούν στους μήνες αυτούς στη διάρκεια ενός «κανονικού» υδρολογικού έτους.



Εικόνα 2-2, Μηνιαία κατανομή βροχοπτώσεων υδρολογικών ετών συγκεκριμένης περιόδου επαναφοράς

Θα πρέπει να επισημάνουμε ότι οι παραπάνω τιμές αφορούν τις μέσες μηνιαίες τιμές των βροχοπτώσεων από τους μετεωρολογικούς σταθμούς της Κρήτης (στοιχεία Περιφέρειας Κρήτης: Δ/νση Υδάτων και Τμήμα Εγγείων Βελτιώσεων της Δ/νσης Δημοσίων Έργων), ενώ η κατανομή αυτών σε τοπικό επίπεδο είναι διαφορετική.

3 ΚΑΡΣΤΙΚΑ ΥΔΡΟΓΕΩΛΟΓΙΚΑ ΣΥΣΤΗΜΑΤΑ

Ιδιαίτερο ενδιαφέρον στο υδατικό διαμέρισμα της Κρήτης, από υδρογεωλογική και κατ' επέκταση από διαχειριστική άποψη, παρουσιάζουν οι τρεις μεγάλες σε έκταση ανθρακικές ενότητες που αναπτύσσονται στους ορεινούς όγκους των Λευκών Ορέων, του Ψηλορείτη και της Δίκτης, και οι μικρότερες σε έκταση καρστικές ενότητες Σητείας. Η συνολική τους έκταση είναι περίπου 2.729 km^2, και δέχονται μέσο ετήσιο ύψος βροχής 1.300 mm. Ο μέσος όγκος κατακρημνισμάτων που δέχονται ανέρχεται στα 3,5 $x10^9$ m^3/έτος και ο όγκος του κατεισδύοντος νερού, που εμπλουτίζει του καρστικούς υδροφορείς, εκτιμάται σε $1.7x10^9$ m^3/έτος. Οι ασβεστολιθικοί αυτοί όγκοι τροφοδοτούν μεγάλο αριθμό αξιόλογων πηγών στην περίμετρό τους. Οι μεγάλες καρστικές πηγές στην ανατολική Κρήτη είναι είτε παράκτιες είτε υποθαλάσσιες με αποτέλεσμα το νερό τους να είναι υφάλμυρο, λόγω εισόδου της θάλασσας από φυσικά αίτια στον υδροφορέα, σε αντίθεση με τις πηγές της δυτικής Κρήτης που το νερό τους είναι στις περισσότερες γλυκό. Εκτιμάται ότι η συνολική ποσότητα υφάλμυρου νερού μαζί με τις υποθαλάσσιες εκφορτίσεις ανέρχεται σε 800-1.000$x10^6$ m^3/έτος. (Βλέπε περισσότερες πληροφορίες: "Ολοκληρωμένη μελέτη διαχείρισης υδατικών πόρων Κρήτης στο site: www.crete-region.gr ").

3.1 Α. ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΔΙΚΤΗΣ

Η καρστική ενότητα Δίκτης καταλαμβάνει έκταση 380 km^2. Δέχεται ένα όγκο κατακρημνισμάτων της τάξης των 484$x10^6$ m^3/έτος, με μέσο ύψος βροχής 1.275 mm/έτος.

3.1.1 ΛΕΚΑΝΕΣ ΜΑΛΙΩΝ - ΣΙΣΙΟΥ

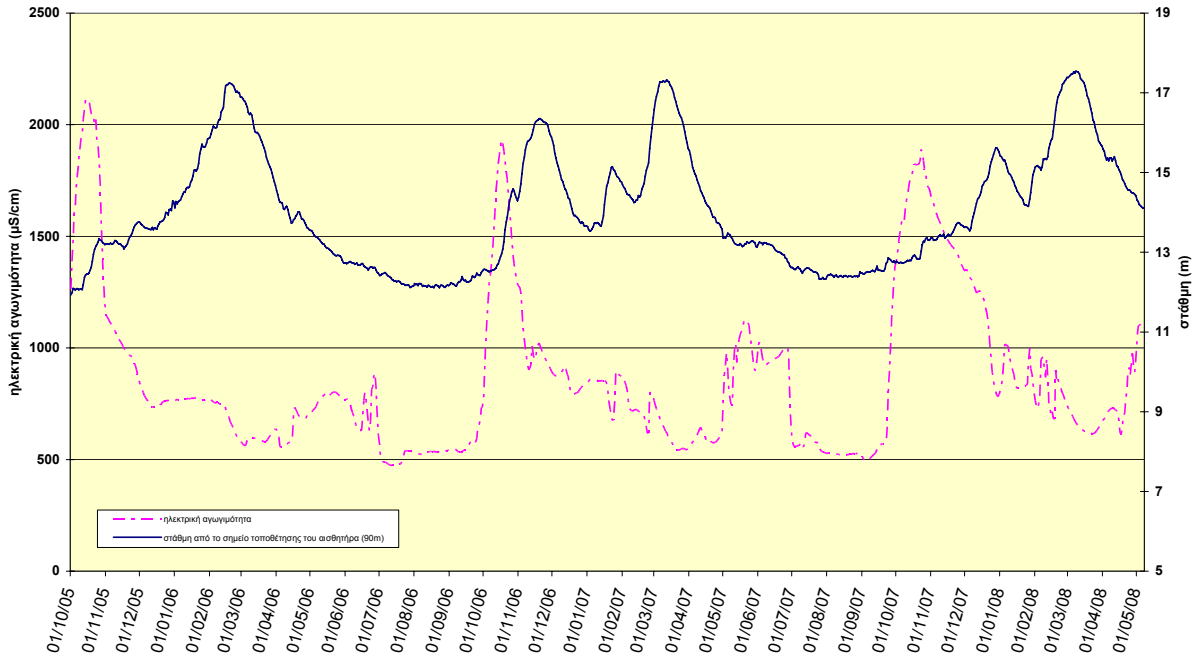
Το καρστικό αυτό υδρογεωλογικό σύστημα εκτείνεται στους νομούς Ηρακλείου και Λασιθίου, εκμεταλλεύεται δε εντατικά από αριθμό γεωτρήσεων κύρια κατά τη θερινή περίοδο, λόγω της μεγάλης ζήτησης από τον τουρισμό (ξενοδοχειακά συγκροτήματα βόρειου άξονα από Σίσι μέχρι Ηράκλειο), και τη γεωργία. Το νερό του επίσης χρησιμοποιείται καθ΄ όλη τη διάρκεια του έτους για την υδροδότηση των δήμων του βόρειου τμήματος του νομού Ηρακλείου (Μάλια, Χερσόνησος, Γούβες, Ν. Αλικαρνασσός και Ηράκλειο). Αποτέλεσμα είναι, το παράκτιο τμήμα του να υφαλμυρώνεται με την είσοδο της θάλασσας, κατά τη διάρκεια του καλοκαιριού, λόγω των υπεραντλήσεων.

Στην εικόνα 3-1 φαίνεται το διάγραμμα διακύμανσης της στάθμης και της ηλεκτρικής αγωγιμότητας στο σταθμό Μαλίων. Είναι εμφανής η αναπλήρωση του υδροφορέα κατά τη χειμερινή περίοδο και διακρίνονται οι περίοδοι ανόδου της στάθμης λόγω των βροχοπτώσεων τους μήνες Οκτώβριο και Μάρτιο. Χαρακτηριστικό του υδροφορέα είναι ότι η ποιότητα του νερού υποβαθμίζεται, λόγω της υφαλμύρωσης (βλ. διακύμανση ηλ. αγωγιμότητας), η οποία οφείλεται: 1) στη φυσική εκφόρτιση του συστήματος στις παράκτιες πηγές (Αλμυρός Μαλίων) και 2) στις υπεραντλήσεις (υπερεκμετάλλευση) του υδροφορέα. Η ποιότητα όμως του νερού του υδροφορέα αποκαθίσταται στα αρχικά της όρια κατά τη διάρκεια του εμπλουτισμού από τις βροχοπτώσεις.

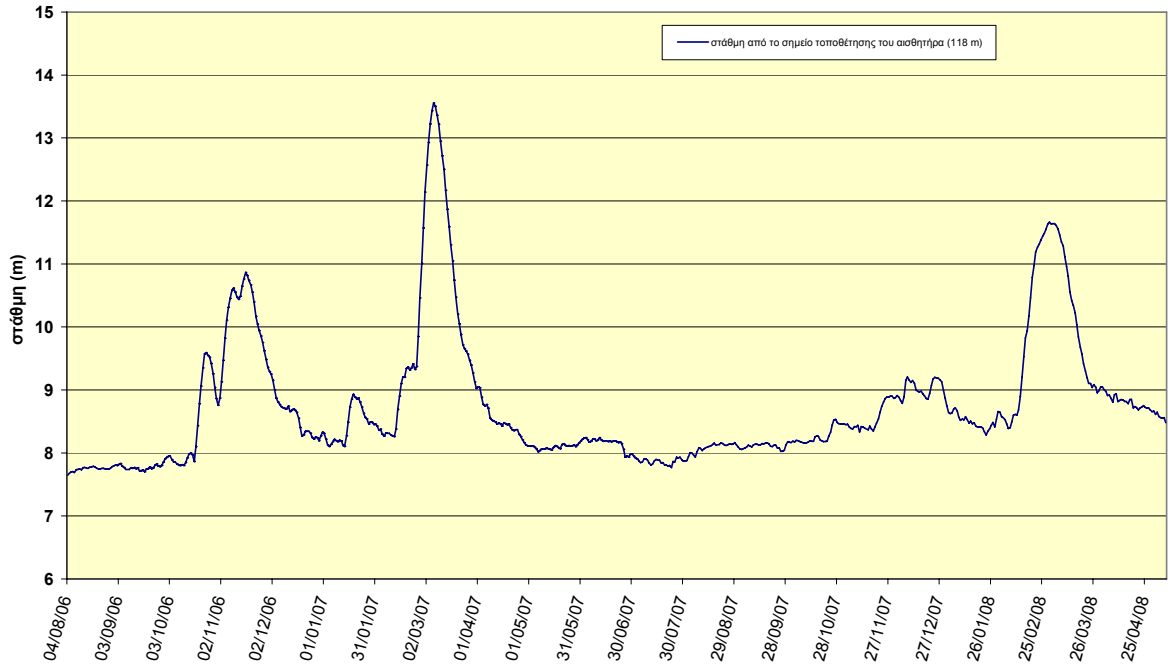
Στην εικόνα 3-2 φαίνεται η διακύμανση της στάθμης στο σταθμό Σισίου και η ανταπόκριση του υδροφορέα στις βροχοπτώσεις. Η ποιότητα του νερού του υδροφορέα στην παράκτια ζώνη έχει υποβαθμιστεί λόγω υφαλμύρωσης.

Ο καρστικός παράκτιος υδροφορέας των περιοχών Χερσονήσου, Μαλίων και Σισίου έχει ενταχθεί στις υπό απαγόρευση περιοχές, σύμφωνα με την κανονιστική απόφαση του Γενικού Γραμματέα Περιφέρειας Κρήτης (ΦΕΚ 303/Β΄/7-3-2007).

Λόγω της σπουδαιότητας του υδροφορέα πρέπει να αποφευχθεί η παραπέρα αύξηση της εκμετάλλευσής του κατά τη θερινή περίοδο, ενώ το φράγμα Αποσελέμη θα ανακουφίσει στο μέλλον μεγάλο μέρος των θερινών αναγκών σε νερό και θα αποσοβήσει την περαιτέρω υποβάθμιση του συστήματος.



Εικόνα 3-1. Διάγραμμα διακύμανσης στάθμης και ηλ. αγωγιμότητας σταθμού Μαλίων.



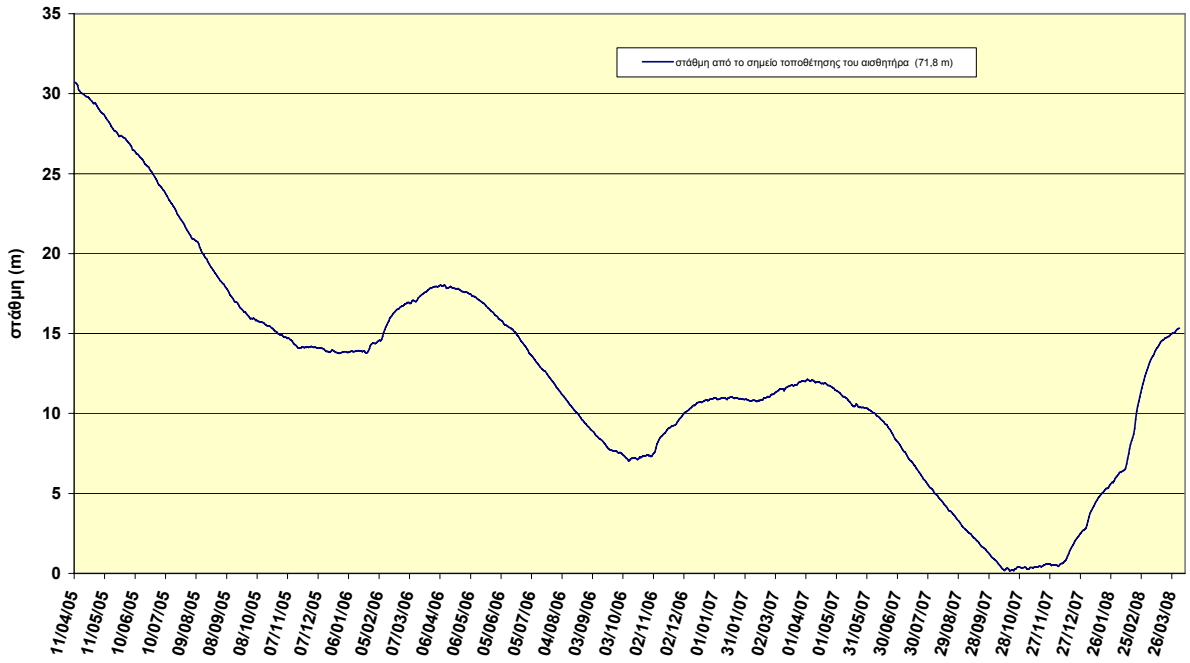
Εικόνα 3-2. Διάγραμμα διακύμανσης στάθμης σταθμού Σισίου.

3.2 ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΑΣΤΕΡΟΥΣΙΩΝ ΟΡΕΩΝ

3.2.1 ΛΕΚΑΝΗ ΠΥΡΓΟΥ

Η λεκάνη του Πύργου βρίσκεται στην οροσειρά των Αστερουσίων ορέων, στην εδαφική περιφέρεια του δήμου Αστερουσίων. Χαρακτηριστικό των καρστικών συστημάτων των Αστερουσίων είναι οι «μεμονωμένες» λεκάνες. Το νερό αυτών των σχηματισμών, με βάση τα μέτρα προστασίας του υδατικού δυναμικού, χρησιμοποιείται κύρια για την κάλυψη των υδρευτικών αναγκών λόγω της καλής ποιότητάς του. Ο σταθμός έχει εγκατασταθεί σε ασβεστολίθους ΝΑ του οικισμού του Πύργου.

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 3-3) παρατηρείται υπεραναπλήρωση του υδροφορέα κατά το τρέχον υδρολογικό έτος (της τάξης του 130%) σε σχέση με την πτώση στάθμης του προηγούμενου υδρολογικού έτους και κατά 80% σε σχέση με αυτή της διετίας 2005-2007. Όμως, η υψηλότερη στάθμη του τρέχοντος έτους εμφανίζει πτώση 15μ. σε σχέση με την αντίστοιχη του έτους 2004-2005.



Εικόνα 3-3. Διάγραμμα διακύμανσης στάθμης σταθμού Πύργου.

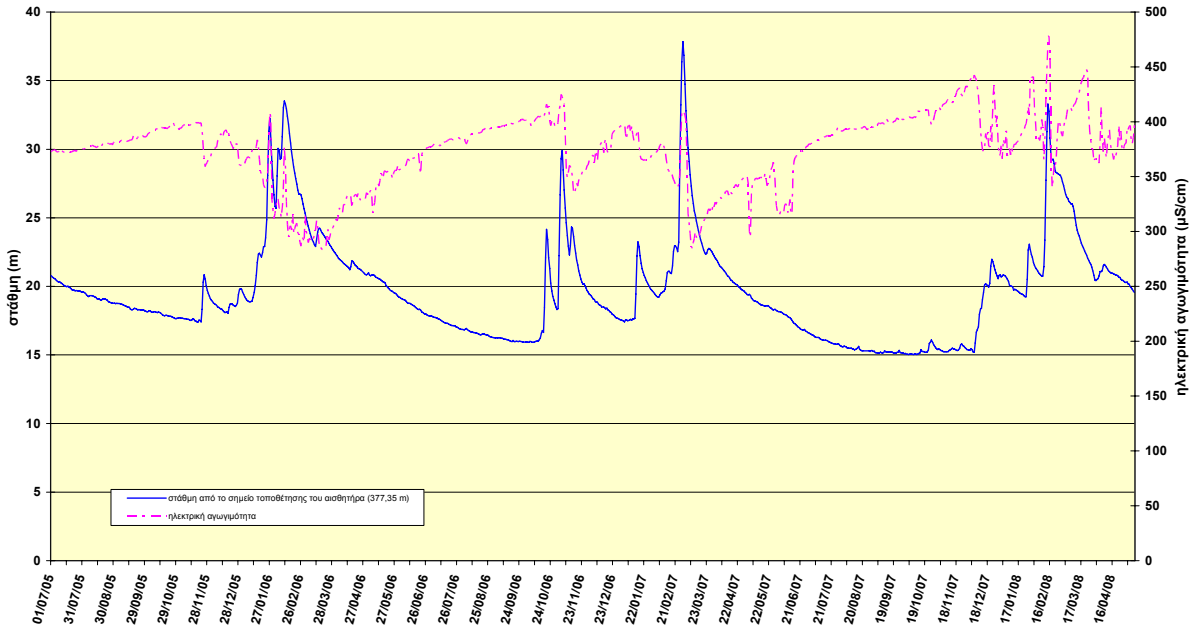
3.3 ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΨΗΛΟΡΕΙΤΗ

Η καρστική ενότητα του Ψηλορείτη καταλαμβάνει έκταση 530 km^2. Δέχεται ένα όγκο κατακρημνισμάτων της τάξης των 780x10^6 m^3/έτος, με μέσο ύψος βροχής 1.473 mm/έτος. Περιμετρικά του ορεινού όγκου απορρέουν αρκετές μεγάλες πηγές με μέση ετήσια εκφόρτιση περίπου 250x10^6 m^3/έτος. Από αυτά, τα 240x10^6 m^3/έτος απορρέουν μόνο από την καρστική υφάλμυρη πηγή του Αλμυρού Ηρακλείου.

3.3.1 ΛΕΚΑΝΗ ΑΓ. ΜΥΡΩΝΑ

Το καρστικό σύστημα του Ψηλορείτη ανάντη της πηγής του Αλμυρού εκμεταλλεύεται από σύστημα γεωτρήσεων στις περιοχές Κέρι, Τύλισσος, Κρουσώνας, Αγ. Μύρωνας και Δαφνές. Το νερό που αντλείται από τα πεδία των γεωτρήσεων Κρουσώνα, Αγ. Μύρωνα και Δαφνών είναι πολύ καλής ποιότητας, ενώ στα πεδία Τυλίσσου και Κέρι, λόγω υπεράντλησης και τοπικών γεωλογικών συνθηκών (σχετικά απομονωμένη υδρογεωλογική λεκάνη), έχει υποστεί υφαλμύριση.

Από το διάγραμμα μεταβολής της ηλεκτρικής αγωγιμότητας και διακύμανσης της στάθμης στο σταθμό του Αγ. Μύρωνα (Εικόνα 3-4), φαίνεται η ταυτόχρονη αύξηση της ηλεκτρικής αγωγιμότητας τις περιόδους ταπείνωσης της στάθμης (θερινή περίοδος). Η ποιότητα όμως του νερού χαρακτηρίζεται ως «πολύ καλή». Η αναπλήρωση του υδροφορέα κατά τη φετινή χειμερινή περίοδο, είναι της τάξης του 80% σε σχέση με την περσινή πτώση στάθμης. Η διαφορετική αναπλήρωση οφείλεται 1) στην κατανομή των φετινών βροχοπτώσεων και 2) στην εντατικοποίηση της εκμετάλλευσης του συγκεκριμένου υδροφορέα.



Εικόνα 3-4. Διάγραμμα διακύμανσης στάθμης και μεταβολής ηλεκτρικής αγωγιμότητας του σταθμού Αγ. Μύρωνα

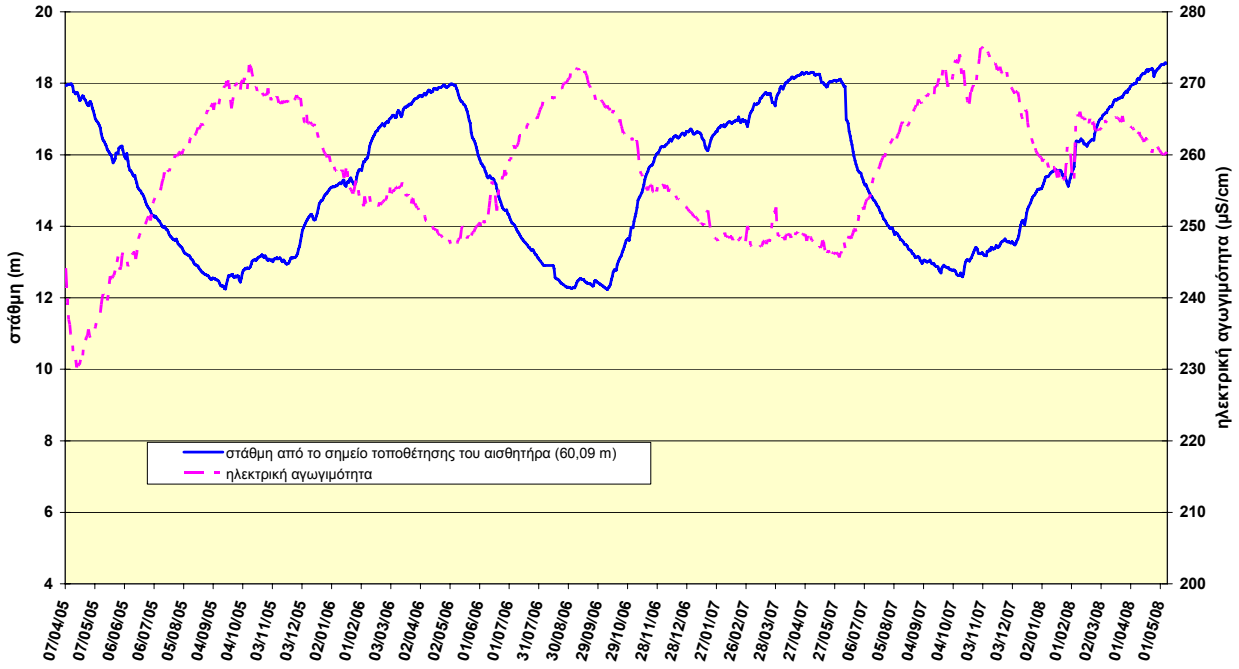
3.4 ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΛΕΥΚΩΝ ΟΡΕΩΝ

Εκτείνεται αποκλειστικά στο Ν. Χανίων και καταλαμβάνει το κεντρικό τμήμα του. Έχει έκταση περίπου 776 km^2. Δέχεται ένα όγκο κατακρημνισμάτων της τάξης των $1.450x10^6$ m^3/έτος, από τα οποία περίπου τα $750x10^6$ m^3/έτος κατεισδύουν. Το μέσο ύψος βροχής είναι 1.850 mm/έτος. Το καρστικό σύστημα των Λευκών ορέων εκφορτίζεται προς βορά κύρια σε τέσσερα συστήματα πηγών ευρισκόμενα (από ανατολικά προς δυτικά): α) Λίμνη Κουρνά – πηγές Γεωργιούπολης, β) πηγές Στύλου – Νιου Χωριού- Κοιλιάρη ποταμού, γ) Πηγές Αγυιάς – Μεσκλών και δ) πηγές Κολενίου.

3.4.1 ΛΕΚΑΝΗ ΑΓΥΙΑΣ - ΜΕΣΚΛΩΝ

Το καρστικό αυτό σύστημα βρίσκεται στο βόρειο κεντρικό τμήμα του Ν. Χανίων και απορρέουν από αυτό (λεκάνη Κερίτη) περίπου 150 X 10^6 m^3/έτος. Από τις πηγές της Αγυιάς απορρέουν περίπου 70 X 10^6 m^3/ έτος, ενώ από τις πηγές Μεσκλών περίπου 30 X 10^6 m^3/ έτος. Το χαρακτηριστικό των πηγών Μεσκλών είναι η έντονη διακύμανσή τους κατά τη διάρκεια του έτους. Έχει εγκατασταθεί ένας σταθμός ανάντη των πηγών Αγυιάς.

Στο διάγραμμα διακύμανσης της στάθμης και της ηλ. αγωγιμότητας (Εικόνα 3-5) παρατηρούμε αύξηση της ηλεκτρικής αγωγιμότητας τις περιόδους ταπείνωσης της στάθμης, ενώ η ποιότητα του νερού είναι σταθερή και χαρακτηρίζεται ως «πολύ καλή». Στο ίδιο διάγραμμα διακρίνεται η πλήρης αναπλήρωση του υδροφορέα με επαναφορά της στάθμης στα επίπεδα του προηγούμενου έτους. Από στοιχεία που έχουμε, το σύνολο των βροχοπτώσεων μέχρι στιγμής στην περιοχή είναι της τάξης των 780 χιλιοστών κατά 140 χιλιοστά λιγότερα από πέρσι.

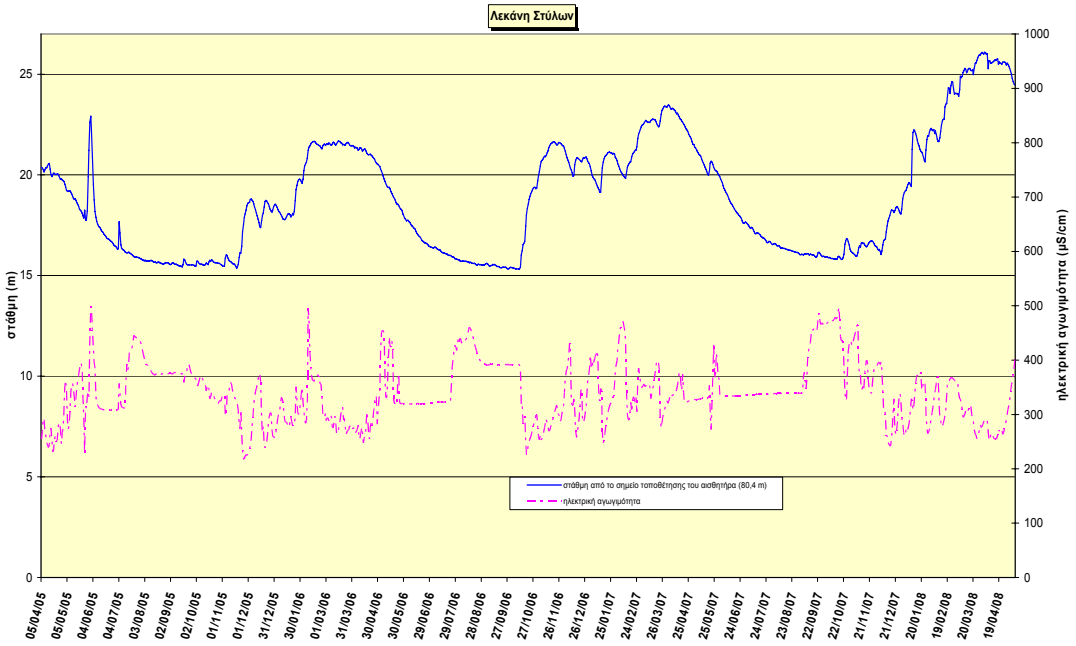


Εικόνα 3-5 Διάγραμμα διακύμανσης στάθμης και μεταβολής ηλεκτρικής αγωγιμότητας του σταθμού Αγυιάς

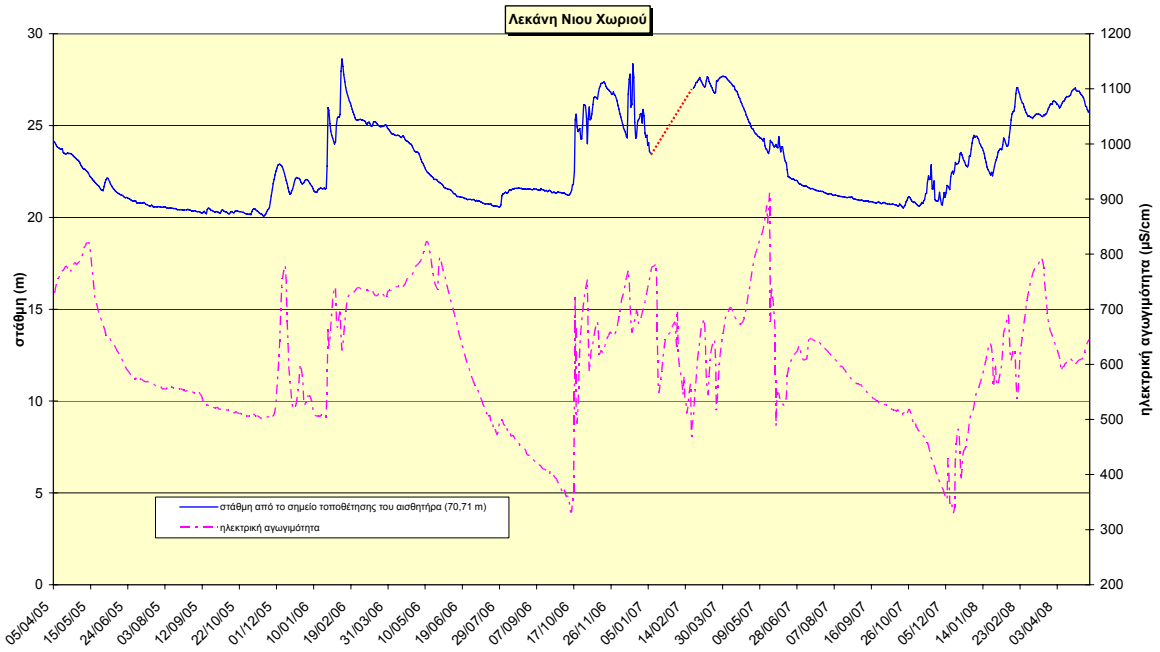
3.4.2 ΛΕΚΑΝΗ ΣΤΥΛΩΝ – ΚΟΙΛΙΑΡΗ - ΝΙΟ ΧΩΡΙΟ

Το καρστικό αυτό σύστημα βρίσκεται στο βόρειο κεντρικό τμήμα του Ν. Χανίων και απορρέουν από αυτό περίπου 160x10^6 m^3/έτος. Από τις πηγές του Στύλου απορρέουν περίπου 80x10^6 m^3/ έτος, ενώ από άλλες πηγές απορρέουν μικρότερες ποσότητες: Αρμένων, περίπου 30x10^6 m^3/έτος, Ελεονόρας ή Ζούρμου, περίπου 30x10^6 m^3/έτος. Το χαρακτηριστικό των πηγών αυτών είναι η έντονη διακύμανσή τους κατά τη διάρκεια του έτους. Έχουν εγκατασταθεί δύο σταθμοί, ένας ανάντη των πηγών Στύλων και ένας στο πεδίο του Νιου- Χωριού.

Από τη διακύμανση της στάθμης (Εικόνα 3-6 και Εικόνα 3-7), φαίνεται η υπεραναπλήρωση (της τάξης του 180%) του υδροφορέα στους Στύλων σε σχέση με την πτώση στάθμης που πραγματοποιήθηκε το περασμένο υδρολογικό έτος και η σχεδόν πλήρης αναπλήρωση (της τάξης του 90%) του υδροφορέα στο Νιο Χωριό. Από τη διακύμανση της ηλεκτρικής αγωγιμότητας και στα δυο διαγράμματα, συμπεραίνεται η σταθερά καλή ποιότητα του νερού του συστήματος.



Εικόνα 3-6, Διάγραμμα διακύμανσης στάθμης και μεταβολής ηλ. αγωγιμότητας του σταθμού των Στύλων

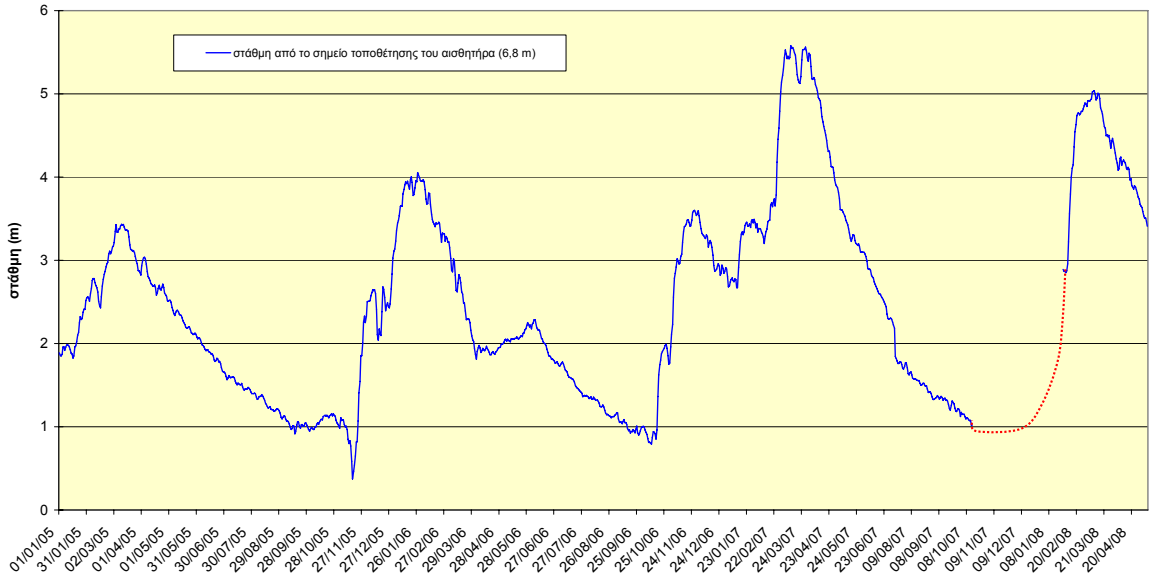


Εικόνα 3-7 Διάγραμμα διακύμανσης στάθμης και μεταβολής ηλ. αγωγιμότητας του σταθμού του Νιου Χωριού
(**……..** περίοδος κατά την οποία το όργανο παρακολούθησης ήταν εκτός λειτουργίας)

3.4.3 ΛΙΜΝΗ ΚΟΥΡΝΑ

Η λίμνη δέχεται μια μέση ετήσια πηγαία εκφόρτιση από το σύστημα των Λευκών Ορέων της τάξης των 80 εκ. m^3/έτος (στοιχεία ΙΓΜΕ). Το νερό της χρησιμοποιείται τόσο για ύδρευση όσο και για άρδευση. Συμπεριλαμβάνεται στα σημεία παρακολούθησης χημικών παραμέτρων του προγράμματος ΕΠΕΡ του ΥΠΕΧΩΔΕ.

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 3-8) παρατηρείται ανατροφοδότηση της λίμνης, σε ποσοστό 90% σε σχέση με την πτώση στάθμης που πραγματοποιήθηκε την περσινή χρονιά, που αντανακλά τη διαφορετική ετήσια κατανομή των βροχοπτώσεων.

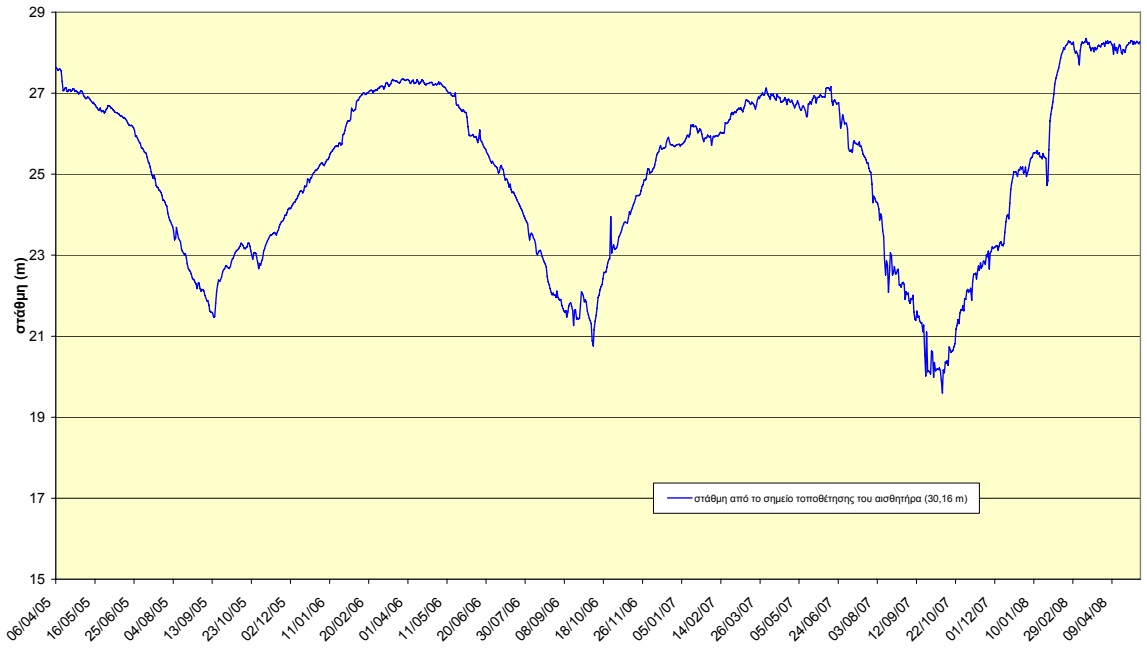


Εικόνα 3-8, Διάγραμμα διακύμανσης στάθμης του σταθμού Λίμνης Κουρνά

3.5 ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΚΟΛΕΝΙΟΥ

Το καρστικό αυτό σύστημα βρίσκεται στο βορειοδυτικό τμήμα του Ν. Χανίων και έχει συνολικές απορροές (λεκάνη Κολενίου) περίπου 20 Χ 10^6 m^3/ έτος. Από την όμορη λεκάνη του Ταυρωνίτη, επιφανειακά απορρέουν περίπου 60 Χ 10^6 m^3/ έτος. Από τις πηγές του Κολενίου απορρέουν περίπου 10 Χ 10^6 m^3/έτος. Ανάντη των πηγών έχει κατασκευασθεί αριθμός γεωτρήσεων που εκμεταλλεύονται το πεδίο του συστήματος των πηγών. Ο σταθμός έχει εγκατασταθεί ανάντη των πηγών Κολενίου.

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 3-9) παρατηρείται υπεραναπλήρωση του υδροφορέα κατά τη διάρκεια της χειμερινής περιόδου, σε ποσοστό 120%, σε σχέση με την πτώση στάθμης που πραγματοποιήθηκε το περασμένο υδρολογικό έτος, το οποίο οφείλεται στις αυξημένες βροχοπτώσεις και στις αντλήσεις.



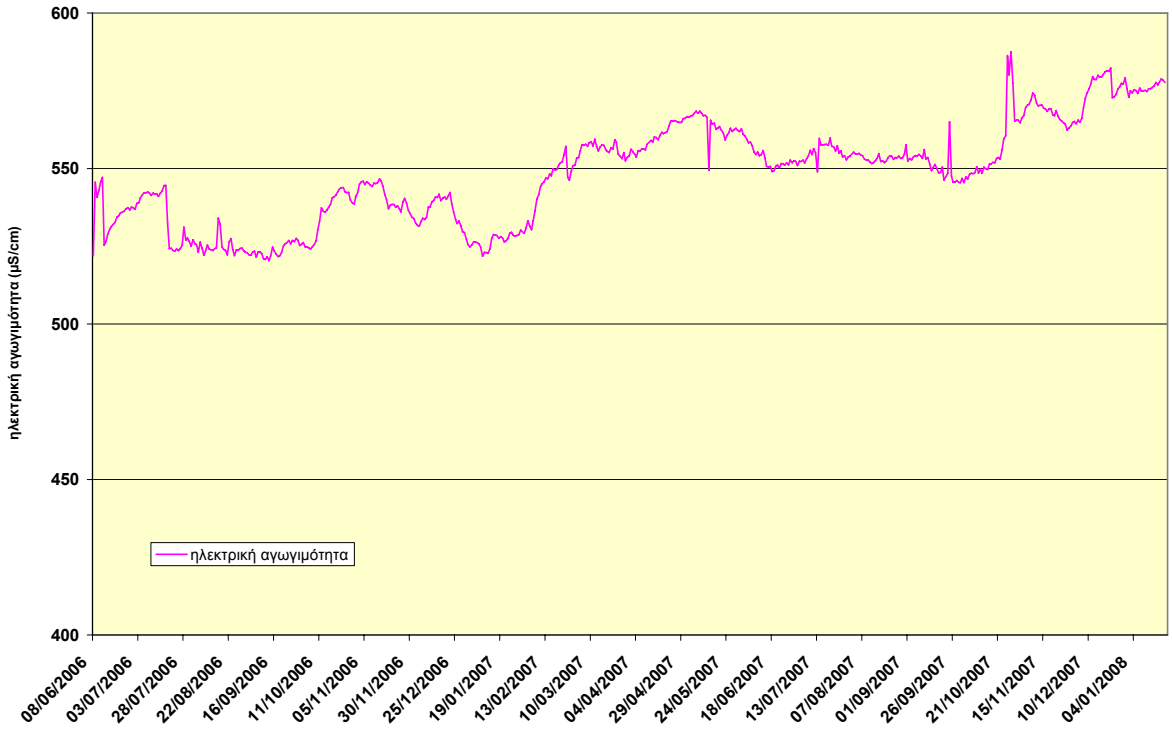
Εικόνα 3-9, Διάγραμμα διακύμανσης στάθμης του σταθμού Κολενίου

3.6 ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΣΗΤΕΙΑΣ-ΠΑΛΑΙΚΑΣΤΡΟΥ

Πρόκειται για έναν ιδιαίτερα σημαντικό υδροφορέα, ο οποίος καλύπτει τις υδρευτικές και αρδευτικές ανάγκες της περιοχής με σημαντικές δυνατότητες παραπέρα τουριστικής ανάπτυξης. Λόγω της υδραυλικής σχέσης με τη θάλασσα απαιτείται η συνεχής παρακολούθησή του, προκειμένου να αποφευχθεί η υποβάθμισή του.

Όπως φαίνεται από τη διακύμανση της ηλεκτρικής αγωγιμότητας (Εικόνα 3-10), παρατηρείται μια μικρή τάση ανόδου, όμως η σημερινή κατάσταση της ποιότητας του νερού χαρακτηρίζεται ως «πολύ καλή».

Ο υδροφορέας έχει ενταχθεί στις υπό απαγόρευση περιοχές για νέες αρδευτικές χρήσεις.

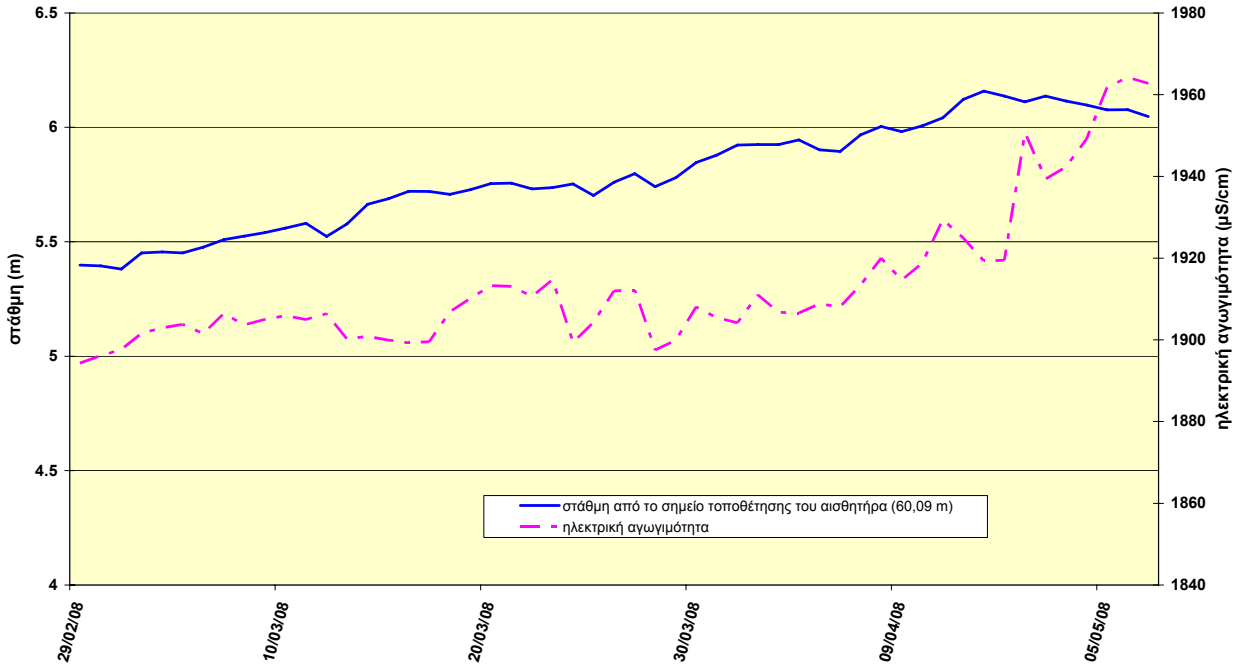


Εικόνα 3-10 Διάγραμμα μεταβολής ηλεκτρικής αγωγιμότητας του σταθμού Παλαίκαστρου Σητείας

3.7 ΥΔΡΟΓΕΩΛΟΓΙΚΟ ΣΥΣΤΗΜΑ ΚΕΡΑΤΟΚΑΜΠΟΥ

Εγκαταστήσαμε ένα νέο σταθμό παρακολούθησης των ποιοτικών και ποσοτικών χαρακτηριστικών του παράκτιου καρστικού υδροφορέα στον Κερατόκαμπο (εικόνα 3-11) (νότια του νομού Ηρακλείου), ο οποίος καλύπτει τις υδρευτικές και αρδευτικές ανάγκες της περιοχής, η οποία παρουσιάζει σημαντικές δυνατότητες περαιτέρω τουριστικής ανάπτυξης. Λόγω της υδραυλικής σχέσης με τη θάλασσα απαιτείται η συνεχής παρακολούθησή του, προκειμένου να αποφευχθεί η υποβάθμισή του.

Ασφαλή συμπεράσματα για την κατάσταση του υδροφορέα θα εξαχθούν μετά από εκτενέστερη μελέτη των διακυμάνσεων της ηλ. αγωγιμότητας και της στάθμης. Πάντως, είναι γνωστό ότι το νερό του συγκεκριμένου υδροφορέα είναι επιβαρυμένο με θειικά και χλωριούχα ιόντα.



Εικόνα 3-11 Διάγραμμα διακύμανσης στάθμης και μεταβολής ηλεκτρικής αγωγιμότητας του σταθμού του Κερατόκαμπου

4 ΝΕΟΓΕΝΕΙΣ - ΠΡΟΣΧΩΣΙΓΕΝΕΙΣ ΛΕΚΑΝΕΣ

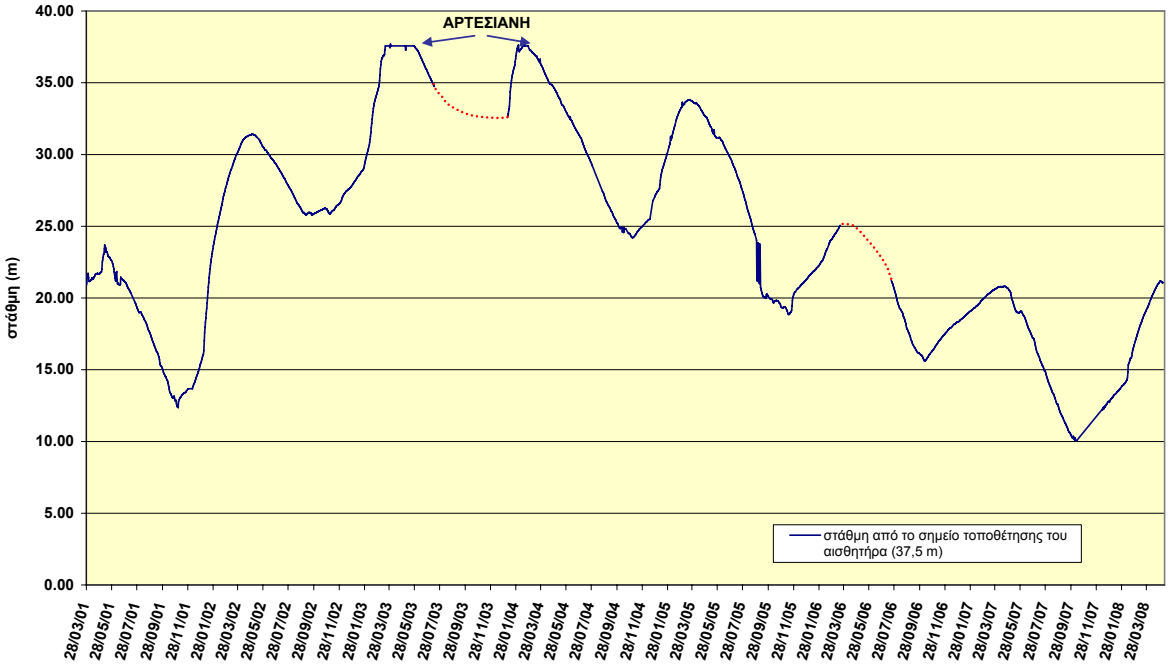
Σημαντική έκταση στην υδρογεωλογική δομή της Κρήτης καταλαμβάνουν και οι νεογενείς-προσχωσιγενείς λεκάνες, στις οποίες αναπτύσσονται σημαντικοί υδροφορείς μικρού βάθους, οι οποίοι είναι και εκείνοι που εκμεταλλεύονται εντατικά. Η συνολική τους έκταση υπολογίζεται σε 2.598 km^2, δέχονται ένα μέσο ετήσιο ύψος βροχής 693 mm και ο όγκος του κατεισδύοντος νερού, το οποίο τροφοδοτεί τους υπόγειους υδροφορείς ανέρχεται στα $364x10^6$ m^3/έτος.

4.1 ΛΕΚΑΝΗ ΑΝΩ ΒΙΑΝΝΟΥ

Πρόκειται για προσχωματική λεκάνη μικρής έκτασης και η διαχείρισή της γίνεται εξ ολοκλήρου από τον ΤΟΕΒ Βιάννου. Έχει εγκατασταθεί ένας σταθμός στο κέντρο της λεκάνης.

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 4-1) παρατηρείται πλήρης αναπλήρωση του υδροφορέα το τρέχον υδρολογικό έτος σε σχέση με την πτώση στάθμης του προηγούμενου υδρολογικού έτους.

Ο ΤΟΕΒ θα πρέπει να συνεχίσει τη λήψη μέτρων για τη φετινή αρδευτική περίοδο.



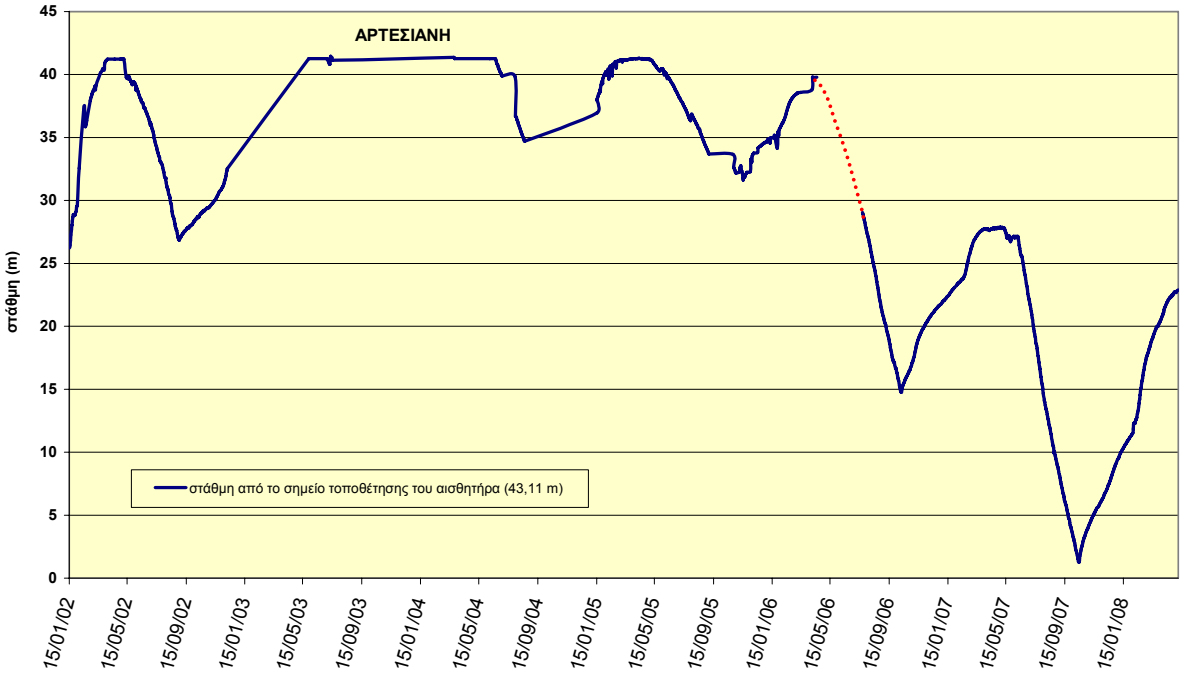
Εικόνα 4-1 Διάγραμμα διακύμανσης στάθμης του σταθμού Βιάννου
(**……..** περίοδος κατά την οποία το όργανο παρακολούθησης ήταν εκτός λειτουργίας)

4.2 ΛΕΚΑΝΗ ΕΜΠΑΡΟΥ

Πρόκειται για προσχωματική λεκάνη μικρής έκτασης αλλά σημαντική για την οικονομία της περιοχής. Η εκμετάλλευσή της γίνεται από πηγάδια και γεωτρήσεις μικρού βάθους και το νερό της χρησιμοποιείται για άρδευση (κυρίως ελιών και δίκταμου). Κατά την διάρκεια του χειμώνα πραγματοποιείται τεχνητός εμπλουτισμός. Η λεκάνη εκφορτίζεται κυρίως στις πηγές Εμπάρου οι οποίες λειτουργούν όταν πληρωθεί ο υδροφορέας. Έχει εγκατασταθεί ένας σταθμός στο κέντρο περίπου της λεκάνης.

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 4-2) παρατηρείται αναπλήρωση του υδροφορέα για το τρέχον υδρολογικό έτος κατά 80% σε σχέση με την πτώση στάθμης του προηγούμενου υδρολογικού έτους, λόγω υπεράντλησης.

Η λεκάνη έχει ενταχθεί στις υπό απαγόρευση περιοχές (ΦΕΚ 303/Β΄/7-3-2007).



Εικόνα 4-2 Διάγραμμα διακύμανσης στάθμης του σταθμού Εμπάρου
(…….. περίοδος κατά την οποία το όργανο παρακολούθησης ήταν εκτός λειτουργίας)

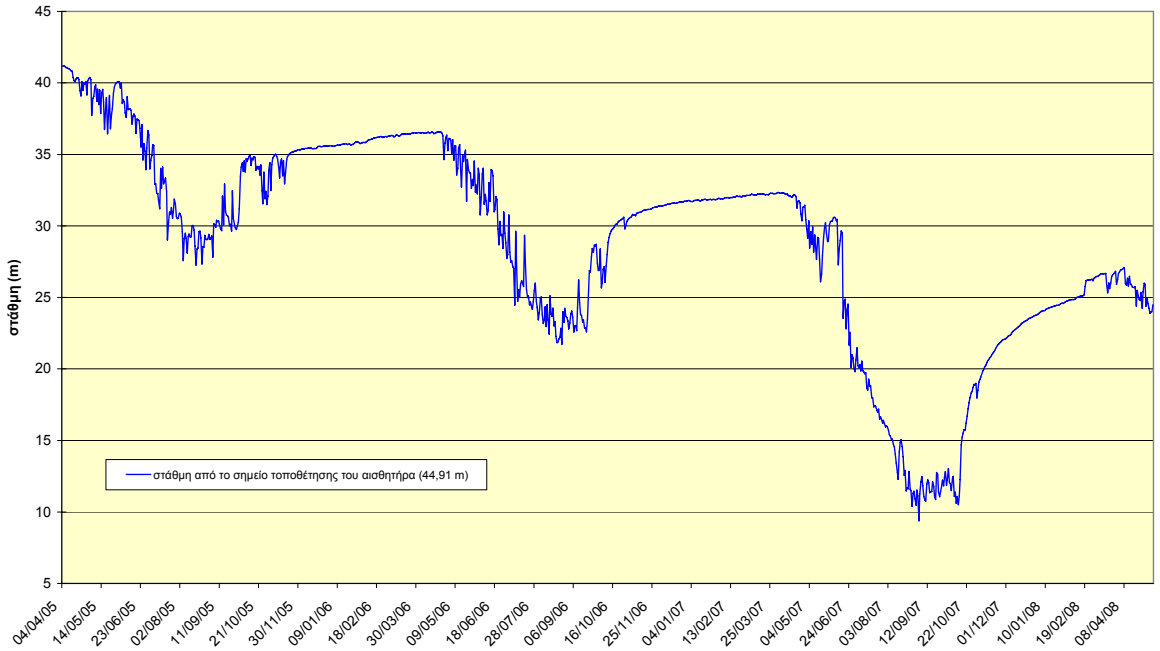
4.3 ΑΝΑΤΟΛΙΚΗ ΜΕΣΑΡΑ

Η προσχωματική αυτή λεκάνη δομείται γεωλογικά αποκλειστικά από αλλουβιακές αποθέσεις. Καταλαμβάνει μια έκταση περίπου 60 km^2, δέχεται ένα μέσο ετήσιο ύψος βροχής 656 mm, με όγκο κατακρημνισμάτων $39x10^6$ m^3/έτος, από τον οποίο περίπου $8x10^6$ m^3/έτος κατεισδύουν. Η εκμετάλλευση της λεκάνης γίνεται αποκλειστικά από γεωτρήσεις.

4.3.1 ΛΕΚΑΝΗ *ΠΡΑΙΤΩΡΙΩΝ*

Ο σταθμός Πραιτωρίων έχει εγκατασταθεί στο κέντρο περίπου της προσχωματικής λεκάνης.

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 4-3) παρατηρείται ότι η αναπλήρωση της λεκάνης κατά το τρέχον υδρολογικό έτος είναι της τάξης του 75% σε σχέση με την πτώση στάθμης του περασμένου υδρολογικού έτους, ενώ η υδροστατική στάθμη, το μήνα Μάιο, είναι πέντε μέτρα (5 m) χαμηλότερη σε σχέση με την αντίστοιχη ημερομηνία του έτους 2007.



Εικόνα 4-3 Διάγραμμα διακύμανσης στάθμης του σταθμού Πραιτωρίων

4.4 ΔΥΤΙΚΗ ΜΕΣΑΡΑ

4.4.1 ΛΕΚΑΝΕΣ: ΑΣΗΜΙΟΥ–ΜΟΙΡΩΝ–ΠΟΜΠΙΑΣ

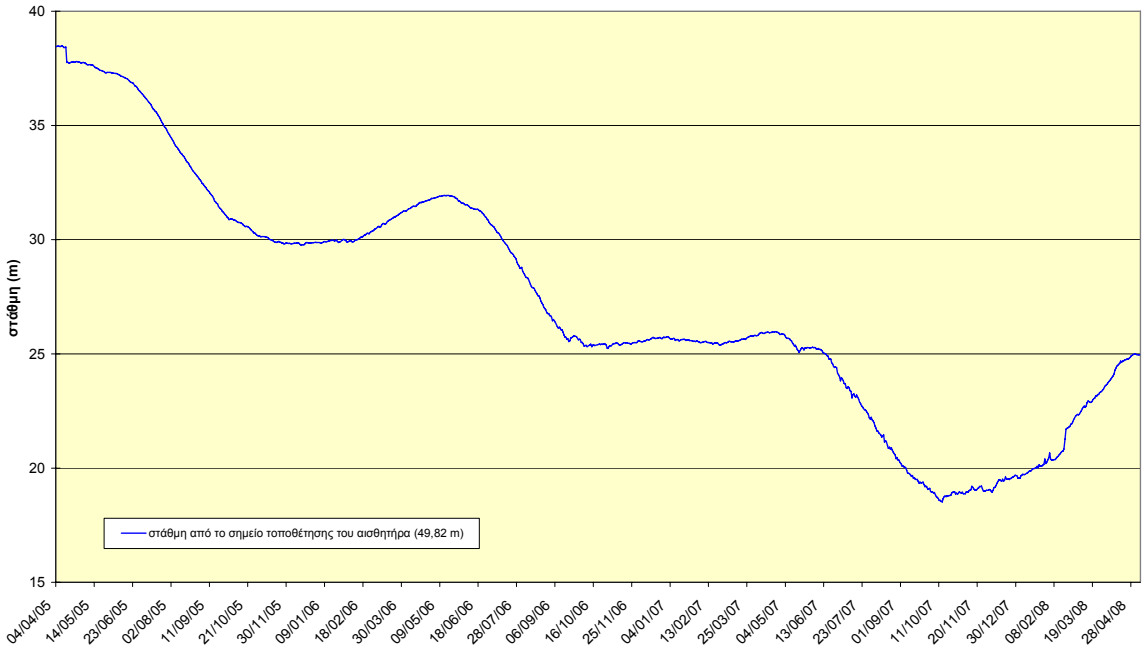
Η πεδιάδα της δυτικής Μεσσαράς (υδρολογική λεκάνη Γεροπόταμου), η οποία εκτείνεται από το Ασήμι μέχρι τη Φαιστό, αποτελεί τη σημαντικότερη αγροτική περιοχή της Κρήτης. Όλη η αγροτική οικονομία σήμερα της περιοχής στηρίζεται στα υπόγεια νερά της. Ο αλουβιακός – πλειστοκαινικός υδροφορέας καταλαμβάνει το κεντρικό τμήμα της λεκάνης, έχει έκταση περίπου 100 Km^2 και δέχεται μέσο ύψος βροχής 650 mm. Ο υπόγειος υδροφορέας άρχισε να εκμεταλλεύεται από το 1970 με την ανόρυξη των πρώτων γεωτρήσεων στα πλαίσια του προγράμματος FAO. Η εκμετάλλευσή του άρχισε βαθμιαία να αυξάνει και μετά το 1981 άρχισε η υπερεκμετάλλευσή του και η πτώση του υδροφόρου ορίζοντα. Ο υδροφορέας αυτός διακρίνεται σε μικρότερες λεκάνες, οι οποίες όμως επικοινωνούν υδραυλικά μεταξύ τους. Λόγω της σπουδαιότητας του υδροφορέα έχουν εγκατασταθεί τρεις σταθμοί στις θέσεις Ασήμι, Μοίρες και Πόμπια.

Από τα διαγράμματα που ακολουθούν φαίνεται ότι εξακολουθεί να παρατηρείται μια σημαντική πτώση της στάθμης των υδροφορέων, αποτέλεσμα της μειωμένης αναπλήρωσης αλλά και των αυξημένων αντλήσεων.

Ειδικότερα από τα διαγράμματα παρατηρούνται τα εξής:

4.4.1.1 Λεκάνη Ασημίου

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 4-4) παρατηρείται ότι η αναπλήρωση της λεκάνης κατά το τρέχον υδρολογικό έτος είναι της τάξης του 85% σε σχέση με την πτώση στάθμης του προηγούμενου υδρολογικού έτους και της τάξης του 50% σε σχέση με την πτώση στάθμης του υδρολογικού έτους 2005-2006, ενώ η υδροστατική στάθμη, το μήνα Μάιο, είναι επτά μέτρα (7 m) χαμηλότερη σε σχέση με την αντίστοιχη ημερομηνία του έτους 2006. Απαιτείται η εφαρμογή έκτακτων μέτρων στην περιοχή, όπως η μείωση των ποσοτήτων του νερού άρδευσης.

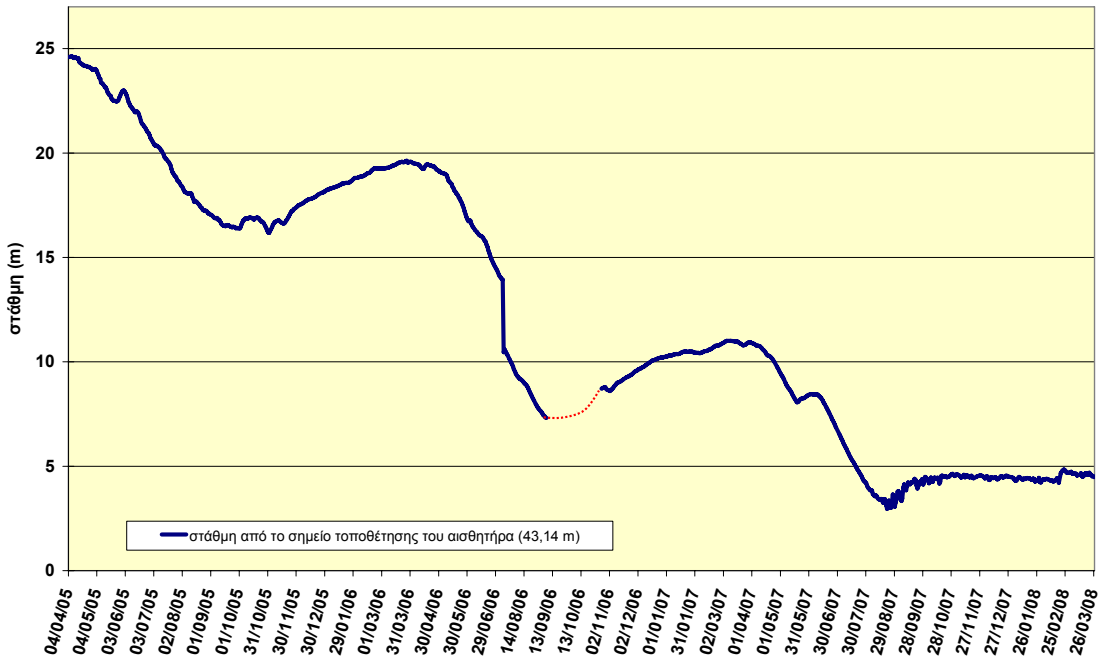


Εικόνα 4-4. Διάγραμμα διακύμανσης στάθμης του σταθμού Ασημίου

4.4.1.2 Λεκάνη Μοιρών

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 4-5) παρατηρείται αναπλήρωση του υδροφορέα κατά το τρέχον υδρολογικό έτος, κατά περίπου 20% σε σχέση με την πτώση στάθμης του προηγούμενου υδρολογικού έτους, ενώ η υδροστατική στάθμη, το μήνα Μάιο, είναι δεκαπέντε μέτρα (15μ) χαμηλότερη σε σχέση με την αντίστοιχη περίοδο του έτους 2006.

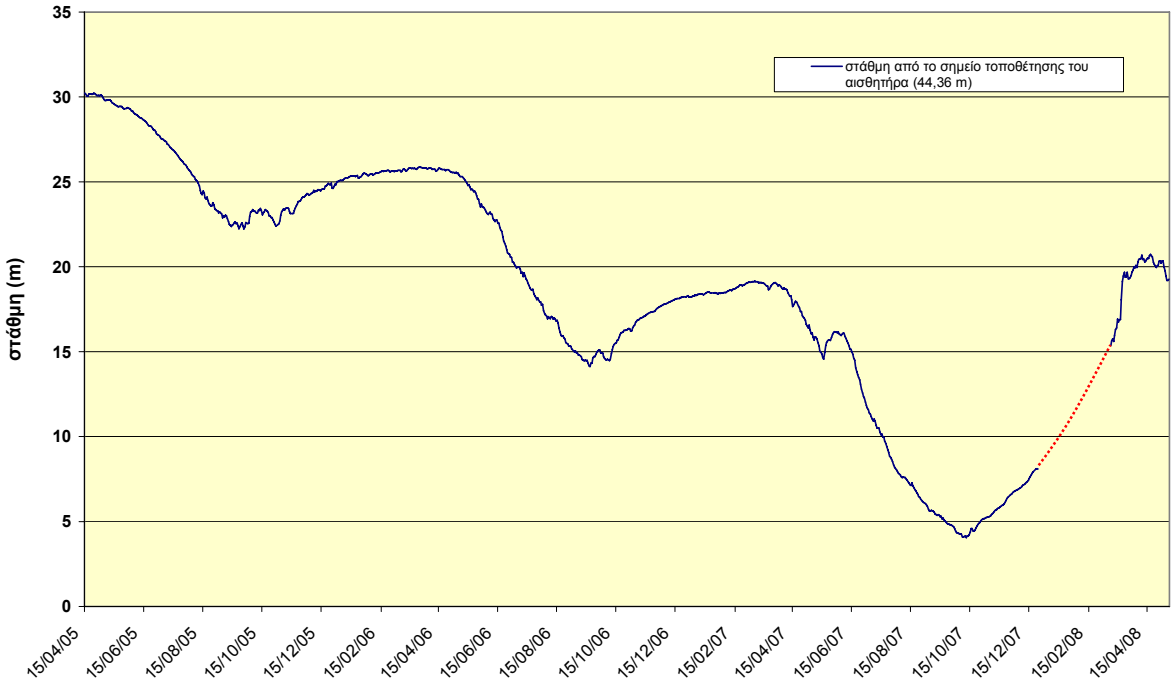
Απαιτείται η εφαρμογή έκτακτων μέτρων στην περιοχή, όπως η μείωση των ποσοτήτων του νερού άρδευσης.



Εικόνα 4-5. Διάγραμμα διακύμανσης στάθμης του σταθμού Μοιρών

4.4.1.3 Λεκάνη Πόμπιας

Από το διάγραμμα διακύμανσης της στάθμης (Εικόνα 4-6) παρατηρείται υπεραναπλήρωση της λεκάνης κατά το τρέχον υδρολογικό έτος (της τάξης του 110%) σε σχέση με την πτώση στάθμης του περασμένου υδρολογικού έτους, και αναπλήρωση κατά 75% σε σχέση με το υδρολογικό έτος 2005-2006. Αυτό, εν μέρει οφείλεται στα αυξημένα επίπεδα των φετινών βροχοπτώσεων στην περιοχή (514 mm) σε σχέση με τις περσινές βροχοπτώσεις (370 mm), αλλά και στο πρόγραμμα εμπλουτισμού του υπόγειου υδροφορέα που εφαρμόζεται στη συγκεκριμένη περιοχή.



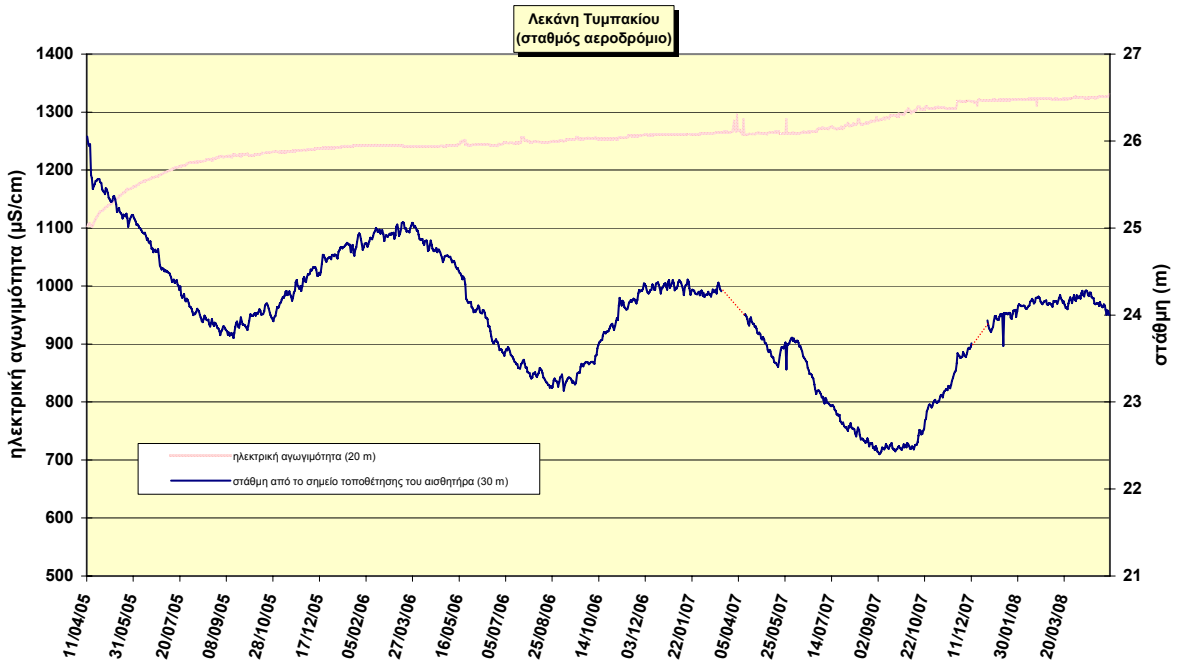
Εικόνα 4-6. Διάγραμμα διακύμανσης στάθμης του σταθμού Πόμπιας

4.4.2 ΛΕΚΑΝΗ ΤΥΜΠΑΚΙΟΥ

Η πεδιάδα του Τυμπακίου αποτελεί μια από τις σημαντικότερες αγροτικές περιοχές της Κρήτης με την καλλιέργεια πρώιμων κηπευτικών σε θερμοκήπια καθώς και ελαιοδέντρων. Η αρδευόμενη έκταση είναι 40.000 στρέμματα και το σύνολο του αρδευτικού νερού που χρησιμοποιείται μέχρι σήμερα προέρχεται από το υπόγειο δυναμικό. Ο αλουβιακός - πλειστοκαινικός υδροφορέας καταλαμβάνει το παράκτιο - κεντρικό τμήμα της λεκάνης, έχει έκταση περίπου 50 Km^2 και δέχεται μέσο ύψος βροχής λιγότερο από 500 mm. Λόγω της γειτνίασής του με τη θάλασσα ο υδροφορέας στο ΝΔ παράκτιο τμήμα του (περιοχή Κόκκινου Πύργου) έχει υποστεί υφαλμύρινση. Λόγω της σπουδαιότητας του υδροφορέα έχουν εγκατασταθεί τρεις σταθμοί, δύο κοντά στην ακτή (Αεροδρόμιο - Γεροπόταμος και Κόκκινος Πύργος) και ένας στο κέντρο περίπου της λεκάνης (γεώτρηση Α3).

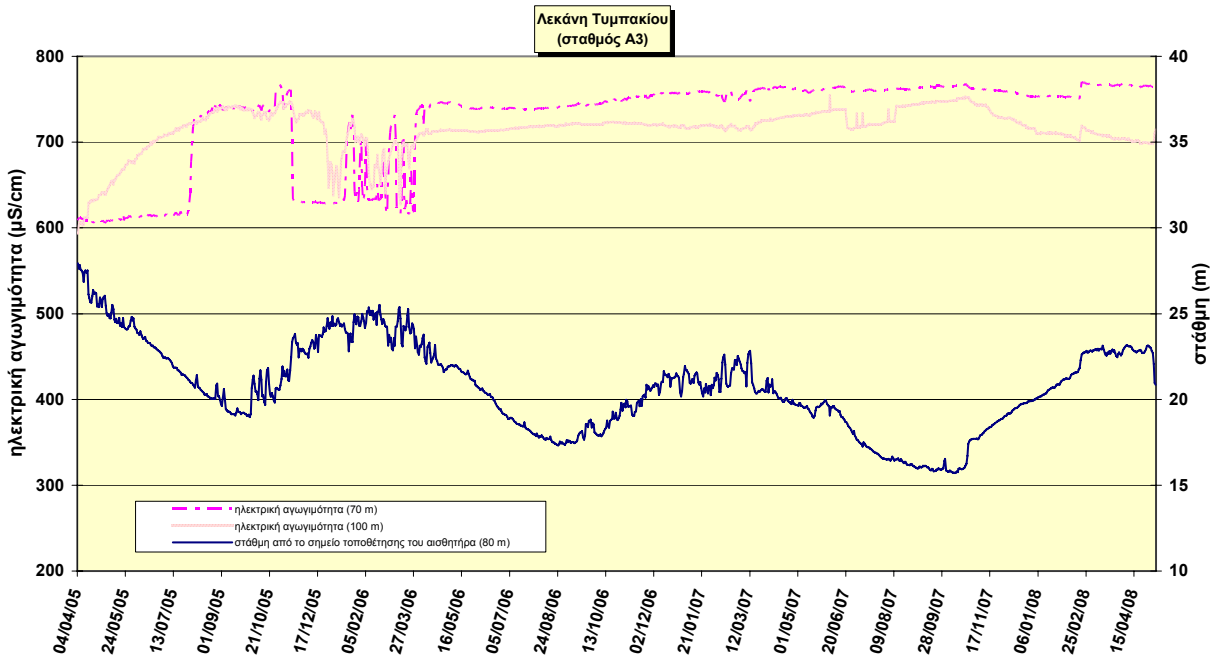
Από τα διαγράμματα διακύμανσης της στάθμης (Εικόνα 4-7, Εικόνα 4-8 και Εικόνα 4-9) παρατηρείται η πλήρης αναπλήρωση του υδροφορέα μετά τις βροχοπτώσεις της χειμερινής περιόδου, σε σχέση με την πτώση στάθμης του προηγούμενου υδρολογικού έτους. Αυτό οφείλεται στο ύψος των φετινών βροχοπτώσεων, οι οποίες ήταν αυξημένες σε σχέση με την περσινή χρονιά (507 mm για το τρέχον υδρολογικό έτος, έναντι 344 mm για το περσινό). Παρατηρείται όμως μια συνεχής πτωτική τάση της υδροστατικής στάθμης από το 2005 έως σήμερα, της τάξης των 1,5 μέτρων (σταθμός αεροδρομίου) έως 4 μέτρων (σταθμός Α3), γεγονός που οφείλεται στις αυξημένες χειμερινές αντλήσεις λόγω των θερμοκηπιακών καλλιεργειών και τη δέσμευση της απορροής του υδρορέματος Κουτσουλίδη από το φράγμα Φανερωμένης. Απαιτείται η λήψη μέτρων για την αποφυγή μελλοντικής επιδείνωσης.

Όσον αφορά την ποιότητα του νερού, όπως φαίνεται από τις διακυμάνσεις της ηλεκτρικής αγωγιμότητας, απαιτείται ιδιαίτερη προσοχή για πιθανή επιδείνωση ενόψει της θερινής περιόδου.

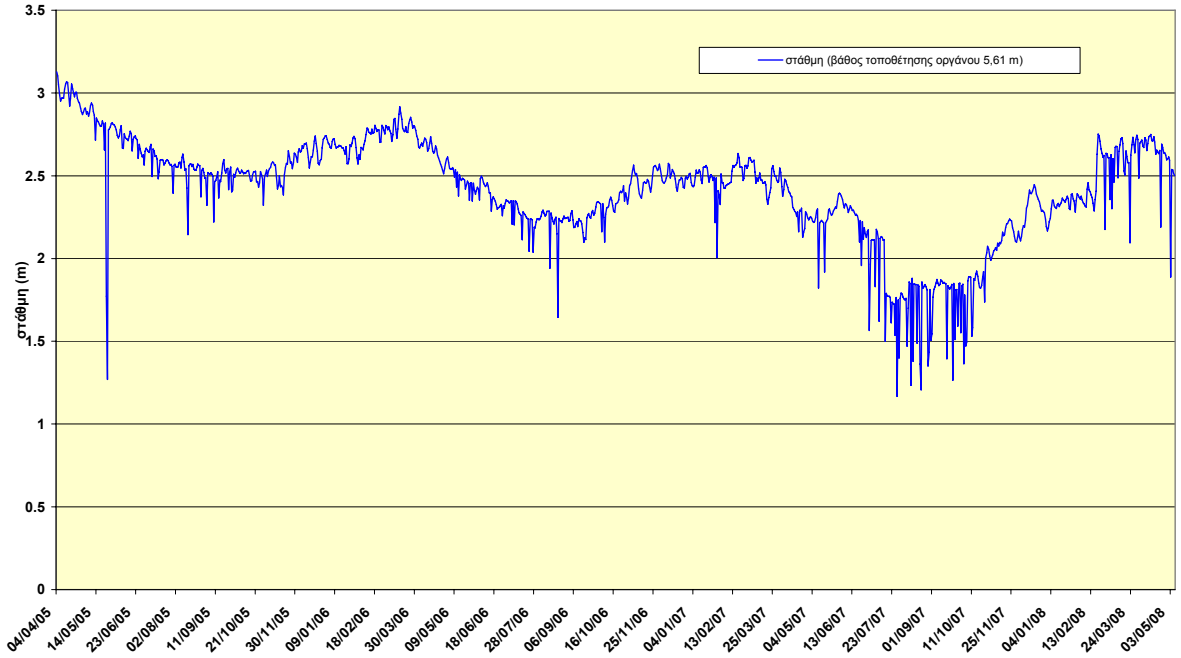


Εικόνα 4-7 Διάγραμμα διακύμανσης στάθμης και μεταβολής αγωγιμότητας του σταθμού Τυμπακίου-αεροδρόμιο (Γεροπόταμος)

(..... περίοδος κατά την οποία το όργανο παρακολούθησης ήταν εκτός λειτουργίας)



Εικόνα 4-8 Διάγραμμα διακύμανσης στάθμης και μεταβολής ηλ. αγωγιμότητας του σταθμού Α3-Τυμπάκιου



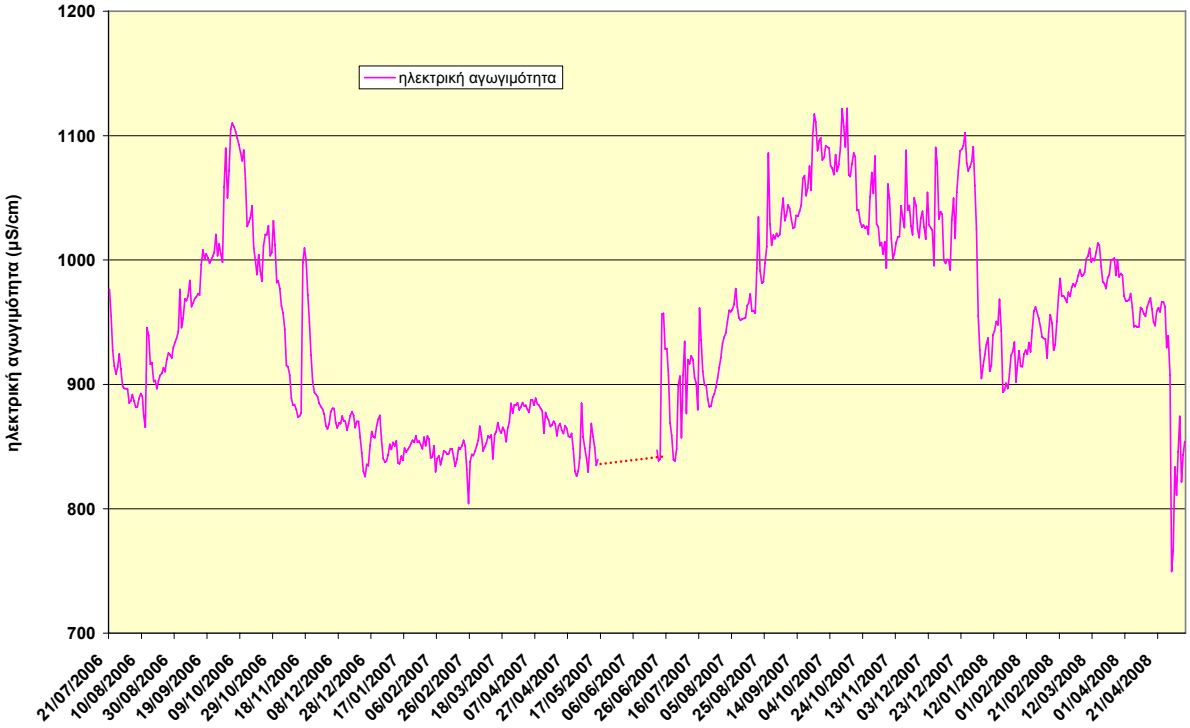
Εικόνα 4-9 Διάγραμμα διακύμανσης στάθμης του σταθμού Κόκκινος Πύργος (πηγάδι)

4.5 ΠΡΟΣΧΩΜΑΤΙΚΗ ΛΕΚΑΝΗ ΠΛΑΤΑΝΙΑ ΡΕΘΥΜΝΟΥ

Πρόκειται για ένα νέο σταθμό παρακολούθησης των ποιοτικών χαρακτηριστικών του υπόγειου υδροφόρου της προσχωματικής λεκάνης Πλατανιά.

Η ενότητα καταλαμβάνει έκταση 6,5 km^2. Δέχεται έναν όγκο κατακρημνισμάτων της τάξης των $5x10^6$ m^3/έτος, με μέσο ύψος βροχής 761 mm/έτος. Από αυτά, τα $1x10^6$ m^3/έτος αποτελούν τον όγκο του κατεισδύοντος νερού.

Όσον αφορά την ποιότητα του νερού, όπως φαίνεται από τη διακύμανση της ηλεκτρικής αγωγιμότητας (Εικόνα 4-10), αυτή παρουσιάζει κάποιες σημαντικές διακυμάνσεις, που πρέπει να οφείλονται στην υπεράντληση, παρατηρείται όμως προς το παρόν και πτώση-αποκατάσταση των τιμών, εξαιτίας της μικρής έκτασης του υδροφορέα και της πλούσιας ανατροφοδότησής του (υδρόρεμα Ποταμών).



Εικόνα 4-10. Διάγραμμα μεταβολής ηλ. αγωγιμότητας του σταθμού Πλατανιά Ρεθύμνου

5 ΣΥΜΠΕΡΑΣΜΑΤΑ

Τα γενικά συμπεράσματα από τις μετρήσεις του τηλεμετρικού δικτύου, όπως αναλύονται στην παρούσα έκθεση, είναι ότι οι προσχωματικοί υδροφορείς εμφανίζουν υπερεκμετάλλευση (μικρότερη υδροστατική στάθμη στην Ανατολική και Δυτική Μεσαρά κατά 15 περίπου μέτρα σε σχέση με το έτος 2005). Η φετινή αναπλήρωσή τους, λόγω των βροχοπτώσεων, αλλά και των χιονοπτώσεων που σημειώθηκαν, είναι σχετικά καλή σε σχέση με την πτώση στάθμης που είχε παρατηρηθεί κατά την καλοκαιρινή περίοδο του περσινού υδρολογικού έτους (της τάξης του 75% για την Ανατολική Μεσαρά, ενώ για τη Δυτική Μεσαρά κυμαίνεται από 100% στη λεκάνη Τυμπακίου έως 20% για τη λεκάνη Μοιρών).

Οι υδροφορείς των καρστικών συστημάτων εμφανίζουν πολύ καλή αναπλήρωση σε σχέση με το περσινό υδρολογικό έτος. Σε αυτό βοήθησαν οι χιονοπτώσεις που σημειώθηκαν τη φετινή χρονιά.

6 ΠΡΟΤΑΣΕΙΣ - ΜΕΤΡΑ

Σύμφωνα με την αρ. 145/22-1-2008 απόφαση του Γενικού Γραμματέα Περιφέρειας Κρήτης, ανεστάλη η κατάθεση αιτήσεων στην υπηρεσία μας, για την εκτέλεση νέων έργων υδροληψίας στην περιοχή της Μεσαράς (Δήμοι Αστερουσίων, Κόφινα, Γόρτυνας, Μοιρών και Τυμπακίου).

Ακόμα, με βάση τα παραπάνω, οι προτάσεις μας προς τους ΟΤΑ, ΤΟΕΒ, συνεταιρισμούς, ομάδες παραγωγών και τους ιδιώτες, για τη θερινή περίοδο που διανύουμε, επικεντρώνονται στα εξής:

1) Την επιλογή της στάγδην άρδευσης ως του πιο κατάλληλου συστήματος για την εξοικονόμηση νερού.
2) Την άρδευση τις νυκτερινές ώρες ή νωρίς το πρωί και αργά το απόγευμα για την αποφυγή μεγάλης εξάτμισης καθώς και όταν η ένταση του ανέμου δεν είναι μεγάλη.
3) Την προσαρμογή της άρδευσης (διάρκεια ποτίσματος-επανάληψη) στις εδαφικές συνθήκες, μετά από οδηγίες των τοπικών γεωπόνων.
4) Την τοποθέτηση υδρομέτρων για τον έλεγχο της ποσότητας του νερού που χρησιμοποιείται στην άρδευση.
5) Τον τακτικό έλεγχο και συντήρηση τόσο των δικτύων μεταφοράς, όσο και των δικτύων διανομής, προς αποφυγή διαρροών που οδηγούν σε άσκοπη κατανάλωση νερού.
6) Την προσαρμογή της άρδευσης στη διαθέσιμη ποσότητα νερού.
7) Τον περιορισμό κατά το δυνατόν των υδροβόρων καλλιεργειών.
8) Την αποτροπή της υπεράντλησης σε όλες τις περιοχές και κατά μείζονα λόγο σε αυτές που παρουσιάζουν έντονο πρόβλημα, προς αποφυγή της δραματικής πτώσης της στάθμης και της επιδείνωσης της υφαλμύρωσης των παράκτιων υδροφορέων.
9) Τη διαφύλαξη πάση θυσία της ποσότητας και της ποιότητας του νερού ύδρευσης.
10) Την εφαρμογή κατάλληλης τιμολογιακής πολιτικής για την αποτροπή της σπατάλης του νερού.

Γενικότερα, η εκπόνηση των διαχειριστικών σχεδίων για κάθε λεκάνη απορροής που προωθείται από την Κεντρική Υπηρεσία Υδάτων του ΥΠΕΧΩΔΕ, η συμπλήρωση του δικτύου παρακολούθησης των υπόγειων και επιφανειακών υδάτων της Κρήτης, αλλά και η προώθηση και η επίσπευση κατασκευής σημαντικών έργων υποδομής, όπως τα φράγματα Αποσελέμη, Πλακιώτισσας, Αρχανών, Αμιρών-Αγ. Βασιλείου, Καλαμίου κ.α., η κατασκευή των δικτύων του φράγματος Φανερωμένης, η εκτροπή του Πλατύ, η κατασκευή φράγματος εκτροπής για τον εμπλουτισμό των υδατικών αποθεμάτων της περιοχής της Ιεράπετρας από τη γειτονική υδρολογική λεκάνη του Μύρτου, η κατασκευή λιμνοδεξαμενής στην περιοχή Παλαιόχωρας-Κουντούρας, ο εμπλουτισμός των υδροφορέων της Μεσαράς, της Εμπάρου, της Βιάννου, του Μακρύ Γιαλού κ.α., αποτελούν μέτρα που θα συντελέσουν στην ορθή διαχείριση των υδατικών πόρων του νησιού.

Ακόμα, απαιτείται ο έλεγχος των δικτύων ύδρευσης εντός των πόλεων για τον έλεγχο των απωλειών, ενώ είναι σκόπιμο να προχωρήσει η περαιτέρω επεξεργασία της εκροής των βιολογικών καθαρισμών, ειδικά στις μεγάλες πόλεις (π.χ. Ηρακλείου, Ιεράπετρας, Αγ. Νικολάου κλπ) μετά από τριτοβάθμια επεξεργασία και να δρομολογηθούν τα έργα αξιοποίησης των νερών

αυτών για άρδευση περιοχών (π.χ. Φοινικιάς κ.α.) ή για εμπλουτισμό υδροφορέων μετά από κατάλληλους ελέγχους και προϋποθέσεις.

Ειδικά, για τα νερά της πηγής του Αλμυρού Ηρακλείου, θα πρέπει να ξεκινήσει η διαδικασία που θα περιλαμβάνει τη συγκέντρωση των υπαρχουσών μελετών, την αξιολόγησή τους από ειδικούς επιστήμονες, την τεκμηρίωση της επιλεχθείσας μεθόδου με πιθανές συμπληρωματικές έρευνες αν χρειαστούν, ώστε να βγουν τα κατάλληλα συμπεράσματα για την περαιτέρω αξιοποίησή τους.

Τέλος, θα πρέπει να δοθεί ιδιαίτερη έμφαση στον έλεγχο των σημειακών και διάχυτων πηγών ρύπανσης των επιφανειακών και υπόγειων νερών (π.χ. ανεξέλεγκτοι χώροι διάθεσης απορριμμάτων, απόβλητα ελαιουργείων κ.α.).

Παρακαλούμε για κάθε επιπρόσθετη πληροφορία ή διευκρίνιση να απευθύνεστε στην υπηρεσία μας (τηλ. 2810 278-623, -624, -625, -607).

Ηράκλειο, 7 Ιουλίου 2008
Ο Διευθυντής

Δρ. Ηρακλής Μπουλουκάκης

Towards Sustainable Water Use on Mediterranean Islands: Addressing Conflicting Demands and Varying Hydrological, Social and Economic Conditions

Report on Water Resouces of Crete

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Abstract

The area of Crete covers 8336 km^2; the mean altitude is 460 m and the total population is about 600,000 people. The climate is considered to be sub-humid Mediterranean with humid and relatively cold winters and dry and warm summers. The average annual precipitation is estimated to be 750 mm; the potential renewable water resources 2650 $x10^6$ m^3 and the real water used about 384 Mm^3/a. Despite considerable precipitation, it is estimated that from the total precipitation in plains per year about 70% is lost to evapotranspiration, 10% as runoff to sea and only 20% goes to recharging the groundwater. Crete has high per capita water availability, which is slightly lower than that of the country. The major water use in Crete is irrigation for agriculture (83.3% of the total consumption) while domestic use including tourism is 15.6% and industrial use 1%. The demand for irrigation water is high, while at the same time only 31% of the available agricultural land is irrigated. The main vegetable crops grown in Crete are fresh tomatoes, cucumbers, potatoes, eggplants, onions, watermelons, melons, cabbages and peppers, while among fruit crops olive covers more than 89% followed by citrus 3.4%, almonds and avocados.

Crete shows significant regional variations in water availability, especially in coastal, eastern and southern regions due to tourism and agriculture. The rainfall is not uniformly distributed throughout the year, and it is mainly concentrated in the winter months while the drought period is extended to more than six months (May to October) with pan evaporation values ranging from 140 to more than 310 mm in the peak month. Long series rainfall data all over Crete does not show any significant change in precipitation. The temperature of the area shows a great variation. Crete lies between the isotherms 18.5-19°C with an annual latitude of 14-15°C. The annual temperature has increased in the last two decades by 0.3^{o}C. The southern part of the island is warmer than the northern part and it is the warmest part of Greece.

The geology of Crete can be described in terms of four pre Neogene major nappes and one autochthonous isopic zone with a cumulative thickness of 6.5 km. It is estimated that approximately 20% of the groundwater resources of the island, totaling approximately 1.5 billion m^3, are associated with Neogene-Quaternary aquifers while the remaining 80% are associated with their deep Karstic counterparts. There are no perennial streams on Crete and the total mean annual runoff is estimated to be in the region of 0.83 billion m^3. The contribution of the surface water to the potential water resources of Crete is about 40%. The real contribution though is about 13%, which means that almost all the water quantity used in Crete comes from subterranean sources (springs, wells and boreholes).

The main issue in water resources management on the island is focused on the uneven geographical distribution of water resources in relation to the water demand hotspots on the island. The key actions adopted by the Regional Governor of Crete for the implementation of the recommended strategic response to the water resource problems are the following: Protection of groundwater resources against over-exploitation; restrictions in issuing of groundwater abstraction license in areas under pressure; pollution control of surface and ground water; monitoring of water quality; protection of coastal aquifers from saline intrusion; exploitation of Un(der)Exploited Aquifers such as karstic aquifers; the establishment of a water plan on a watershed basis for detailed

water management; the investigation and implementation of artificial recharge of aquifers; feasibility studies for further introduction of surface reservoirs; the improvement of the information services in rural scale; the application of modern effective irrigation methods; improved freshwater storage and transport; groundwater recharge promotion; reuse of water after treatment; utilization of untapped surface water sources; interbasin transfer; agricultural, industrial and domestic demand reduction.

It should be noted that water availability in average terms is not the limiting factor. Much more important are the significant regional and seasonal variations in water availability and demand. To overcome the water shortage, especially in the future, several measures should be taken for conservation of water resources and protection of the environment.

Introduction

The island of Crete may be characterised as having marginal water resources, which, although still adequate at present, will decline over the period to 2025. Irrigation and tourism create peak demands resulting in a seasonal pattern of water demand with an annual volume of waters abstracted exceeding 50% of the average annual runoff or 35% of the groundwater potential. It is therefore considered essential that the water problems the island faces can be effectively encountered only by strategic policies based on integrated water management systems. The climate is considered to be sub-humid Mediterranean with humid and relatively cold winters and dry and warm summers. The average annual precipitation is estimated to be 750 mm; the potential renewable water resources 2650 x10^6 m^3 and the real water used about 384Mm^3/a.

Chapter I
Overview of the island

The area of Crete covers 8336 km^2, the mean altitude is 460 m and the total population is about 600,000 people. Crete consists of four prefectures, namely from west to east these are: Chania prefecture, Rethymnon prefecture, Iraklion prefecture and Lasithi prefecture. The climate is considered to be sub-humid Mediterranean with humid and relatively cold winters and dry and warm summers (Chartzoulakis et al., 2001). The average annual precipitation is estimated to be 750 mm; the potential renewable water resources 2650 x10^6 m^3 and the real water used about 384Mm^3/a. The major water use in Crete is irrigation for agriculture (83.3% of the total consumption) while domestic use, including tourism, is 15.6% and industrial use 1%. Crete shows significant regional variations in water availability, especially in coastal, eastern and southern regions due to tourism and agriculture. It has high per capita water availability, which is slightly lower than that of the country. The demand for irrigation water is high, while at the same time only 31% of the available agricultural land is irrigated. The growing water requirements make the rational management of water resources extremely important for development to be sustainable and for the environment to be served (Chartzoulakis et al., 2001).

Figure 1.1: Geophysical map of Crete. Source: Regional Governor of Crete

1.1 Physical characteristics

1.1.1 Climate

The present climate of Crete is sub-humid Mediterranean with humid and relatively cold winters and dry and warm summers. The annual rainfall ranges from 300 to 700 mm in the low areas and along the coast (Lerapetra 312 mm, Iraklio 512 mm and Chania 665 mm) and from 700 to 1000 mm in the plains of the mainland, while in the mountainous areas it reaches up to 2000 mm (Chartzoulakis et al., 2001). During winter that starts in November, the weather is instabilised due to frequent changes from low to high pressures. Precipitation decreased significantly during the last 20 years in the Messara valley. However, long series of rainfall data all over Crete does not show any significant change in precipitation (Markou-Iakovaki, 1979; Macheras & Koliva-Machera, 1990).

The rainfall is not uniformly distributed throughout the year, and it is mainly concentrated on the winter months while the drought period is extended to more than six months (May to October with pan evaporation values ranging from 140 to more than 310 mm in the peak month (Chartzoulakis et al., 2001).

As noticed, more than one-third of the total precipitation occurs along the northern coast of the island in the three main mountainous terrains (White Mountain, Idi and Dikti).

Spring is short because of the cold fronts often affecting the region in March, whereas May is rather warm, especially due to the appearance of the first south winds and the disappearance of the action of low pressures. North winds are dominant in the island. In summer, the north winds predominate, creating very dry conditions, which are also enhanced by the diminishing of low pressures in the Eastern Mediterranean and are only interrupted by some local rainfall of tropical origin (Chartzoulakis et al., 2001).

The temperature of the area shows a great variation. Crete lies between the isotherms 18.5-19°C with an annual latitude of 14-15°C. The southern part of the island is warmer than the northern part and it is the warmest area of Greece. During the cold period, temperature increases with decreasing latitude, whereas in the warm period and especially in the period from May to August, temperature increases from the coast to the mainland and particularly in the plains. In winter the lowest temperatures scarcely fall below 0°C in the plains. During the summer temperatures greater than 40°C may occur in the lowlands of Crete. The annual temperature has increased by 0.3^{o}C over the last two decades (Chartzoulakis et al., 2001).

1.1.2 Geology

The geology of Crete can be described in terms of four pre Neogene major nappes and one autochthonous isopic zone with a cumulative thickness of 6.5 km. The nappes were transported from the north along E-W trending thrusts and were emplaced between Late Eocene and early Miocene times. Shortly after nappe emplacement during the Middle Miocene an N-S extensional regime was established in the region due to the initiation of subduction in the Hellenic trench. The extensional tectonics has resulted in the development of numerous E-W grabens with offsets of up to 5 km. This period was associated with the deposition within the grabens of Miocene to Quaternary sediments, which consist mainly of red beds, sandstones, marls, limestones and evaporites (Source: Regional Governor of Crete).

It is the nappe emplacement and post emplacement tectonic and depositional history of the island, which formulated its present day hydrogeological structure. The Neogene-Quaternary sediment filled grabens host shallow aquifers whereas the carbonates of the pre Neogene nappes host the deep Karstic aquifers. Furthermore, the major fault systems play a central role in the ground water flow regime and spring discharge by imbedding or facilitating flow, depending on their relative structural positions. It is estimated that approximately 20% of the groundwater resources of the island (totaling approx. 1.5 billion m^3) are associated with the Neogene-Quaternary aquifers, whereas the remaining 80% represent the groundwater potential of deep Karstic counterparts (Source: Regional Governor of Crete).

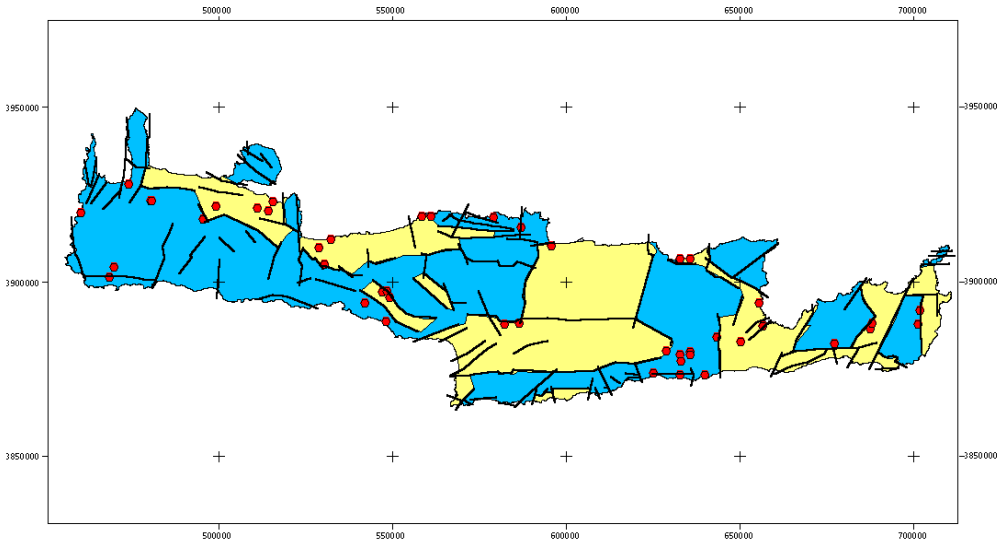

Figure 1.1.2.1: Spatial distribution of Neogene – Quaternary sediment
Filled grabens hosting shallow, mainly alluvial aquifers (yellow) and pre Neogene formations hosting deep Karstic aquifers (blue). Also depicted are the major fault systems (black lines) and the most important karstic springs (red dots) (Source: Regional Governor of Crete.)

Karstic aquifers occupy an area of 3,200 sq. Km (39% of the total area of the island) and are characterised by negligible runoff and high infiltration rates. It is estimated that 40 to 55% of the mean annual precipitation infiltrates into the ground, in these formations, creating a renewable annual groundwater potential of approximately 1.25 billion m^3, 80% of which is discharged from karstic springs the majority of which are unfortunately disposed along the coast, thus contaminated by intruding seawater (Source: Regional Governor of Crete).

The Neogene and Quaternary sediment filled grabens occupy an area of 3000 km^2 (36% of the total area of the island), include the major plains and are commonly characterised by a rich network of streams due to the presence of surface marly deposits and shallow aquifers hosted by quaternary alluvial and/or older sandstone-conglomeratic deposits with a renewable annual groundwater potential of approximately 0.25 billion m^3. These plains are the focus of intense agricultural activity with cultivation of olives, grapes, fruits and vegetables. The alluvial aquifers, which are among the most productive on the island, have undergone severe overexploitation (Source: Regional Governor of Crete).

The remaining 25% of the island comprises aquitards of impermeable geological formations such as phyllites and flysch, characterised by a rich network of streams. It should be noted that there are no perennial streams on Crete and the total mean annual runoff is estimated to be in the region of 0.83 billion m^3 (Source: Regional Governor of Crete). There are three main mountainous terrains in Crete (White mountain, Idi and Dikti). These three mountains extend over an area of 1900 km^2 and consist mainly of limestone masses intensely karstic.

1.1.3 Hydrology

1.1.3.1 Precipitation

The average annual precipitation in Crete is estimated to be 750 mm. Rainfall decreases from west to east and from north to south and is higher at high elevation areas than at the lowlands. As mentioned, the annual rainfall ranges from 300 to 700 mm in the low areas and along the coast (Ierapetra 312 mm, Iraklio 512 mm and Chania 665 mm), and from 700 to 1000 mm in the plains of the mainland, while in the mountainous areas it reaches up to 2000 mm (Chartzoulakis et al., 2001). More than one third of the total precipitation occurs along the northern coast of the island in the three mountainous terrains (White Mountains, Idi, Dikti). Figure 1.1.3.1 shows the monthly variation of rainfall at the Askifou rainfall station (White Mountains), which has an elevation of 740 m and a mean annual rainfall of 2085 mm.

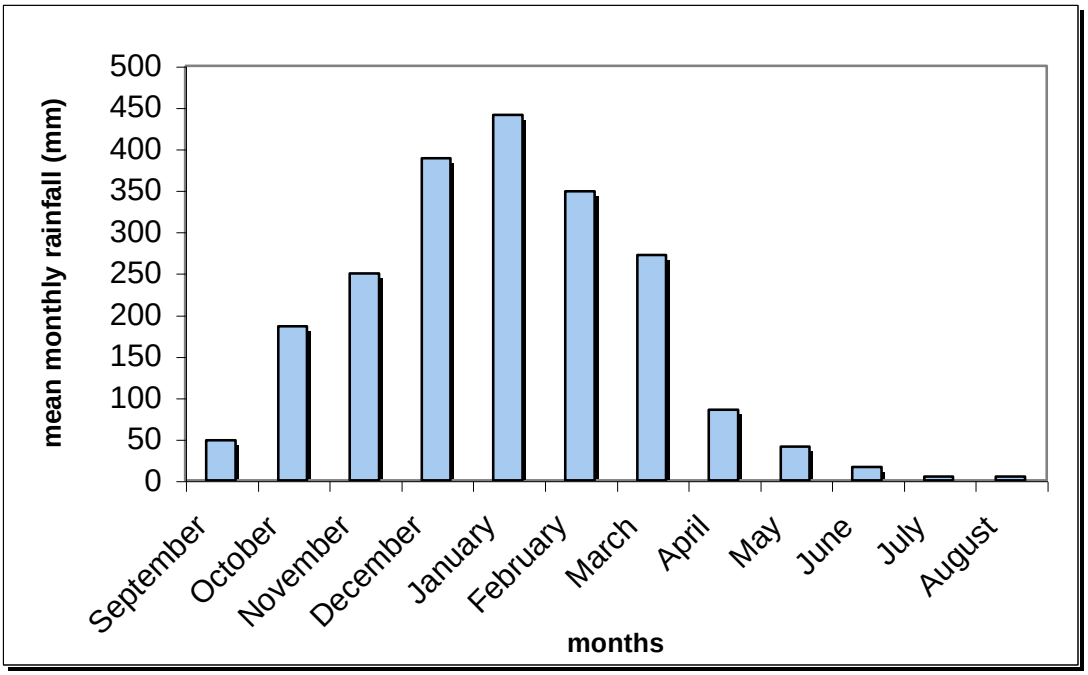

Figure 1.1.3.1: Monthly variation of rainfall at the Askifou rainfall station (White Mountains)

There are 56 stations in Crete measuring rainfall. Of those stations 28 are situated in Iraklion prefecture, 10 in Rethymnon prefecture, 12 in Lasithi prefecture and 6 in Chania prefecture. The spatial distribution of the rainfall stations in Iraklion prefecture is shown in figure 5. There is a fairly even spatial distribution of stations in the prefecture. Figure 1.1.3.3 shows the distribution of rainfall stations and their height for Iraklion prefecture. Most stations fall into heights between 200 and 500 m while there are only three stations between 500 and 800 m and five stations in heights lower than 200 m. There is no direct relationship between rainfall and height in the prefecture (figure 1.1.3.4) due to the complex vertical and horizontal distribution of the area. The highest precipitation is observed at Borizia station with an elevation of 520 m and a mean annual rainfall of around 1100 mm, while the lowest precipitation is observed at Kapsaloi station with an elevation of 10 m only and a mean annual rainfall of 410 mm. The station with the highest elevation in the prefecture (Kapetaniana station at an elevation of 800 m) has a mean annual precipitation of 680 mm. Borizia station lies in the mainland in West

Messara Valley and shows higher precipitation than Kapetaniana station, which has a higher elevation but lies closer to the south coast in the same valley. Figure 1.1.3.5 shows the mean annual rainfall distribution for the different stations in Iraklion.

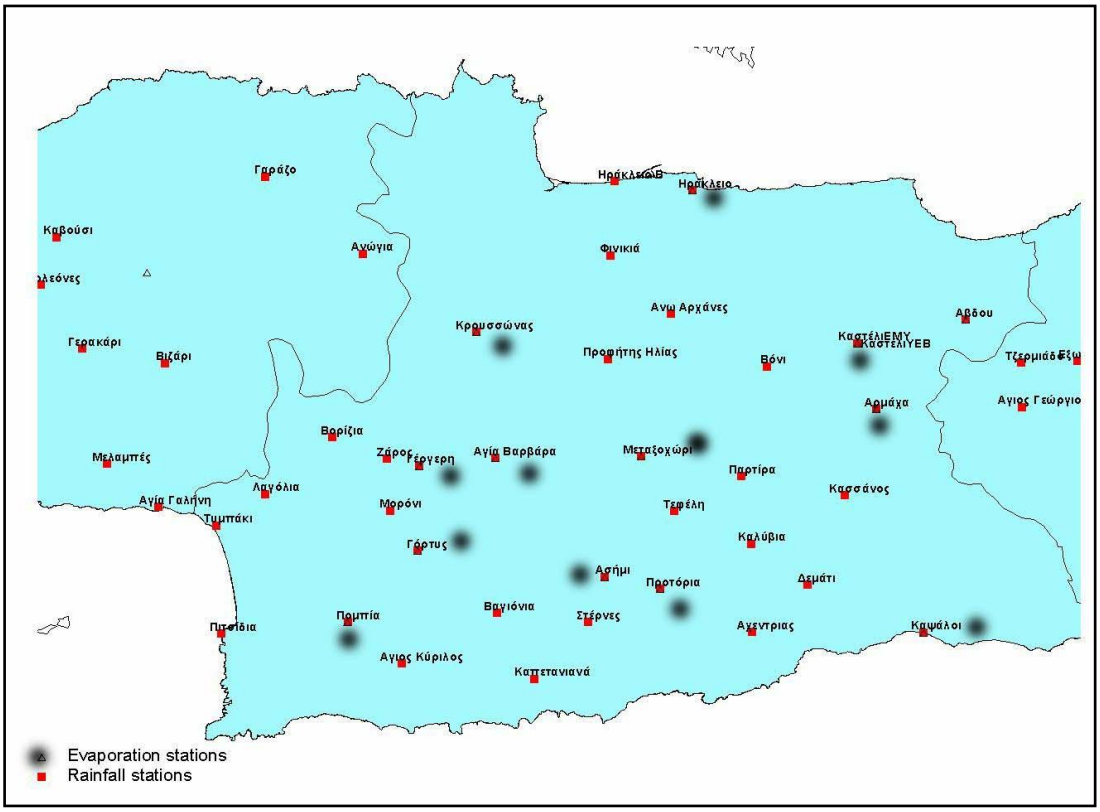

Figure 1.1.3.2: Rainfall and evaporation stations in the prefecture of Iraklion. (Source: RGC)

During the period 1909-1987, the annual average rainfall in the prefecture of Iraklion was 489 mm while the seasonal precipitation for winter was 252 mm, for spring 95 mm, for summer 5.3 mm and for autumn 138.2 mm (Macheras and Koliva-Machera, 1990). During this time there were observed two moist periods, the first lasting for 16 years (1917-1932) and the second for 8 years (1961-1969), and one dry period lasting 23 years (1938-1960). During the first moist period there was an increase in precipitation of 13% while for the second period the increase was around 28%. It was concluded that the dry season in Iraklion lasts for five months (November to March) and the moist for seven. The dry period was accompanied by a 13% decrease in rainfall (Macheras and Koliva-Machera, 1990).

The profile for mean annual and monthly rainfall for the years 1969 to 1999 of the existing stations in the prefecture of Iraklion is shown in figures 1.1.3.6 and 1.1.3.7. The wettest year for Iraklion prefecture was 1977-1978, while the driest year appears to have been the hydrological year 1989-1990.

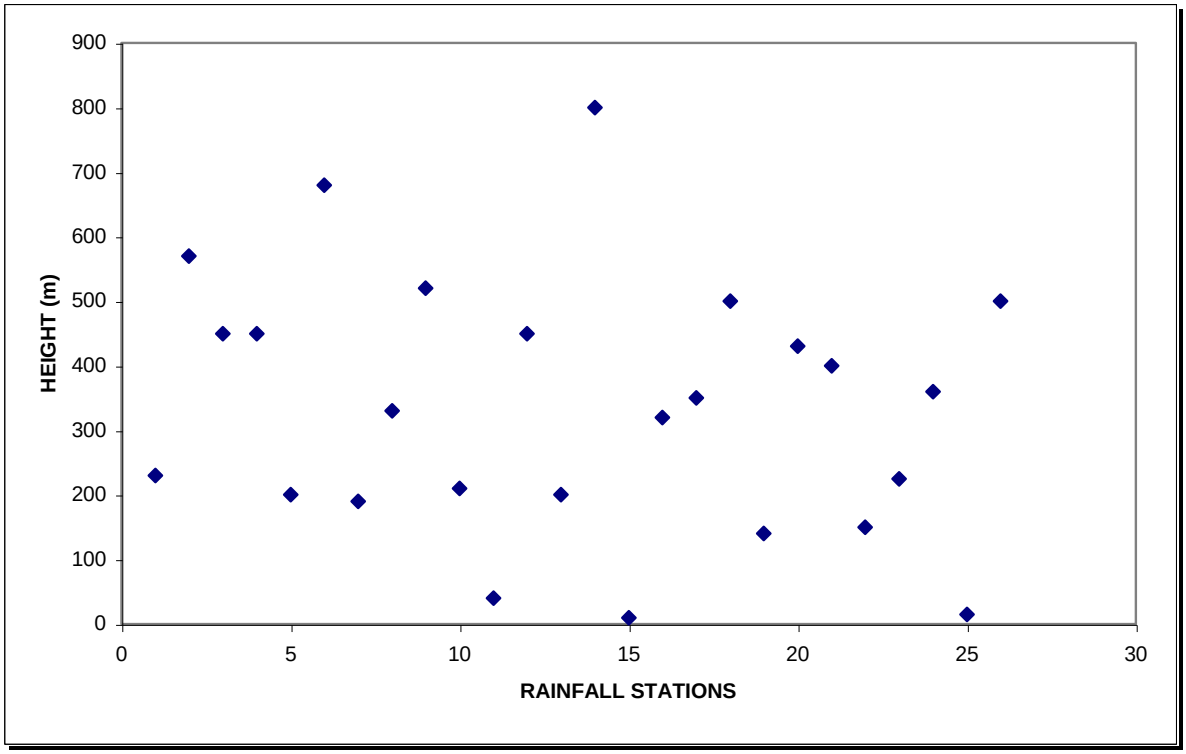

Figure 1.1.3.3: Rainfall stations height distribution in the prefecture of Iraklion

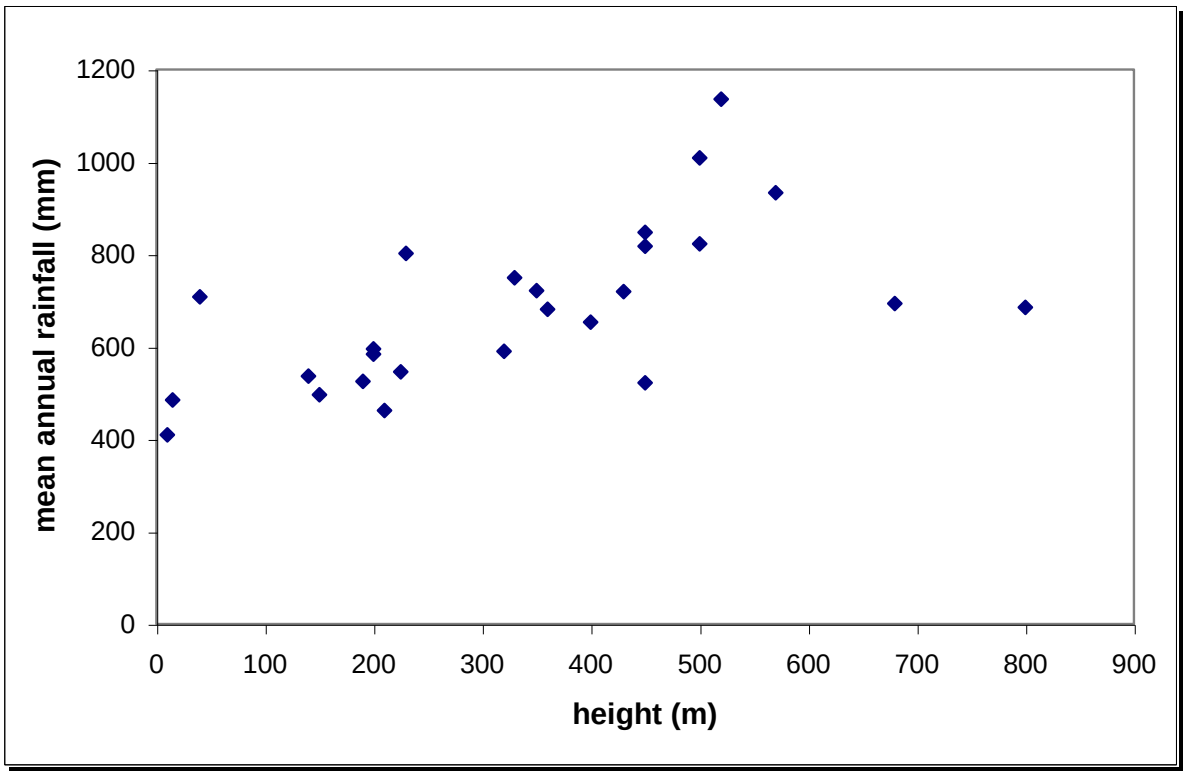

Figure 1.1.3.4: Rainfall – height distribution in the prefecture of Iraklion

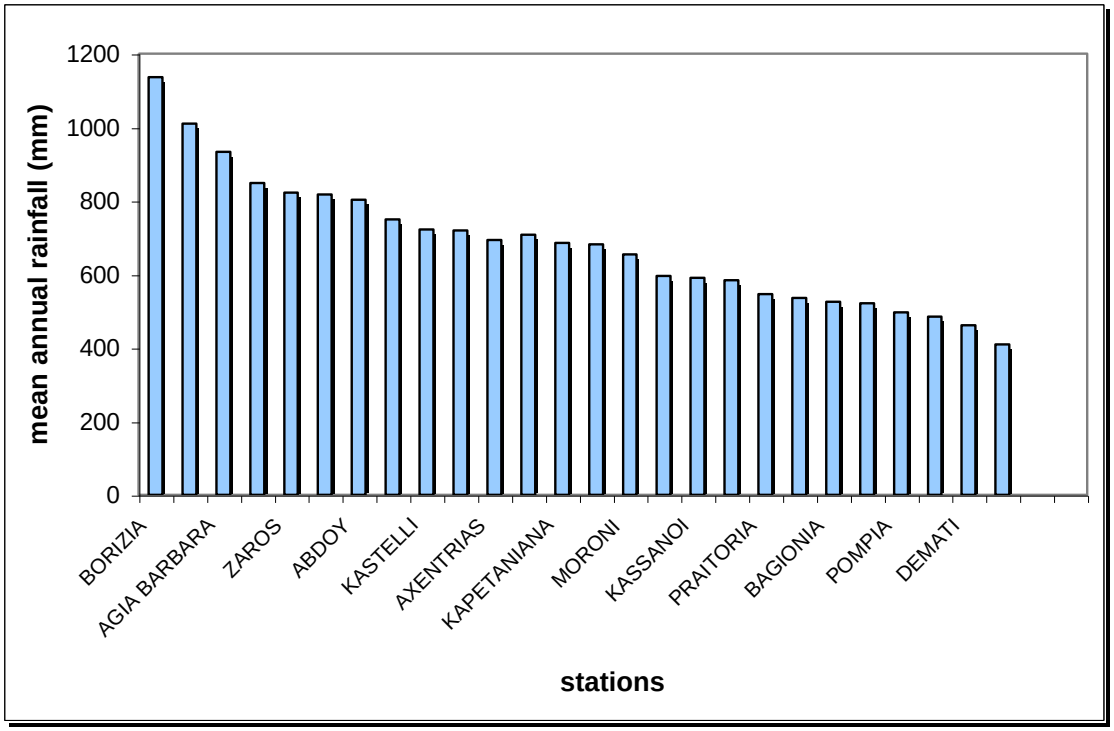

Figure 1.1.3.5: Rainfall distribution in Iraklion

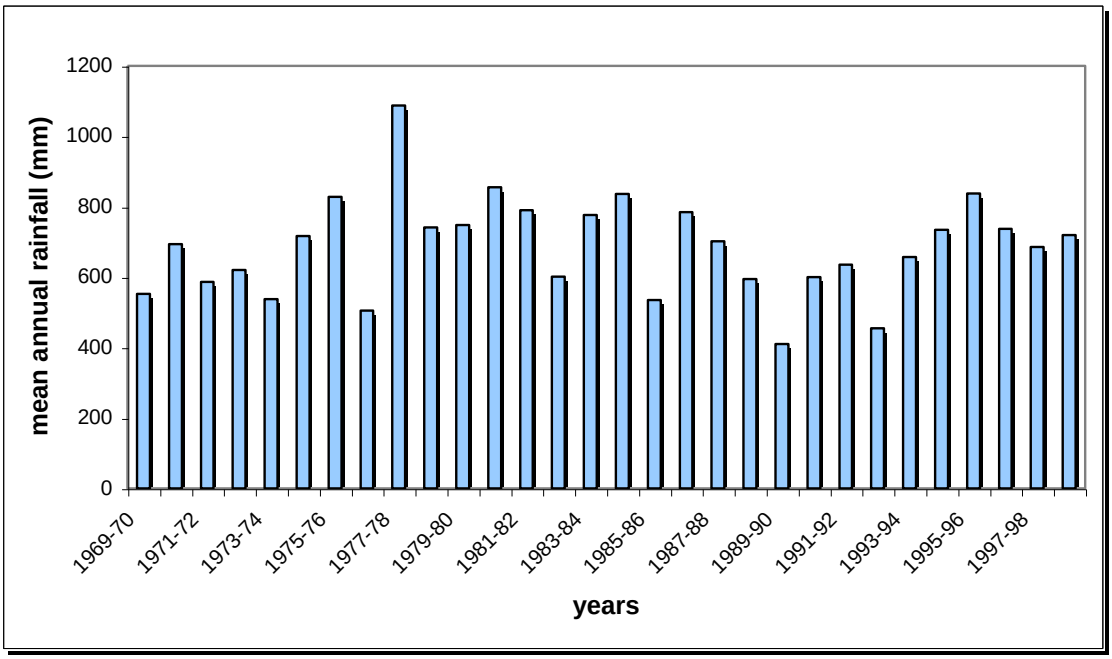

Figure 1.1.3.6: Mean annual rainfall for the prefecture of Iraklion

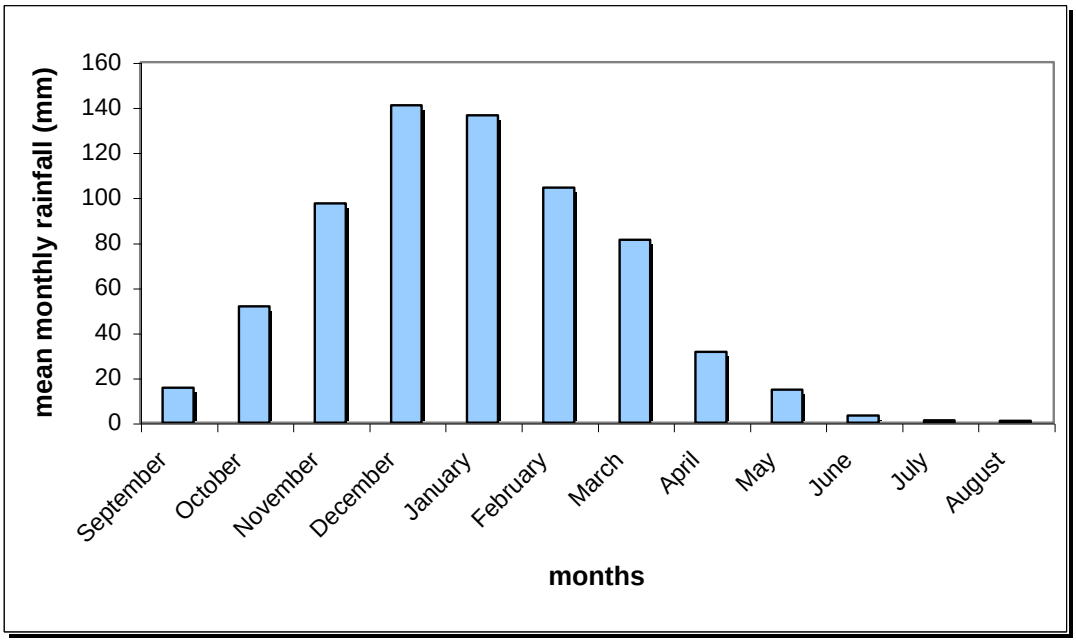

Figure 1.1.3.7: Mean monthly rainfall pattern for the prefecture of Iraklion

The spatial distribution of rainfall and evaporation stations in the prefecture of Lasithi is shown in figure 1.1.3.8. No direct relationship is again observed between rainfall and elevation for the prefecture (figure 1.1.3.9).

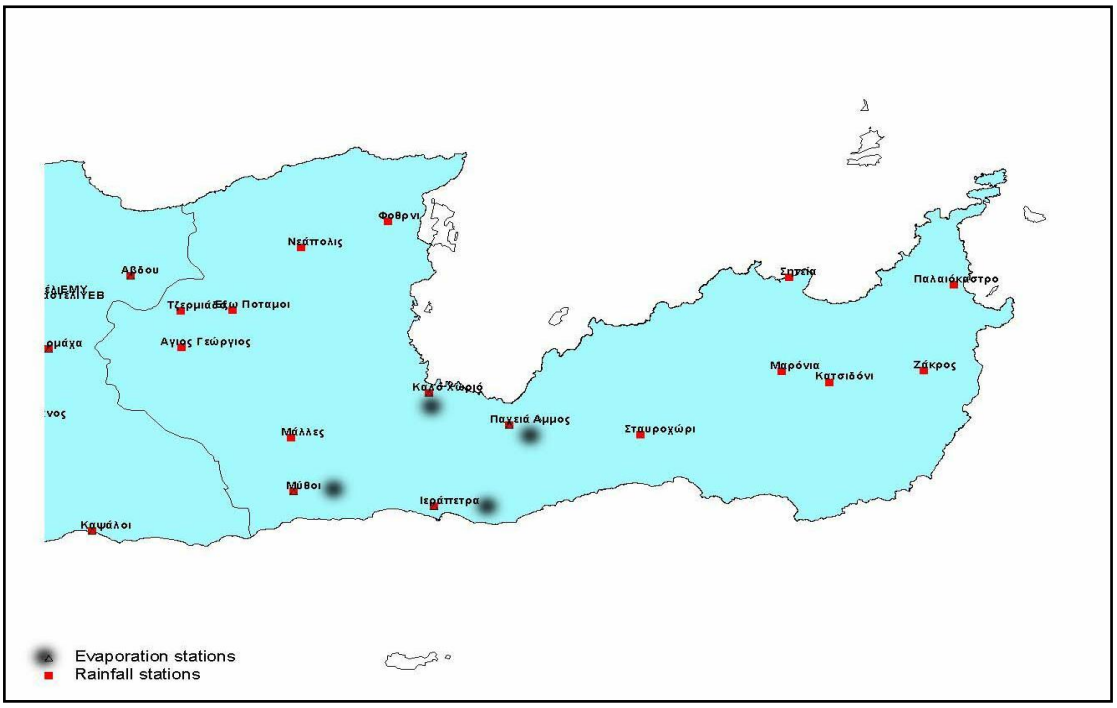

Figure 1.1.3.8: Rainfall and evaporation stations in the prefecture of Lasithi

The highest mean annual precipitation is observed at Exo Potamoi station, which has an elevation of 800 m and mean annual rainfall of 1360 mm, while the lowest mean annual precipitation is observed at Siteia station, which has as elevation of 114 m and mean annual rainfall of 490 mm.

The station with the highest elevation (Agios Georgios at 850 m) shows a mean annual precipitation of 1056 mm. Stations with lower elevations than Siteia station (Kalo Xwrio, Palaikastro, Paxeia Ammos) show higher mean annual precipitation.

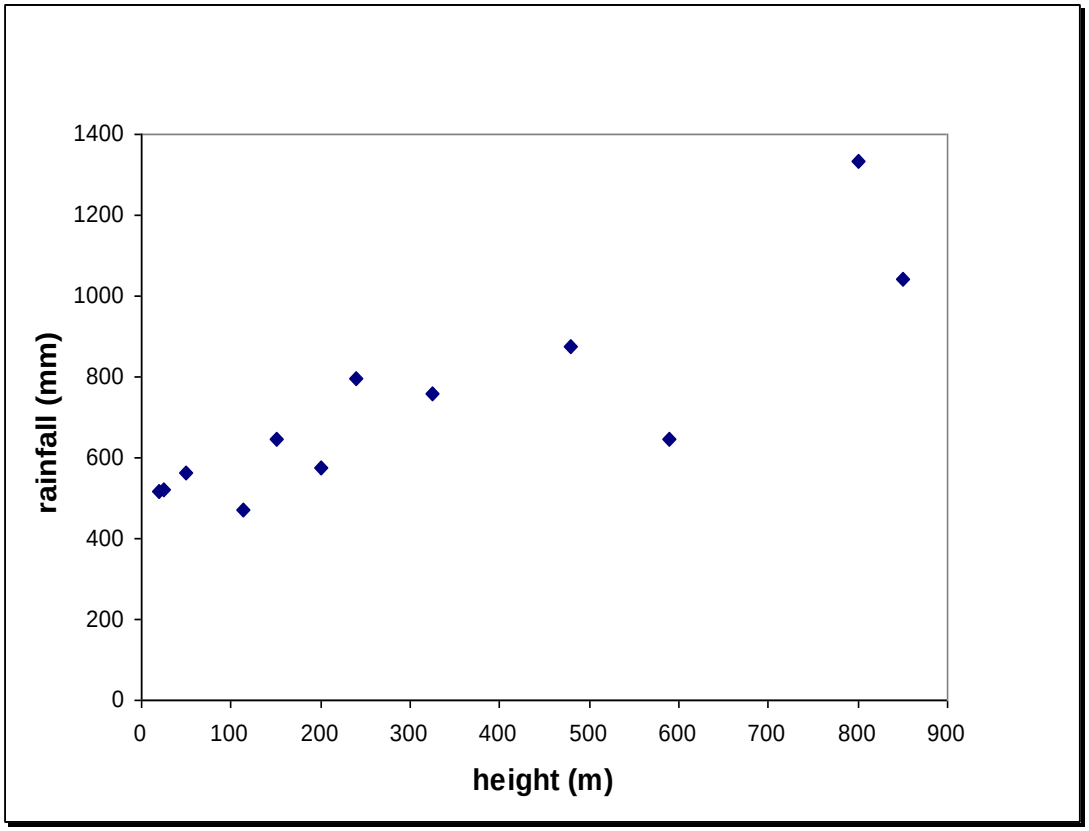

Figure 1.1.3.9: Rainfall distribution with height in Lasithi prefecture

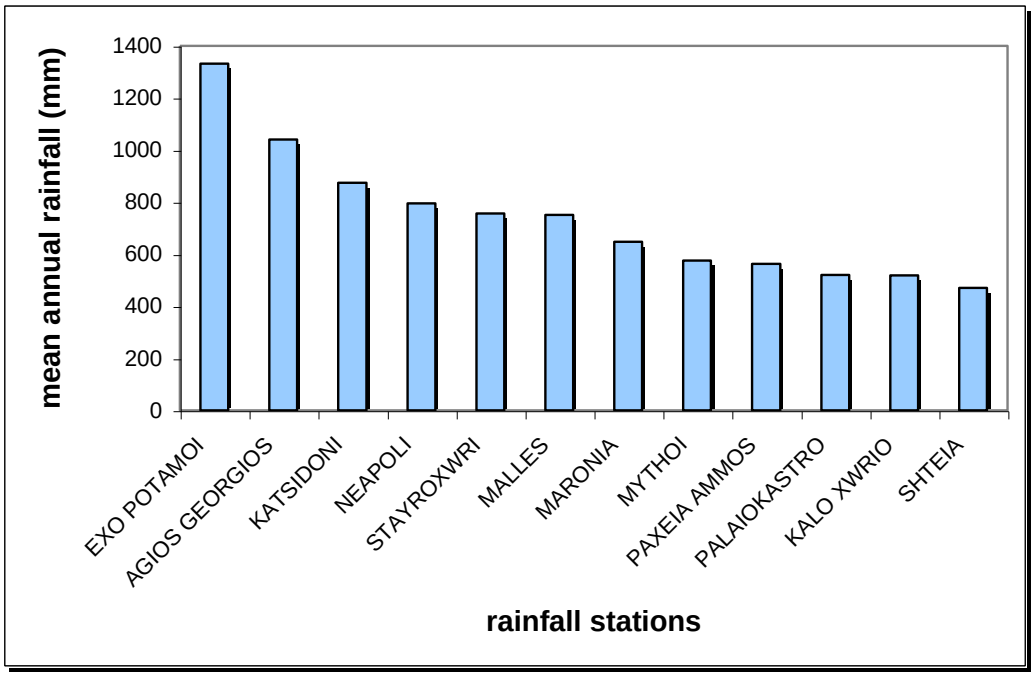

Figure 1.1.3.10: Rainfall distribution in Lasithi prefecture

The driest year for Lasithi was the hydrological year 1989-1990 and the wettest the hydrological year 1986-1987.

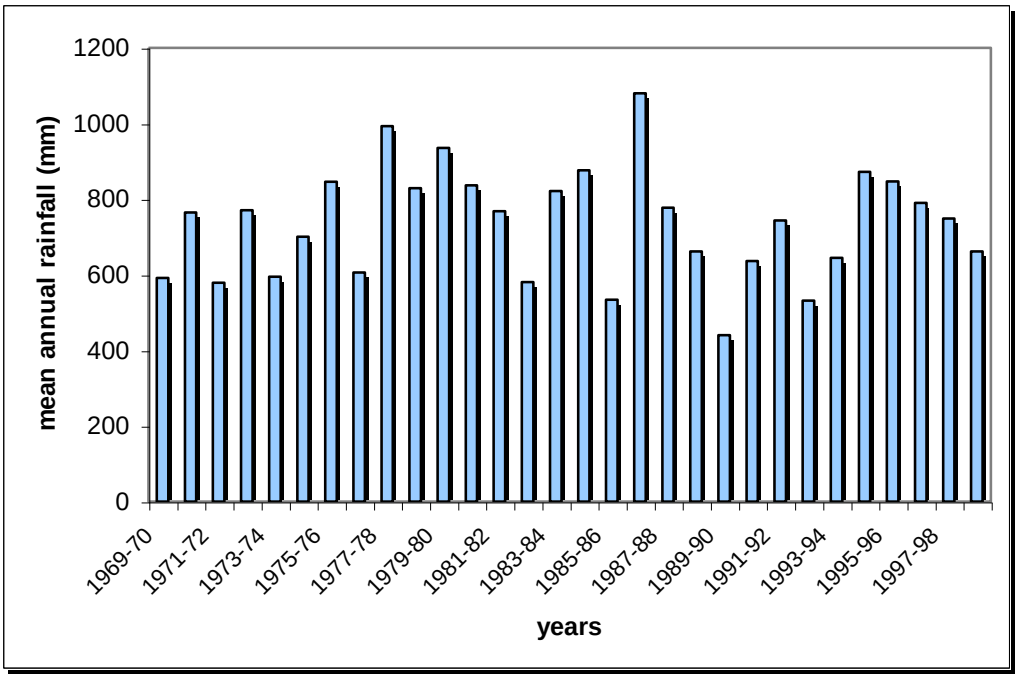

Figure 1.1.3.11: Mean annual rainfall in Lasithi prefecture

In Chania prefecture the existing rainfall stations, are set up at elevations between 20 and 740 m as shown in figure 1.1.3.12. According to these particular stations, rainfall increases with height.

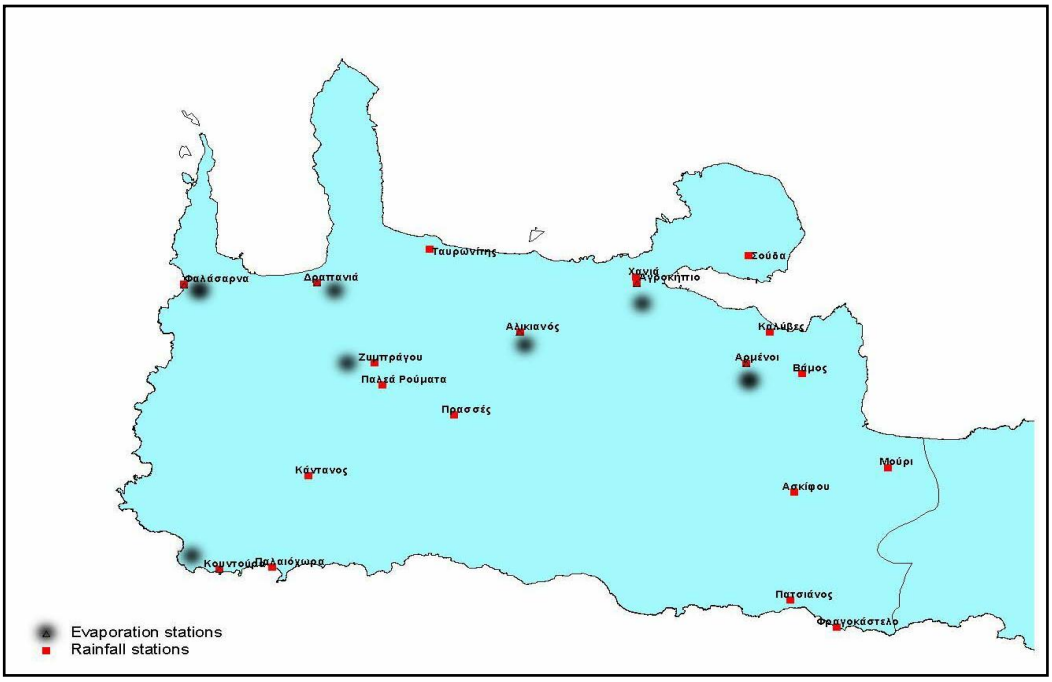

Figure 1.1.3.12: Rainfall and evaporation stations in Chania prefecture

The highest precipitation is observed at Askifou station while the lowest precipitation is observed at the island of Gaydos at the very south of the prefecture, which has an elevation of 10 m and mean annual precipitation of 330 mm.

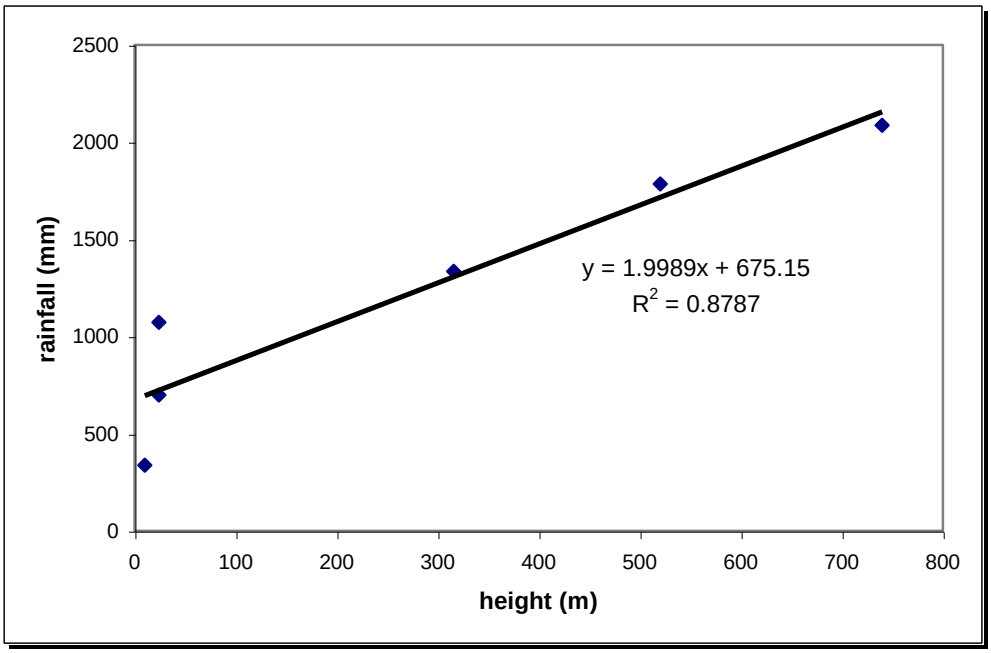

Figure 1.1.3.13: Rainfall distribution with height in Chania

The rainfall distribution in the prefecture of Chania is depicted in figure 1.1.3.14.

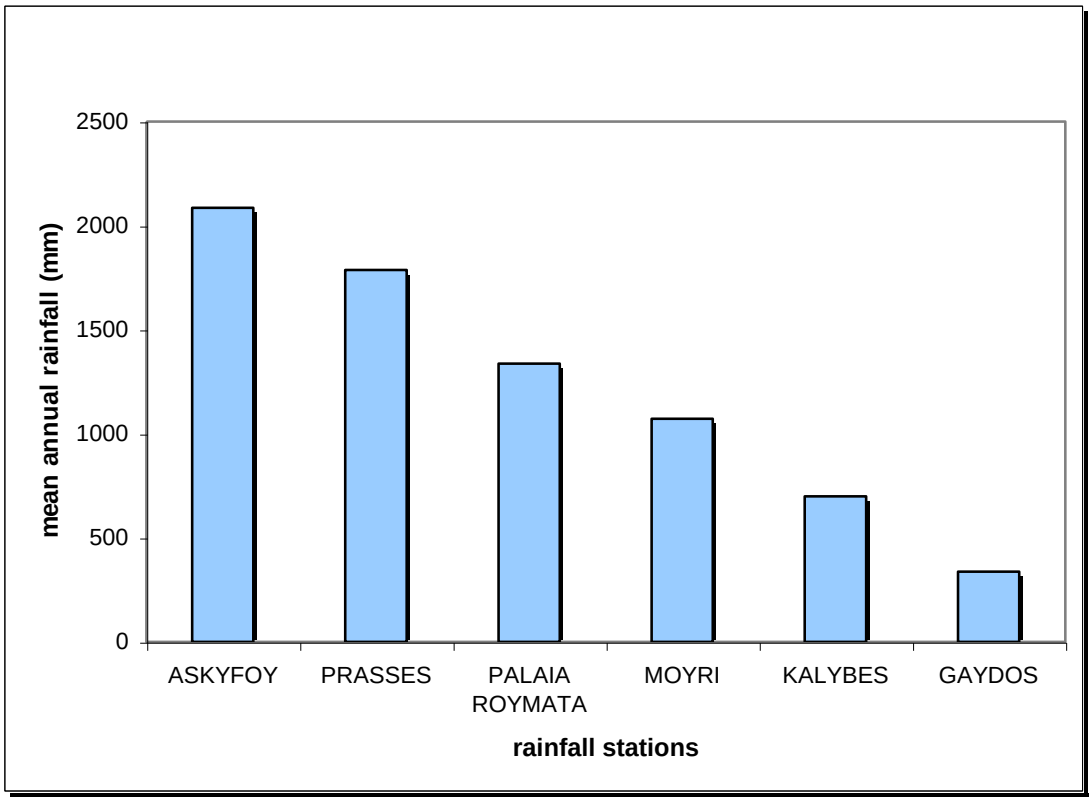

Figure 1.1.3.14: Rainfall distribution in Chania

For Rethymnon prefecture the spatial distribution and the height distribution of the rainfall stations are shown in figures 1.1.3.15 and 1.1.3.16 respectively.

The highest precipitation is observed at Garazo station and the lowest at Agia Galini station. Garazo station has an elevation of 260 m and shows mean annual rainfall of 1370 mm. Agia Galini station lies in the south of the prefecture near Tympaki and has an elevation of 20 m and mean annual precipitation of 570 mm. The station with the highest elevation in the prefecture is Anogeia station, which is located 740 m ASL. Anogeia station shows a mean annual precipitation of 1030 mm. The rainfall distribution in the prefecture is depicted in figure 1.1.3.17.

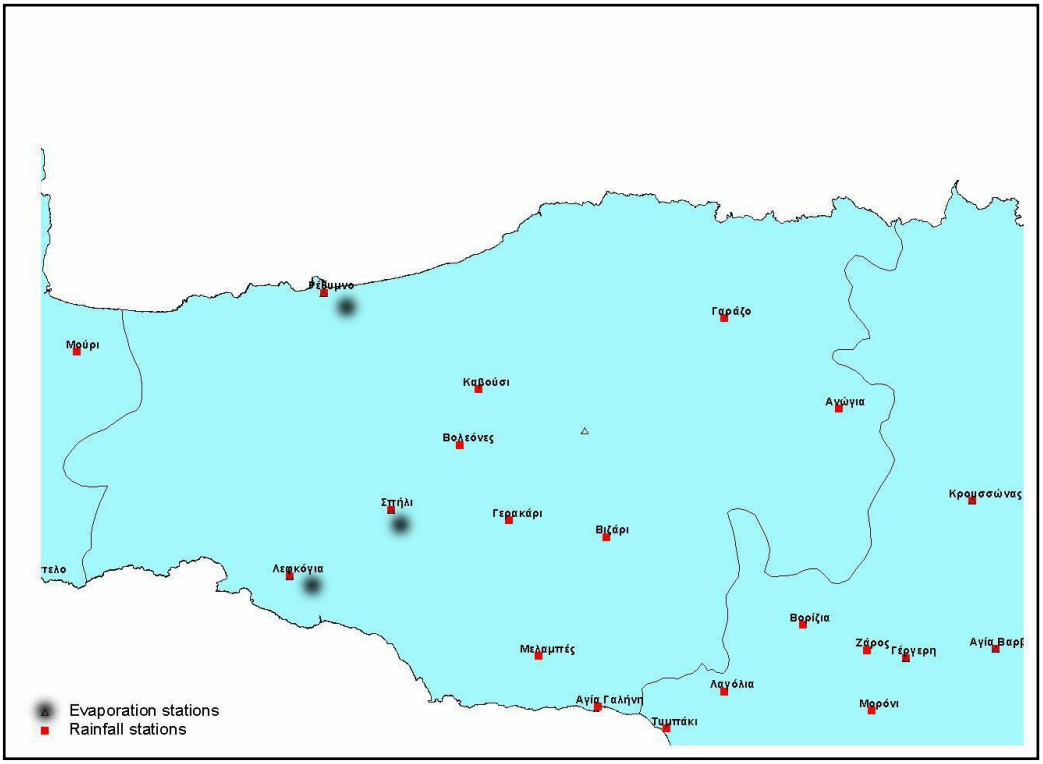

Figure 1.1.3.15: Rainfall and evaporation stations in Rethymnon prefecture. (Source: RGC)

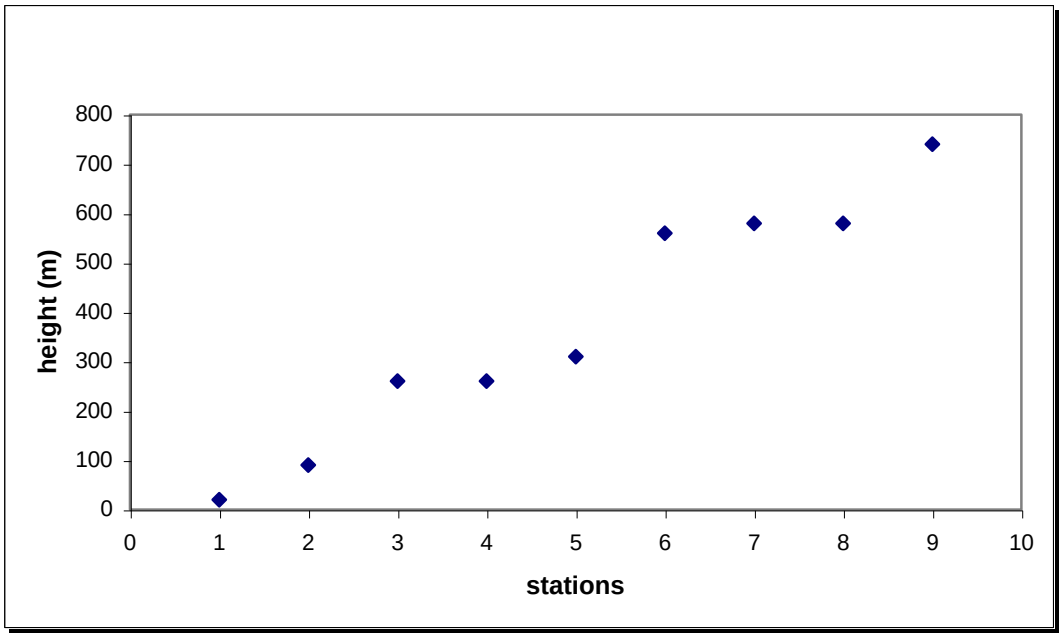

Figure 1.1.3.16: Rainfall stations height distribution in Rethymnon

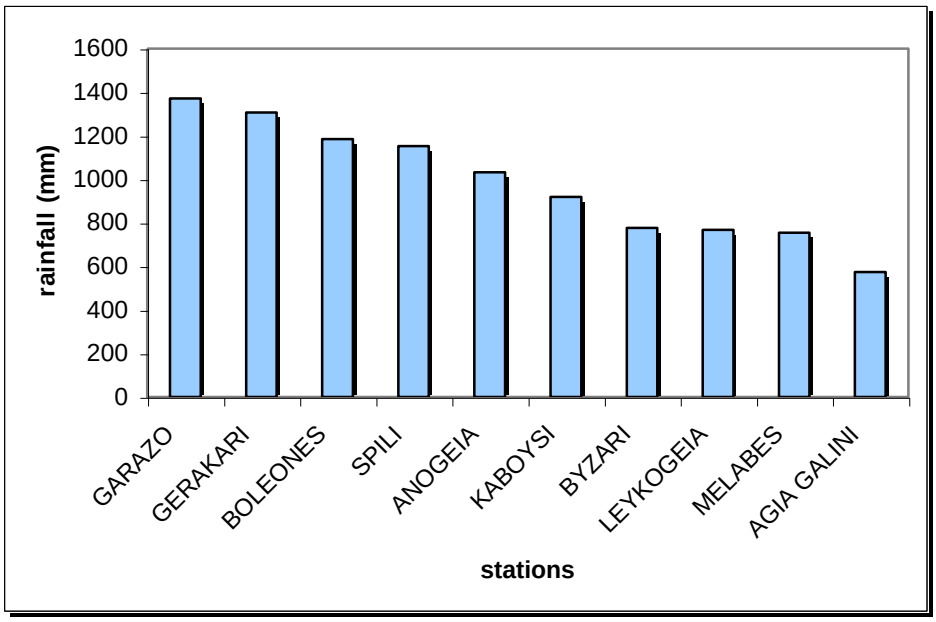

Figure 1.1.3.17: Rainfall distribution in Rethymnon

The rainfall data of the past thirty years of the stations in Rethymnon show that the driest year for the prefecture was the hydrological year 1977-1978 while the wettest year was 1989-1990. The same situation is observed for Iraklion prefecture. Figures 1.1.3.18 and 1.1.3.19 show the mean annual and mean monthly rainfall in Rethymnon prefecture.

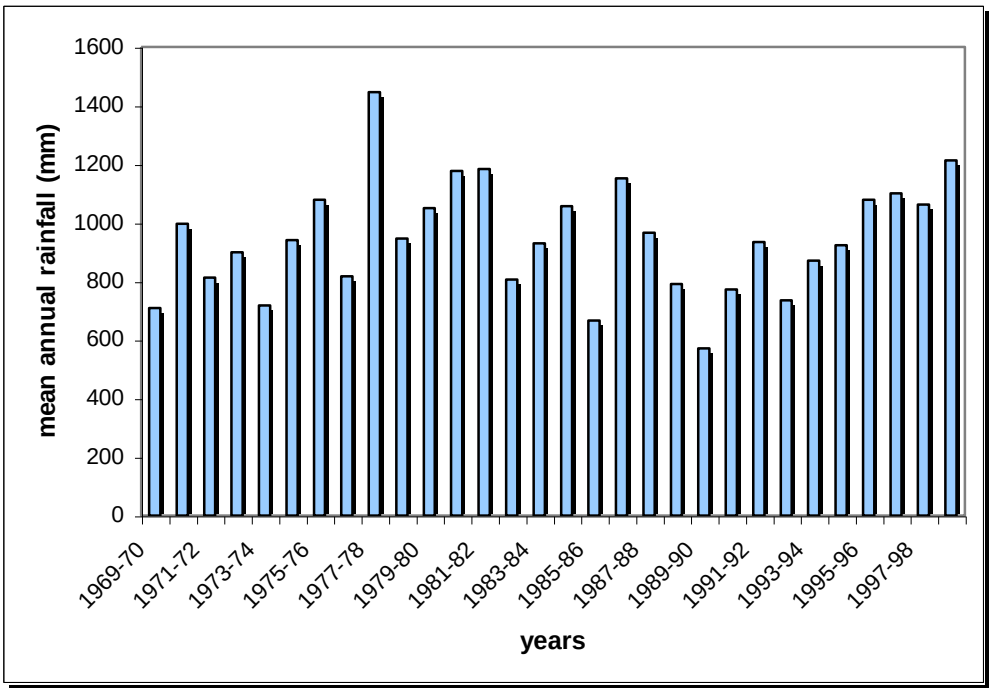

Figure 1.1.3.18: Mean annual precipitation in Rethymnon

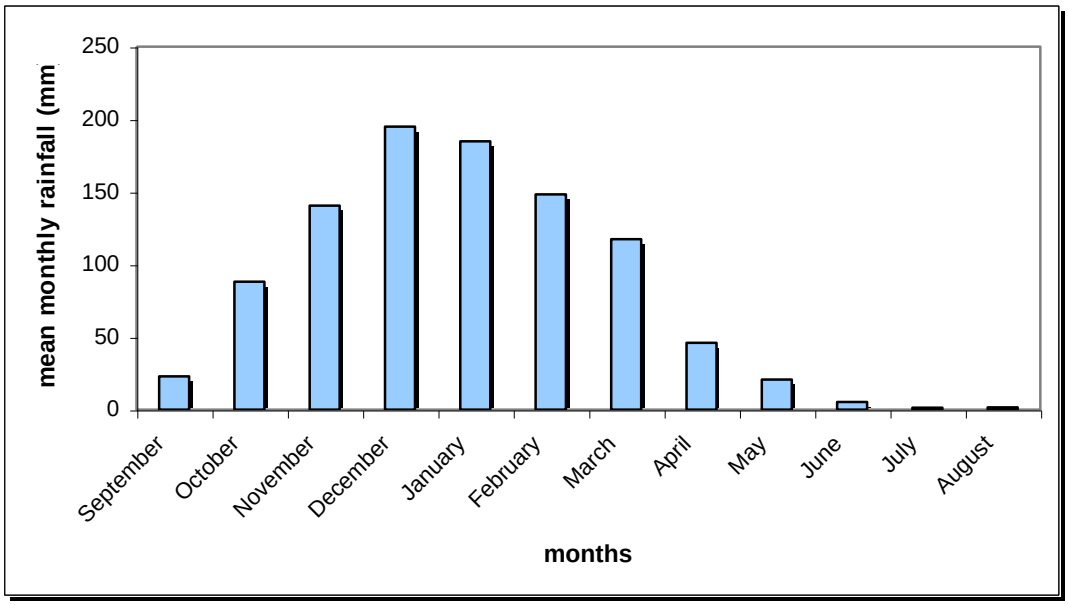

Figure 1.1.3.19: Mean monthly rainfall in Rethymnon

Data from the 56 existing rainfall stations in Crete shows that the highest precipitation is observed at Askifou station in Chania prefecture and the lowest at the island of Gaydos, south of Chania prefecture. This pattern is depicted in figure 1.1.3.20.

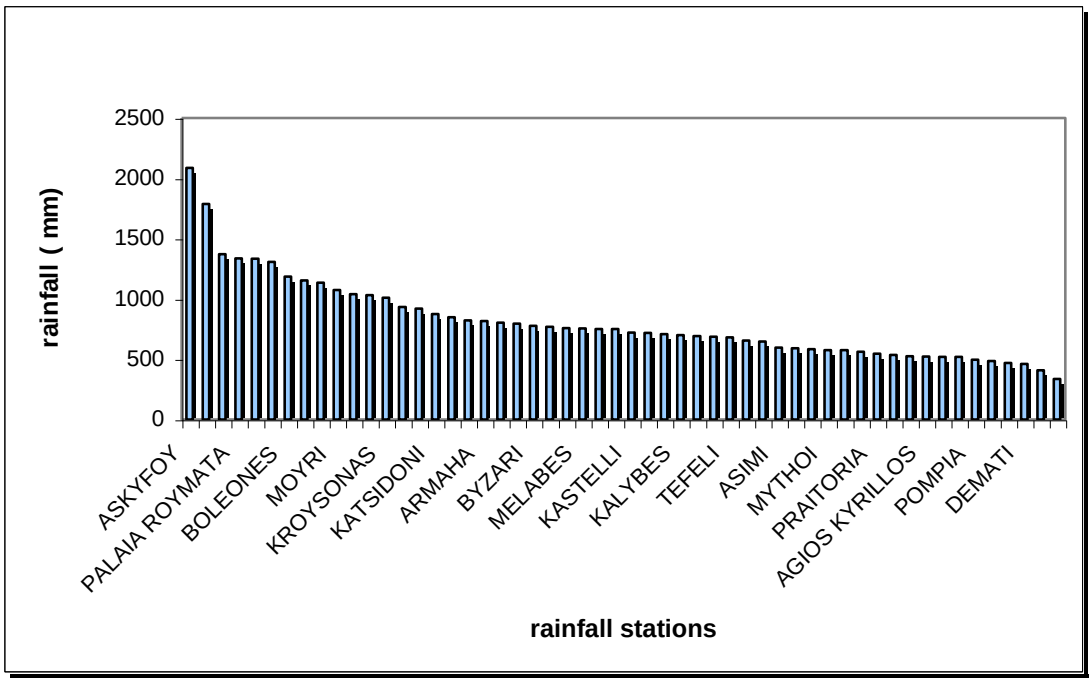

Figure 1.1.3.20: Rainfall distribution for Crete

Rainfall in Crete is not uniformly distributed throughout the year. It is mainly concentrated in the period from November to April while the drought period is extended to more than six months (May to October). The mean annual precipitation in eastern Crete is 816 mm while in the western Crete is 927 mm. About 60% of the annual precipitation occurs in months December to February. On average the number of rainy

days ranges from 15 in December and January to 0.3 in July and August. Snowfall is restricted to the main mountain ranges (Source: Regional Governor of Crete). Long series rainfall data all over Crete does not show any significant change in precipitation (Markou-Iakovaki, 1979; Macheras & Koliva-Machera, 1990).

1.1.3.2 Temperature

Temperature in the island of Crete shows great variation. Air temperature increases from west (17°C at Alikianos station) to east (18.7^{o}C at Siteia station). The southern part of the island is warmer than the northern and the warmest of Greece (Chartzoulakis et al., 2001). The mean annual temperature at Siteia station (north part of Lasithi prefecture) is 18.7^{o}C while the mean annual temperature at Ierapetra station (south part of Lasithi prefecture) is 19.6^{o}C. The mean monthly temperature range at Siteia station is depicted at figure 1.1.3.21.

During the cold period, temperature increases with decreasing latitude while in the warm period and especially in the period from May to August, temperature increases from the coast to the mainland and particularly in the plains (Chartzoulakis et al., 2001).

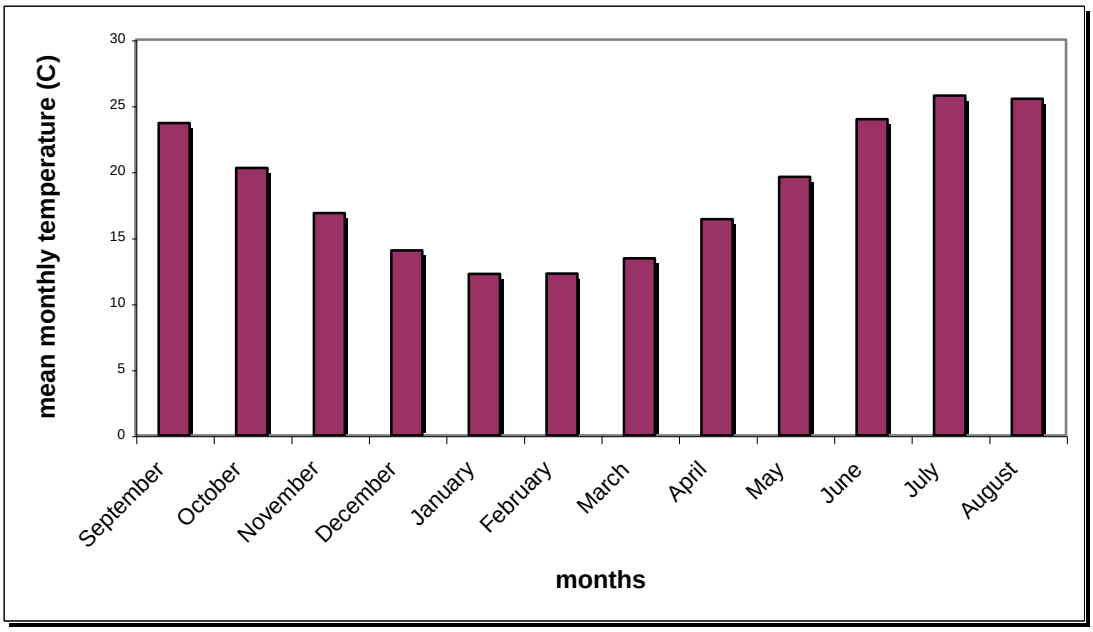

Figure 1.1.3.21: Mean monthly temperature at Siteia station

At Anogeia station, in Rethymnon prefecture, which is located at elevation of 740 m ASL, the mean annual temperature is 15.2 ^{o}C. The mean annual temperature at Kapsaloi station, in the mainland of Iraklion prefecture, which is located at an elevation of 10 m ASL, is 19.6 ^{o}C (figure 1.1.3.22).

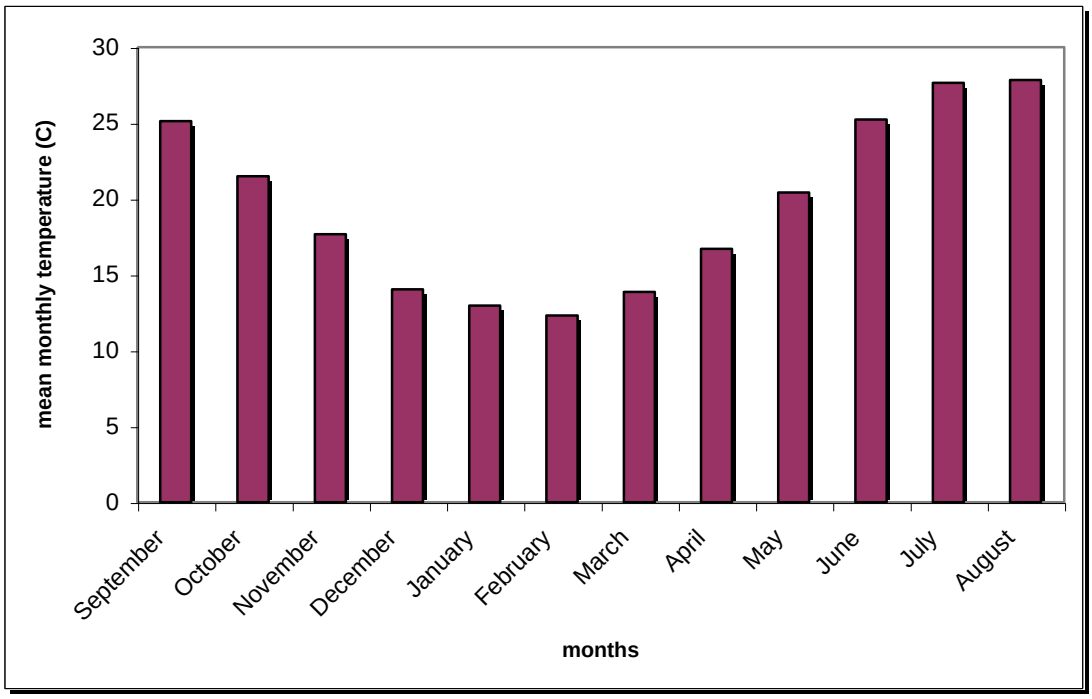

Figure 1.1.3.22: Mean monthly temperature at Kapsaloi station

During the summer, temperatures exceeding 40°C may occur in the lowlands of Crete. In winter, the lowest temperatures scarcely fall below 0°C in the plains. The mean annual temperature range is from 17°C to 20°C. The largest temperature variation within a year is observed at Paxeia Ammos station, where temperature ranges from 10.5°C in February to 26.3°C in August. Generally, the highest temperatures of Crete are observed between July and August and the lowest in January and February. Figure 1.1.3.23 shows mean annual temperature for different stations in Crete.

1.1.3.3 Evaporation

The potential evapotranspiration in Crete varies from 1370 mm/a to 1570 mm/a. The mean annual actual evapotranspiration has been estimated to represent 75% to 85% of the mean annual precipitation in low elevation areas (less than 300 m ASL) and 50% to 70% in high elevation areas (Source: Regional Governor of Crete).

There are 24 stations in Crete measuring pan evaporation. Of those stations 11 are located in Iraklion, 3 in Rethymnon, 4 in Lasithi and 6 in Chania prefecture. The spatial distribution of the stations in each prefecture is shown in figures 1.1.3.2, 1.1.3.8, 1.1.3.13 and 1.1.3.16. The highest mean annual pan evaporation is observed at Kapsaloi station in the mainland of Iraklion prefecture. Kapsaloi station is located at 10 m ASL and shows a mean annual pan evaporation of 2039 mm/a. The mean annual pan evaporation for different stations in Crete is shown in figure 1.1.3.24.

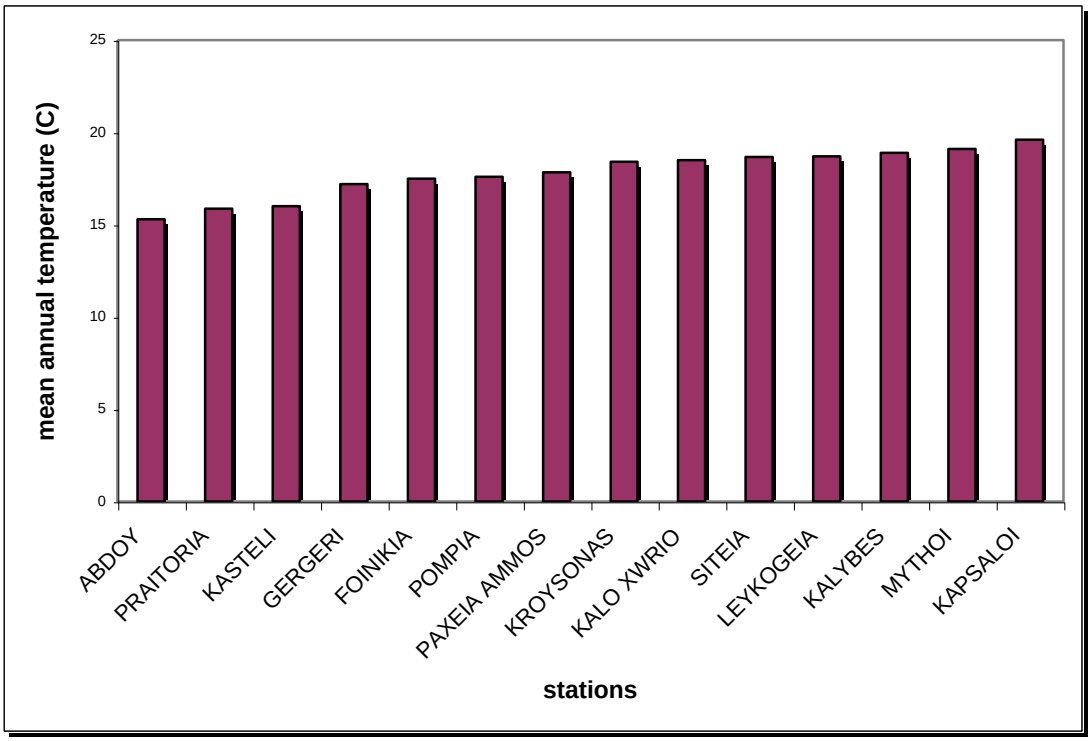

Figure 1.1.3.23: Mean annual temperature at different stations in Crete

According to figures 1.1.3.23 and 1.1.3.24 it seems that evaporation and temperature follow the same pattern. The mean monthly pan evaporation for Kapsaloi station is shown in figure 1.1.3.25. The highest evaporation values are observed in July while the lowest values are observed in December and January. The mean annual evaporation range is from 40 to 265 mm. The highest variation of pan evaporation values within a year is observed at Lefkogeia station in Rethymnon prefecture. Lefkogeia station is located at 90 m ASL and shows a value of mean evaporation of 60 mm in January and of 341 mm in July.

1.1.3.4 Wind direction

The prevailing wind direction is north and northwesterly. High wind speed can occur any time during the year, but is mostly observed in February and March in western Crete and July in eastern Crete (Source: Regional Governor of Crete).

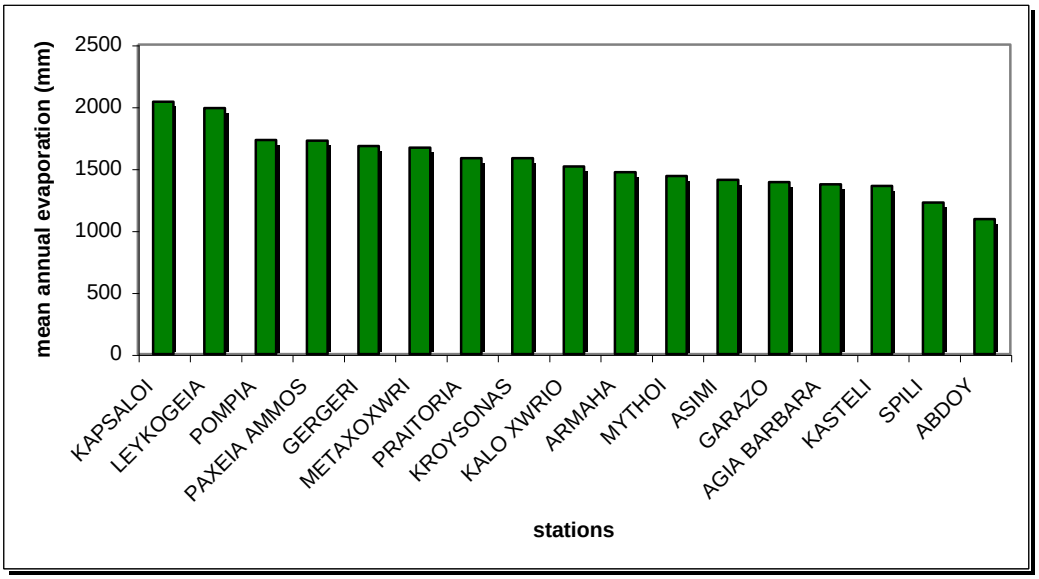

Figure 1.1.3.24: Mean annual pan evaporation for different stations in Crete

1.1.3.5 Humidity

The driest months of the year are June and July with a mean relative humidity of 48.9% at Souda station in Chania prefecture and of 59.88% at Heraklion station. The most humid month is December when the mean relative humidity at Souda station is 72% and 67% at Iraklion station (Source: Regional Governor of Crete).

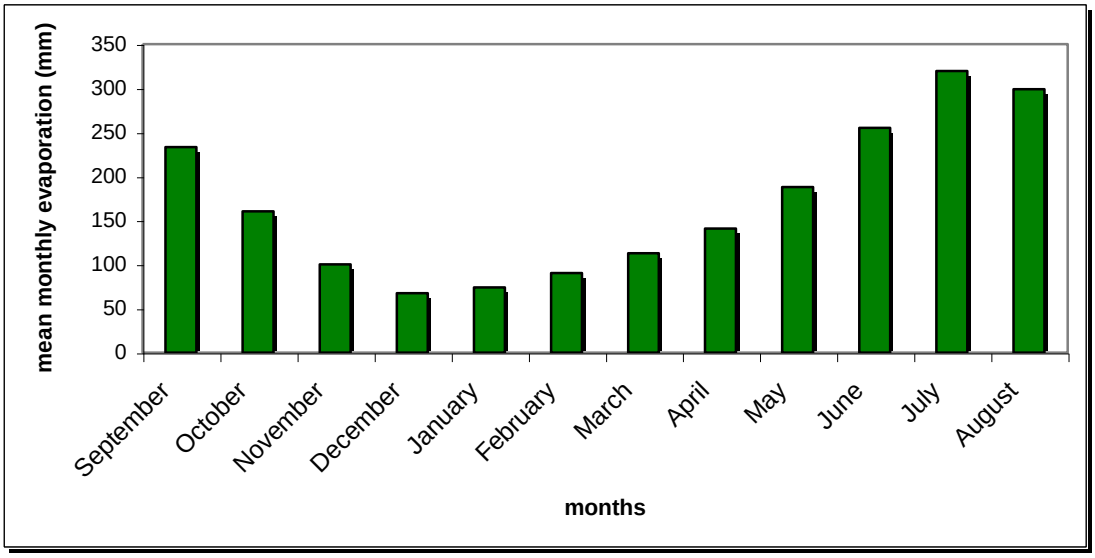

Figure 1.1.3.25: Mean monthly evaporation at Kapsaloi station

1.1.4 Surface water

The contribution of the surface water to the potential water resources of Crete is about 40%. The real contribution though is about 13%, which means that almost all the water quantity used in Crete comes from subterranean sources (springs, wells and boreholes) (Chartzoulakis et al., 2001).

In Crete there are 25 measured streams, 11 in Iraklion prefecture, 5 in Chania prefecture, 3 in Rethymnon prefecture and 6 in Lasithi prefecture. There are no perennial streams on Crete and the total mean annual runoff is estimated to be in the region of 0.83 billion m^3. Figure 1.1.4.1 shows the mean annual runoff for measured streams in the prefecture of Iraklion.

The stream with the highest runoff is Almyros near Iraklion. It has a mean annual runoff of 236 Mm^3. The stream with the highest mean annual runoff in Rethymnon prefecture is Platys with mean annual runoff of 50 Mm^3, in Chania prefecture Sepreniotis with mean annual runoff of 14.9 Mm^3 and in Lasithi prefecture Katabothres with mean annual runoff of 16.6 Mm^3. Almyros stream in Iraklion prefecture is also the stream with the highest mean annual runoff in Crete. Figures 1.1.42, 1.1.4.3 and 1.1.4.4 show a comparison of the mean annual runoff of streams in the prefectures of Chania, Rethymnon and Lasithi and in Crete generally.

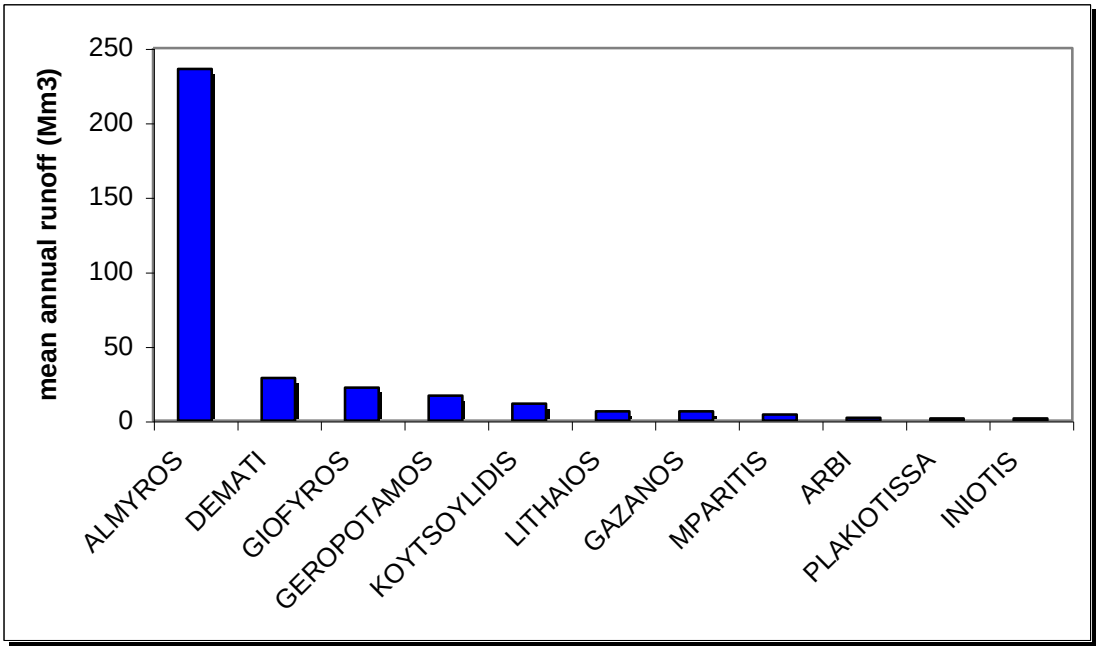

Figure 1.1.4.1: Mean annual runoff in Iraklion

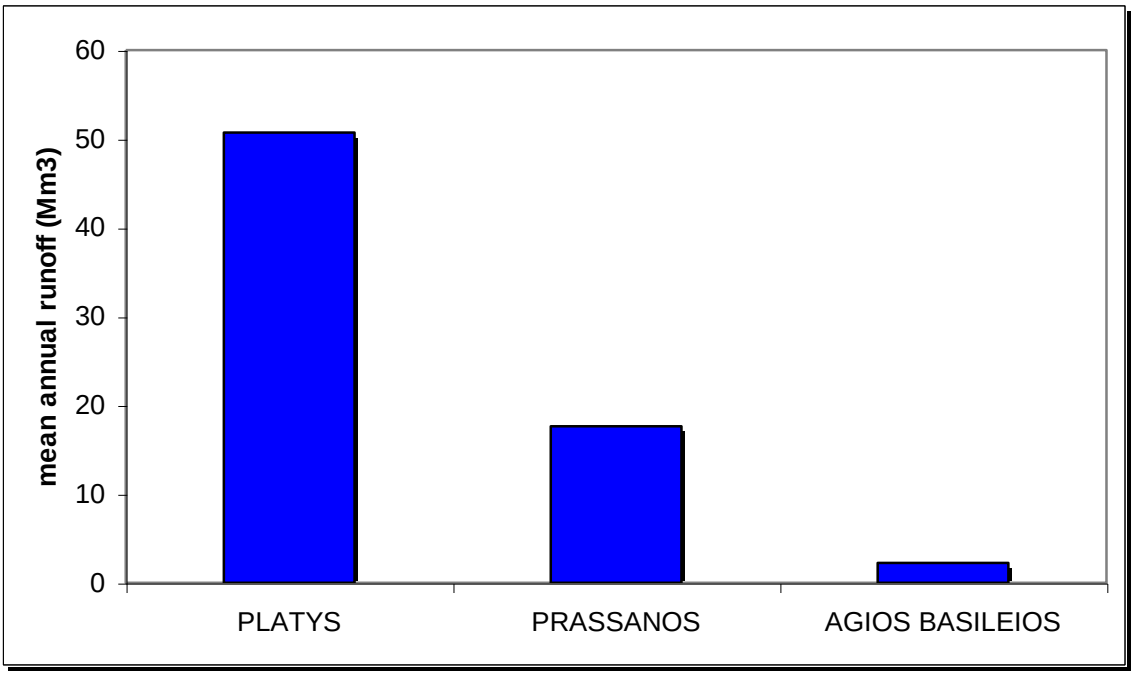

Figure 1.1.4.2: Mean annual runoff of streams in Rethymnon prefecture

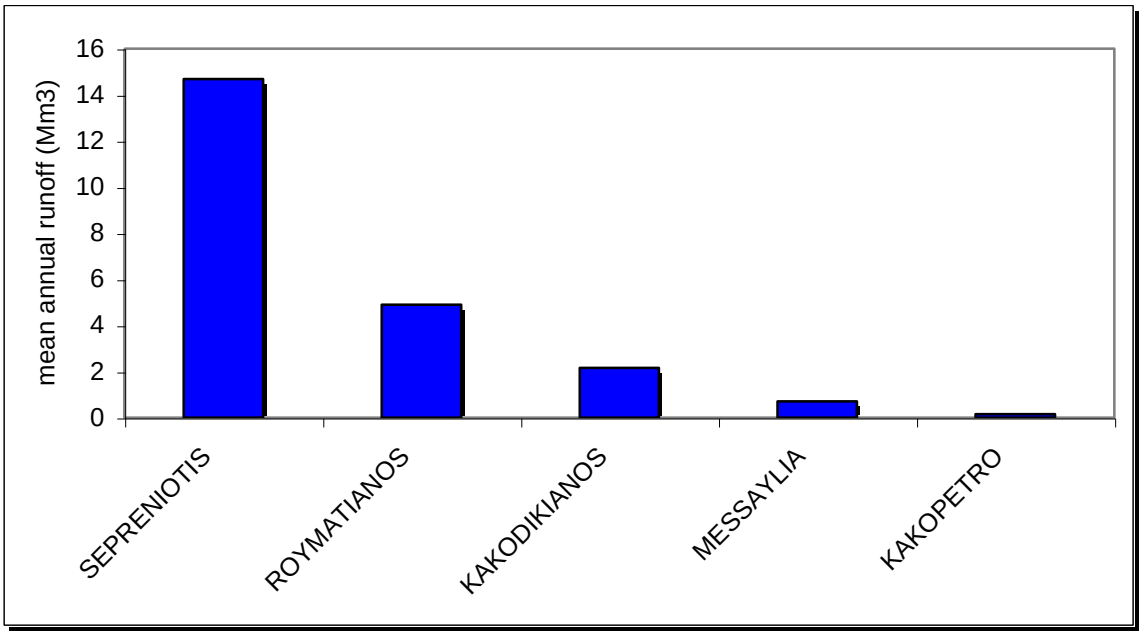

Figure 1.1.4.3: Mean annual runoff of streams in Chania prefecture

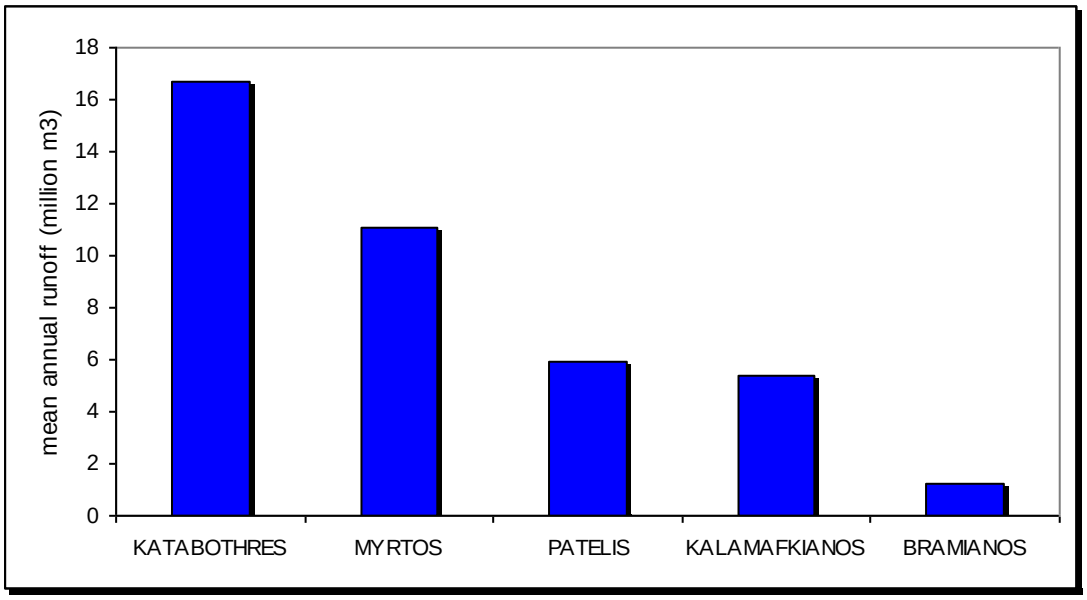

Figure 1.1.4.4: Mean annual runoff of streams in the prefecture of Lasithi

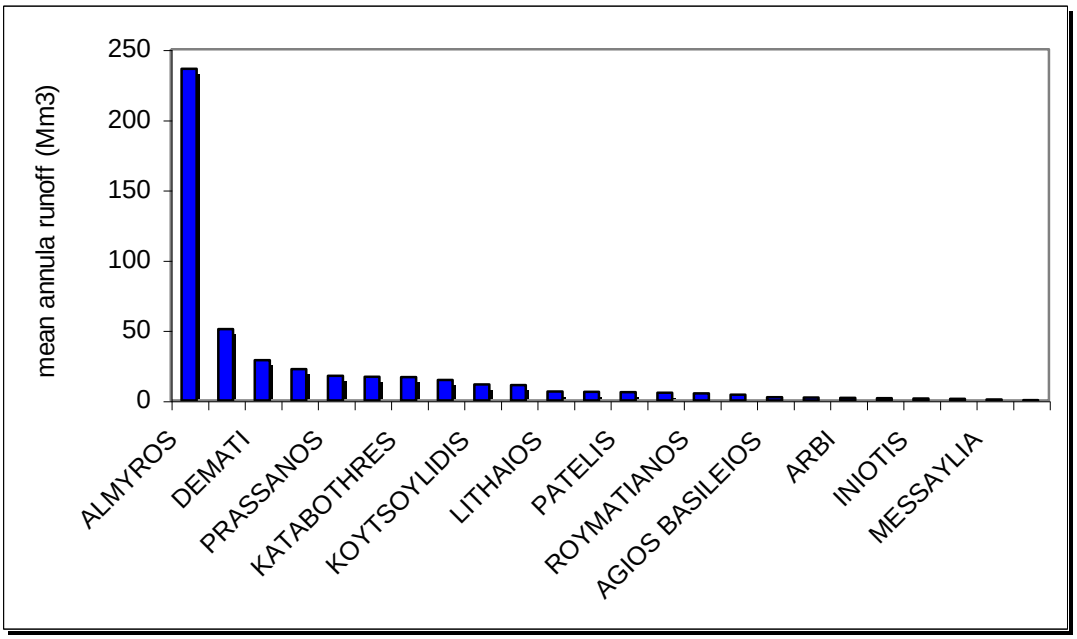

Figure 1.1.4.5: Mean annual runoff of streams in Crete

1.1.5 Groundwater

The contribution of groundwater to the potential renewable water resources in Crete is about 70%. Almost all the water quantity used in Crete comes from subterranean sources (Chartzoulakis et al., 2001). It is estimated that approximately 20% of the groundwater resources of the island, totaling approximately 1.5 billion m^3, are associated with Neogene-Quaternary aquifers while the remaining 80% are associated with their deep Karstic counterparts (Source: RGC). It is estimated that 40 to 55% of the mean annual precipitation infiltrates into the ground in Karstic aquifers, creating a renewable groundwater potential of approximately 1.25 billion m^3. Of that groundwater potential 80% is discharged from karstic springs the majority of which are unfortunately disposed along the coast being thus contaminated by intruding seawater. Shallow aquifers hosted by Quaternary alluvial deposits have a renewable groundwater potential of 0.25 billion m^3.

There are several boreholes and pumping wells on the island where the Regional Governor of Crete and other public services measure groundwater levels and chloride concentrations. In overexploited aquifers such as the Messara Valley there has been observed a drop in the groundwater level. This is mainly due to over pumping of the aquifers for irrigation purposes. In Iraklion prefecture there is an intense exploitation of the existing aquifers. In 1990 alone, approximately 500 licenses for drilling and wells were issued by the responsible public service. It is certain that many additional unauthorized drillings have also been carried out, intensifying the exploitation of the already exploited underground aquifers.

There are 46 springs in Crete for which measurements of their yields exist. The mean annual yield for various springs in Crete is depicted in figure 1.1.5.1.

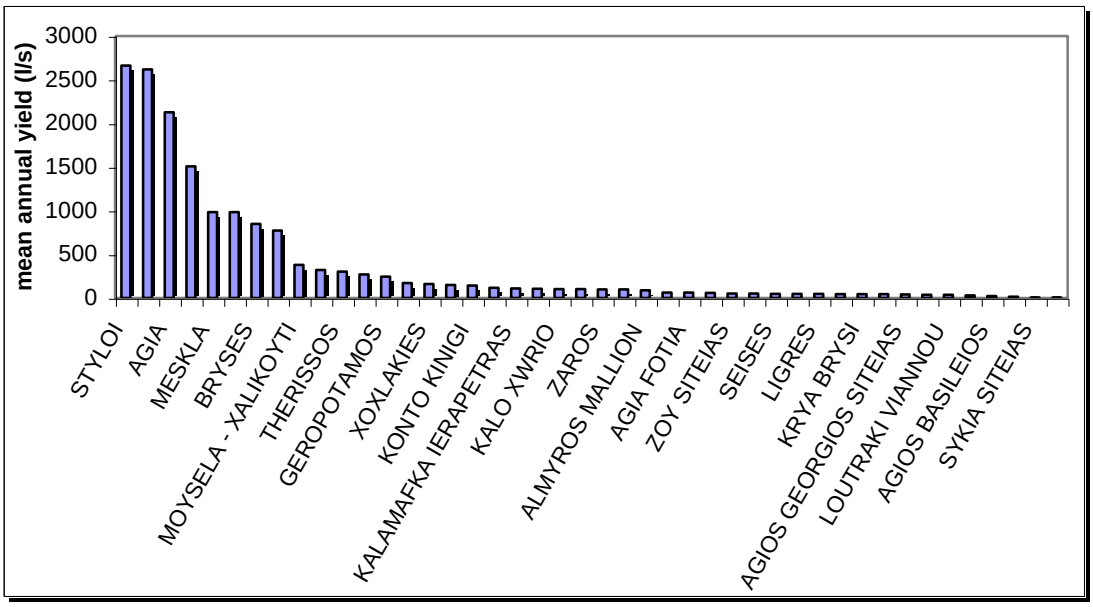

Figure 1.1.5.1: Mean annual yield for various springs in Crete

Generally, the highest yield is observed from January to April. The month with the highest yield is March or April and the month with the lowest yield is August, September or October. This is depicted in figure 1.1.5.2.

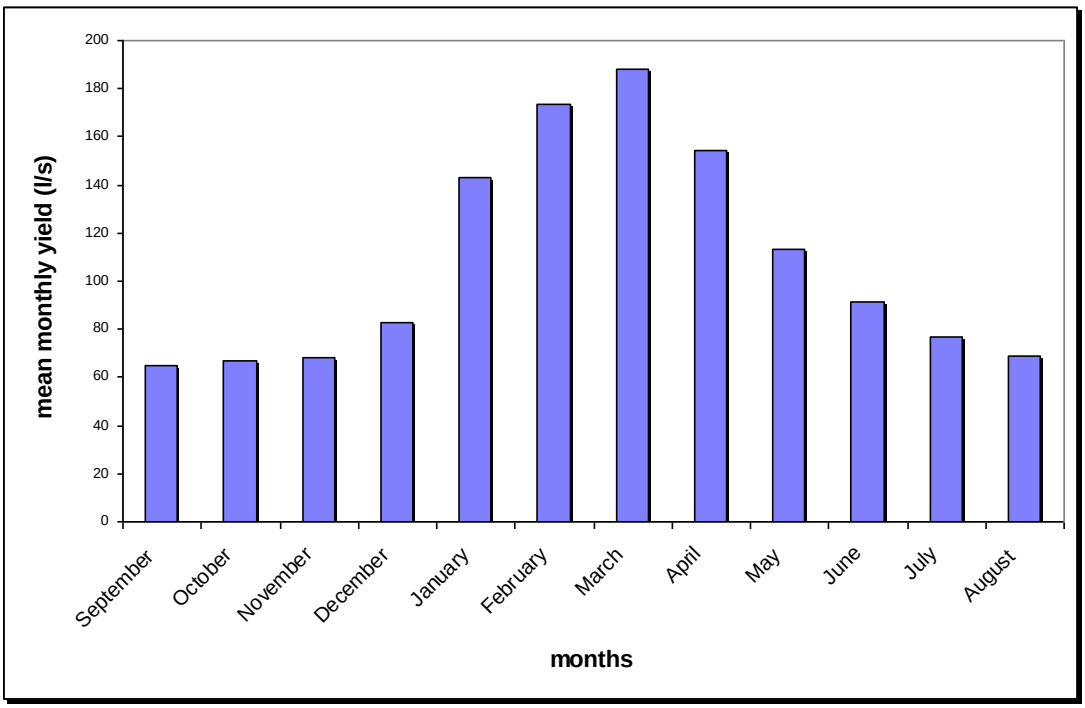

Figure 1.1.5.2: Mean monthly yield for Kalamafka

1.2 Water balance

Despite relatively high precipitation (600 mm in the plains and 2000 mm in the mountains), it is estimated that from the total precipitation in plains per year about 70% is lost to evapotranspiration, 10% as runoff to sea and only 20% goes to recharging the groundwater (Chartzoulakis et al., 2001). The island of Crete receives approximately 7.5 billion m^3 of precipitation per year. Thus, there is an approximate inflow of 1.6 billion m^3 of water in the underground aquifers of the island (Monopolis, 1993).

Table 1.2.1 depicts the estimated hydrological balance of Crete in billions m^3 per year for three hydrological conditions namely a normal year with a return period equal or exceeding 50%, a wet year with a return period equal or exceeding 10%; and a dry year with a return period equal or exceeding 90%.

Table 1.2.1: Estimated hydrological balance of Crete (in billion m^3/a) Source: RGC

Hydrologic Conditions	Precipitation	Actual Evapotranspiration	Runoff	Infiltration
Normal year	7.69	5.38 (70%)	0.83 (10.8%)	1.47 (19.2%)
Wet year	10.33	7.23 (70%)	1.12 (10.8%)	1.98 (19.2%)
Dry year	5.07	3.55 (70%)	0.55 (10.9%)	0.97 (19.1%)

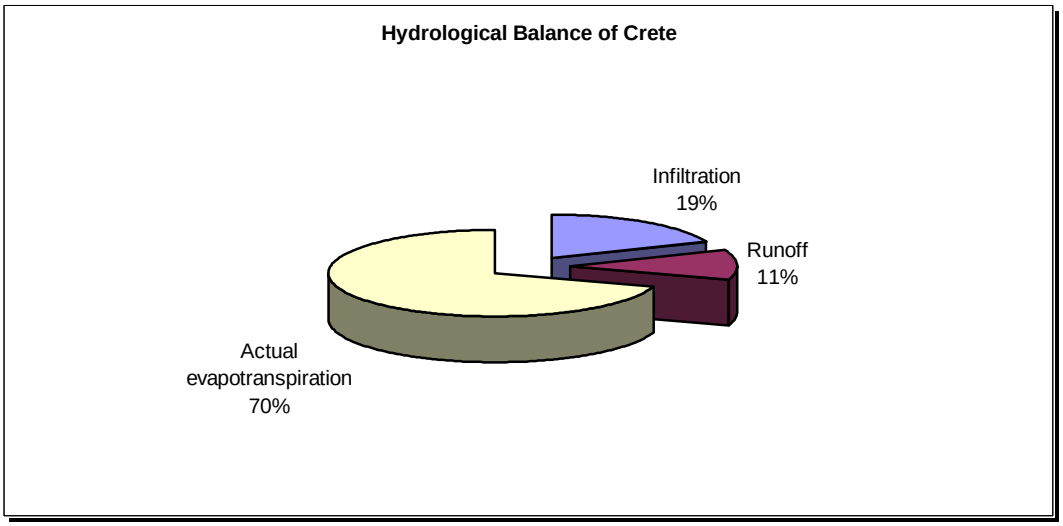

Figure 1.2.1: Hydrological balance of Crete. (Source: RGC)

1.3 Water demand and supply

As mentioned, the average annual precipitation in Crete is estimated at 750 mm. The potential renewable water resources 2650 Mm^3 and the real water used about 384 Mm^3/a. Water consumption constitutes only a small percentage less than 10 and 20% of the annual precipitation and water potential respectively. Although the contribution of the surface water to the potential water resources is around 40% (figure 1.3.1), the real contribution is about 13%, which means that almost all the water quantity used in Crete comes from subterranean sources (Chartzoulakis et al., 2001).

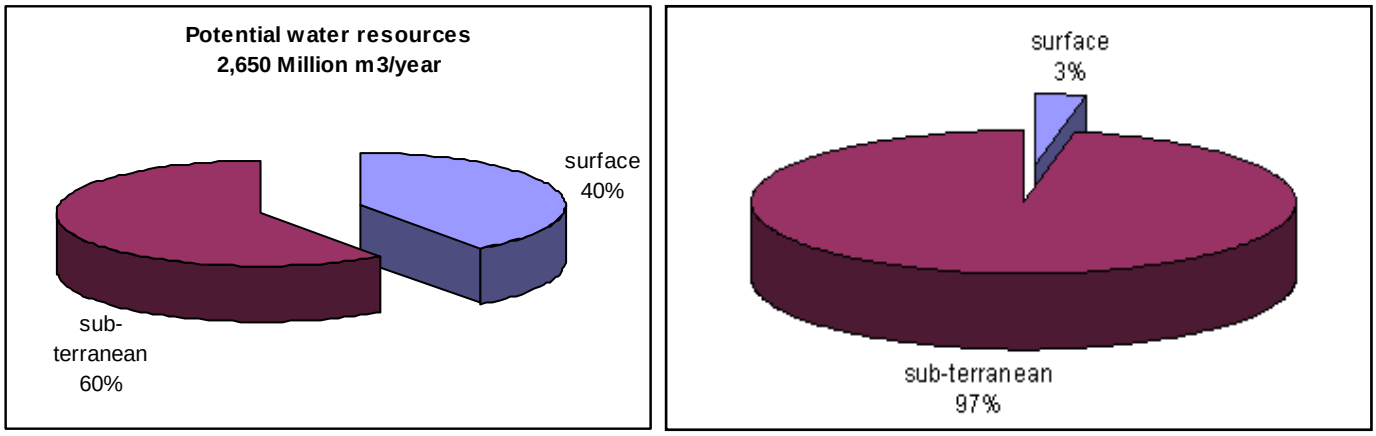

Figure 1.3.1: Water availability (potential water resources) and exploitability on the island of Crete.

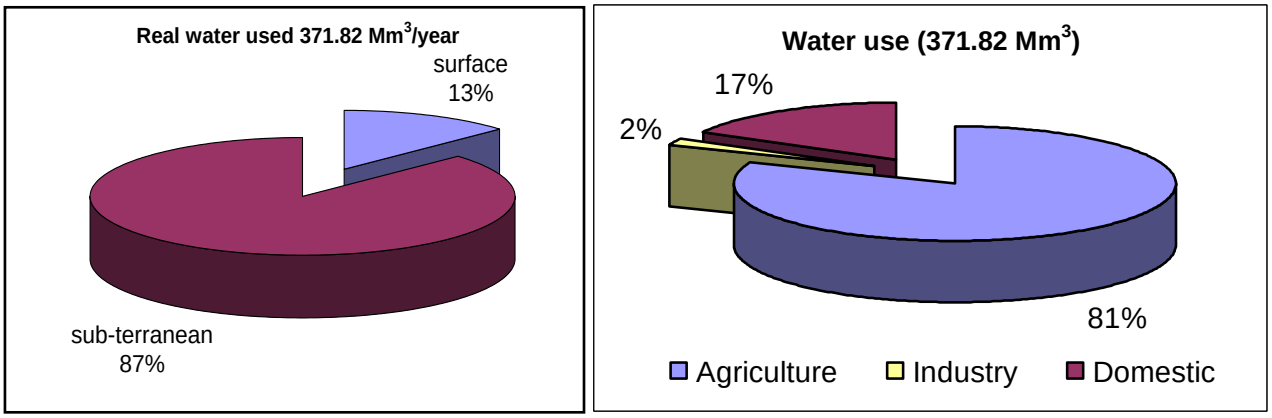

Figure 1.3.2: Water use by sources and sectors on the island of Crete

The major water use in Crete is in irrigation for agriculture (81% of the total consumption) while domestic use including tourism is 17% and industrial use only 2% (mainly for olive extraction plants, packaging plants, livestock and water bottling companies) (figure 1.3.2). Irrigation covers around 31% of the total cultivated land and uses mainly groundwater from wells or spring outflows. Only a very small percentage of irrigation water comes from surface water impounded in reservoirs.

Water used for irrigation is higher in the interval May-September with peak demand during July and August. Household consumption also shows a peak during July and August.

Another sector related to water use is tourism (domestic and international), an important economic activity in Crete, which is still significantly increasing. The total number of tourists in Crete in 1999 exceeded two million. The tourism industry requires huge quantities of water supply, with peak consumption during the high season and excess capacity in the low season (Chartzoulakis et al., 2001).

In Crete in the year 1986 total consumption of water was estimated at 280 x10^6 m^3 (233.5 x10^6 m^3 for irrigation, 39 x10^6 m^3 to supply houses, 3.5 x10^6 m^3 for industrial use and 4 x10^6 m^3 for the remaining uses) (Source: Ministry of Agriculture).

According to research done by the National Statistical Service of Greece in 1999 56.5% of the municipalities and communities in Crete, which represent 44.5% of the island's population, have sufficiency in water all year round, while the remaining 43.5%, which represent 55.5% of the population have problems with the water supply (Xepapadeas, 1996).

It should be noted that water availability in average terms is not the limiting factor. Much more important are the significant regional and seasonal variations which Crete shows in water availability and demand. About 70–80% of annual rainfall occurs in three to four months, while summers are usually long and dry. This situation is further worsened by a seasonal and regional variation in water demand. Both agriculture and tourism require increased supplies in late spring, summer, and early autumn, when water is less abundant (Table 1.3.1). Also, domestic use of water increases during dry and hot periods. On the average, Crete has relatively high per capita water availability, i.e. around 4,800m3/inh/a, which is lower than that of Greece (6700m3/inh/a (Chartzoulakis et al., 2001).

Table 1.3.1: Water demands and deficit in the island of Crete (Mm^3)

Water use	Estimated demands	Consumption	Deficit	Cover Percentage %
Irrigation	458.37	302.06	156.31	65.9%
Domestic & other	77.34	69.75	7.59	90.2%
Total	535.71	371.81	163.90	72.2%

* Irrigation demands are the required quantities for optimum crop yield.

1.4 Environment protection

Water Quality

Hydrogeological and biological factors affecting water quality in Crete include salinity due to the intrusion of seawater in coastal aquifers and high concentration of sulfuric ions originating from gypsum aquifers. The intense exploitation of existing underground aquifers has increased salinity concentrations. As a result the quality of irrigation water is reduced and this could potentially have negative external effects on agricultural production (Xepapadeas, 1996).

Pollution due to human activities has dramatically increased in recent years. This includes groundwater contamination due to the disposal of untreated domestic and industrial wastewater and the widespread use of fertilizers and pesticides in agriculture. However it should be noted that chemical and biological analysis of groundwater has shown that the majority of waters are within the drinking standards.

Wastewater treatment and reuse

In Greece, today, there are 270 Municipal Wastewater Treatment Plants (MWTPs) in operation that serve about 60% of the country's permanent population. For the remaining 26%, it is estimated that 2,000 MWTPs serving more than 500 population equivalent (P.E.) will be needed (Tsagarakis et al., 2001). Fourteen percent of the population is in villages of less than 500 P.E. for which on site sanitation technologies should be used (Tsagarakis, 1999). In Greece specific technologies for municipal wastewater treatment have been developed. Among these systems, 88% percent are activated sludge systems, 10% are natural systems, and 2% are attached growth systems. Among the activated sludge systems 85% are extended aeration systems, 10% are conventional systems and 5% are sequencing batch reactors. Approximately 44% of the activated sludge systems have nitrogen removal, and 15% have considered phosphorous removal. In Crete it is estimated that at present more than 100,000 m^3/d of secondary treated wastewater effluent is produced (Chartzoulakis et al., 2001). There are 23 MWTPs operating in Crete. Among these, 22 are activated sludge systems and 1 is a constructed wetland. Activated sludge systems are currently in operation in the municipalities of Iraklion, Chania, Rethymnon and Agios Nikolaos (Tsagarakis et al., 2001). Conventional wastewater treatment plants are also operating in the municipalities of Chersonisos, Archanes, Tympaki and Matala treating municipal wastewater in the prefecture of Iraklion. There is also a small wastewater treatment plant in the Industrial area of Iraklion treating industrial effluents. There is a constructed wetland in operation

in the community of Pompia in Iraklion prefecture. Many municipalities and communities in Crete are in the process of designing and building wastewater treatment plants, a number of those having reached the stage of conducting Environmental Impact Assessment studies. Such a case is the construction of a wetland in the community of Episkopi in Iraklion prefecture. The trend in Crete is towards the construction of wetlands for treating wastes of small communities.

Tsagarakis (1999) has classified the MWTPs in operation in Greece according to their performance, taking into account effluent qualitative parameters and the effluent quality requirements. Of existing MWTPs in Greece, 42% were operating well, 41% moderately and 17% poorly. Qualitative and quantitative values from some large MWTPs of Crete in comparison with others in the rest of Greece are shown in table 1.4.1.

The uneven atmospheric precipitation (spatially and seasonally), the continued growth of the population, the rapid growth of the tourist industry and the periodic droughts have forced water services and other agencies to search for new and reliable water sources. The use of reclaimed or recycled wastewater for various non-potable uses has proved to be the most reliable of sources, like in most Mediterranean countries. In Greece, no guidelines or criteria for wastewater reclamation and reuse have yet been adopted. Secondary effluent quality criteria are used for discharging purposes with a Health arrangement action of 1965 (Ministries of Interior and Public Health, 1965) and are independent of the disposal, reclamation and reuse effort. Also, no regulation of wastewater reuse exists on the European level. The only reference to it is the article 12 of the European Wastewater Directive (91/271/EEC) (EU, 1991). Thus, the need for establishing wastewater reclamation and reuse standards on both European and national level is obvious (Angelakis et al., 1999). There are a few MWTPs in Greece where effluent is used for direct irrigation of agricultural land. The effluents from four plants are used for the irrigation of forestry and various amenity purposes. There is no industrial reuse of treated effluent apart from some installations that use filtration for treating further effluent that is going to be used in the installation (Tsagarakis et al., 2001). There is no wastewater reuse practiced in Crete. Nevertheless, it has been calculated that by reusing the treated effluent of today's existing plants, a 5.3% increase of irrigated area can be obtained (Tsagarakis et al., 2001).

Table 1.4.1: Average quantitative and qualitative characteristics of treated effluent from different MWTPs in Greece (Source: Tsagarakis et al., 2001)

Parameter	Agios Nikolaos[a]	Heraklion[a]	Rethymnon[a,b]	Chania[b]	Rhodes	Ioannina[a]
P.E.	14,000	110,000	57,500	40,500	120,000	110,000
Q_e (m^3/d)[c]	1,500	15,000	7,500	10,400	8,000	17,089
BOD_5 (mg/L)	16	8	8	4	9	8
COD (mg/L)	54	15	40	29	25	38
TDS (mg/L)	-	950	1,500	-	1,250	-
SS (mg/L)	20	8	13	8	-	13
PH	7.70	7.65	7.75	7.50	7.60	7.69
TKN (mg/L)	-	20.00	2.50	4.50	-	11.50
NH4-N(mg/L)	2.10	4.50	0.65	0.40	0.50	9.65
NO_3-N (mg/L)	-	-	0.15	0.47	-	0.30
Total P (mg/L)	-	12.50	5.00	7.90	7.60	4.28
FC(MPN/100cm^3)	-	0	1,000,000	275	-	0
TC (MPN/100 cm^3)	1,000	15	23,000,000	-	-	25

[a]Average values for 1999; [b] Without desinfection; [c] Effluent average daily flow rate.

1.5 Water laws and regulations

Law 1739/87 for water resources management determines the instruments and the processes that should be employed to allow water resources management in national and regional level. According to this law, water resources management is the set of activities and processes necessary for the best possible cover of water demand for all uses. The main goal of water resources management is coping with problems such as water inefficiency, areas and users of conflict and conservation of the highest possible water quality and quantity according to use, today and in the future. Other goals of water resources management are the orientation of water demand towards uses that comply with research and development programs of the country and the rational development of investigation, exploitation and protection of water resources.

The basic regulations of Law 1739/87 for the achievement of the above-mentioned goals are:

- Institutional framework
  - Enactment of the division of the country in 14 water districts, i.e. areas demarcated by watersheds or islands, which include hydrographic networks with similar hydrological-hydrogeological conditions;
  - The ministry of development is designated as the ministry in charge of natural resources and water resources management;
  - Advisory committees are established for decision making: Ministerial Committee of Water Resources in national level and 14 regional committees for water resources management;
  - Public services are designated in charge of each water use.

- Water resources development
  - Development programs are classified as long-term national, mid-range national and regional in each water district. Implementation and supervision of the development programs is one of the main tasks of water resources management instruments in national and regional level;
  - The main principle on which development programs are based is water availability and demand budget. The water budget takes into account the current situation of water resources as well as future scenarios.

Parallel to law 1739/87 and complimentary to it, law 1650/86 for environment protection is in force. In articles 9 and 10 of this law water is defined as a natural element and legislative measures are foreseen for monitoring and evaluation of water resources quality. In the framework of law 1650/86 the Hellenic ministry for the environment, physical planning and public works presented a comprehensive program for water resources protection. This program was part of the “A’ European Union support framework” (1983-93), which established the necessary infrastructure for water resources monitoring. The water resources quality-monitoring network was completed with the “B’ European Union support framework”.

Apart from these two laws there is a number of legislative decrees, joint ministerial decisions, sanitary regulations and articles of the civil code that refer to the investigation, exploitation and protection of water resources.

1.6 Institutional framework and constraints

The institutional framework for water resources management in Greece was shortly described in paragraph 1.5. In more detail the institutional framework in Greece can be seen in figure 1.6.1.

Figure 1.6.1: Institutional framework for water resources management in Greece

The ministry in charge of natural resources and water resources management on national level is the Ministry of development. There is also a ministerial committee for water resources in national level, which is an advisory and decision-making instrument. Water resources management options are proposed from the ministry of development to the ministerial committee, which then decides on a certain policy option that should be employed by the ministry of development. The ministry for development has a regional structure with 14 regional committees for water resources, one for each water district that Greece is divided in. Water districts are areas demarcated by watersheds or islands, which include hydrographic networks with similar hydrological-hydrogeological conditions. The regional committee of the ministry for development in Crete is the Regional Governor of Crete (RGC). RGC is an advisory and decision-making instrument. The section of water resources of RGC is in charge of water resources management in the island of Crete, which forms a separate water district. The water resources management policy of RGC is employed by public services. The public service responsible for domestic and public water supply is the regional service of

municipalities and communities and users include the municipal service of water supply and sewerage, municipalities and private users. The directorate of land reclamation works is in charge of agricultural water management and users of water for agriculture are local water boards and farmers with private irrigation projects. The National Tourism Organisation regulates water used for tourist activities and services for environment protection regulate water necessary for the protection and conservation of natural systems.

1.7 Management, institutional and policy options

Water resources management is a key issue on the island of Crete mainly due to the spatial and temporal variation of the rainfall events, in relation to the geological setting of the island and also the intense water uses such as tourism and farming. The main issue in water resources management on the island is focused on the uneven geographical distribution of water resources in relation to the water demand hotspots on the island. In general there is abundance of water resources in the west compared to the east of the island. Furthermore, the demand for tourism and farming activities is increased in the east of the island. This combination of availability and demand places the water resources and their management under pressure.

The main stakeholders on the island can be classified in two categories depending on the scale of the areas of responsibility and the nature of the stakeholders' responsibilities. On regional scale the Section of Water Resources Management of the Region of Crete (RGC) comprises the main stakeholder and its main duty is the integrated water resources management and identification of water resources problems on the island, as well as suggestion of actions for future sustainable development. On regional scale the municipal water companies and the local water boards comprise the main stakeholders. They deal with domestic water supply and irrigation water provision and management respectively.

The difficulty of local people in understanding the objectives of a water resources management plan and the misleading belief of the farmers that an increase to the suggested irrigation water volumes leads to a higher farming production, create significant frictions in regional scale. The misconception of water resources ownership status, and the continuously increasing demand and water use are the main reasons for the creation of such frictions. This leads to water resources overexploitation, reduction of the water resources potential, failure of existing infrastructure and results in natural water quality deterioration. Human activities also intensify the pressure for a sound water resources management especially in alluvial plain aquifers.

Under the above conditions, the section of water management has taken into consideration the following proposals in order to protect and to restore the environment in the view of sustainable development:

- Protection of Groundwater Resources Against Over-Exploitation;
- Restrictions in issuing groundwater abstraction licenses in areas under pressure;
- Pollution Control of surface and ground water. Monitoring of Water Quality;

- Protection of Coastal Aquifers from saline intrusion;
- Exploitation of Un(der)Exploited Aquifers such as Karstic Aquifers;
- The establishment of a water plan on a watershed basis for detailed water management;
- The investigation and implementation of artificial recharge of aquifers;
- Feasibility studies for further introduction of surface reservoirs;
- The improvement of the information services on the rural scale;
- The application of modern and effective irrigation methods;
- Improved Freshwater Storage and Transport. Groundwater Recharge promotion;
- Reuse of water after treatment;
- Utilization of Untapped Surface Water Sources. Interbasin Transfer;
- Demand Reduction: Agricultural, Industrial and Domestic.

The implementation of the Water Framework Directive in combination with the application of a strategy that aims to inform local people about the existing issues will assist the regional stakeholders to a geographically balanced water resources management of the island.

1.8 Agricultural situation

1.8.1 Cultivated crops and cultivated land

Agriculture represents an important sector of the local economy in Crete. It contributes 13% to the GDP of the island, while services and tourism represent 77% and industry 10%. Approximately 6.7% of the active island employees are working in the agricultural sector.

Crete is an olive-producing island and the olive oil production is the most important agricultural sector of the island. 99.8% of the olives produced are used for oil production and only 0.21 % of the total production is for edible use (HNSS, 1999). Olives take 38% of the total cultivated land on the island while that percentage is increased on Iraklio prefecture where it takes 53%. Olives cover more than 90% of the total tree crops, followed by citrus 3.4%, almonds and avocados. Along with olives, citrus (oranges, lemons and mandarins), apricots and cherries are cultivated. Tomatoes, cucumber, potatoes, melons and watermelons are the most widely cultivated vegetable crops, while almost all of the row crops are fodder crops and legumes. The total cultivated land is 3223.2 km^2 including fallow land. The main groups of crops and the surfaces covered in Crete are shown in the Table 1.8.1 and their development within the last 40 years in figure 1.8.1. The production of some groups of crops in the four prefectures of Crete is shown in Tables 1.8.2, 1.8.3 and 1.8.4. (HNSS, 1999). The main vegetable crops grown in Crete are fresh tomatoes, cucumbers, potatoes, eggplants, onions, watermelons, melons, cabbages and peppers, while among fruit crops olive covers more than 89% followed by citrus 3.4%, almonds and avocados (Chartzoulakis et al., 2001).

Table 1.8.1: Area and crops cultivated in Crete (km²), Regional Governor of Crete, 2002

Category	Cultivated Area (km²)	Percentage of the total
Row crops	320	9.9
Vegetable crops	80	2.7
Vineyards	309.5	9.6
Fruit crops	1850.2	57.4
Fallow fields	653.5	20.4
Total cultivated land	3223.2	100.0

Table 1.8.2: Crop production in thousand tons/year: vegetables

Vegetables							
	Tomatoes	**Cauliflowers & Cabbages**	**Onions**	**Egg-plants**	**Potatoes**	**Melons**	**Water-melons**
Iraklio	55.73	8.36	3.53	1.33	33.66	8.41	20.49
Lashithi	38.23	2.41	0.65	6.25	39.19	3.32	0.78
Rethimno	5.39	1.37	0.92	0.22	6.79	0.78	4.37
Chania	30.93	1.07	1.59	0.45	8.20	2.43	8.31
Total	130.27	13.21	6.69	8.25	87.84	14.94	33.94

Table 1.8.3: Crop production in tons/year: arable land

Crops on arable land								
	Wheat	**Barley**	**Oats**	**Maize**	**Broad beans**	**Beans**	**Chick peas**	**Lentil**
Iraklio	2894	2688	684	16	556	129	72	24
Lashithi	1378	360	600	54	331	142	39	10
Rethimno	629	1031	1595	90	384	216	41	24
Chania	55	124	681	60	216	127	9	2
Total	4956	4203	3560	220	1487	614	161	60

Table 1.8.4: Crop production in thousand tons/year: tree crops

Tree crops									
	Lemons	**Oranges**	**Manda-rins**	**Pears**	**Peaches**	**Apri-cots**	**Cher-ries**	**Olives**	**Olive oil**
Iraklio	4.67	11.17	1.95	3.39	1.33	45.89	13.78	307.66	66.21
Lashithi	1.04	3.01	0.80	1.15	6.25	3.88	0.19	64.17	22.63
Rethimno	1.10	3.91	0.38	1.38	0.22	4.29	0.43	80.52	20.76
Chania	3.41	107.55	4.50	1.26	0.45	9.25	0.62	182.10	37.58
Total	10.21	125.64	7.63	7.15	8.25	63.31	15.01	634.45	147.17

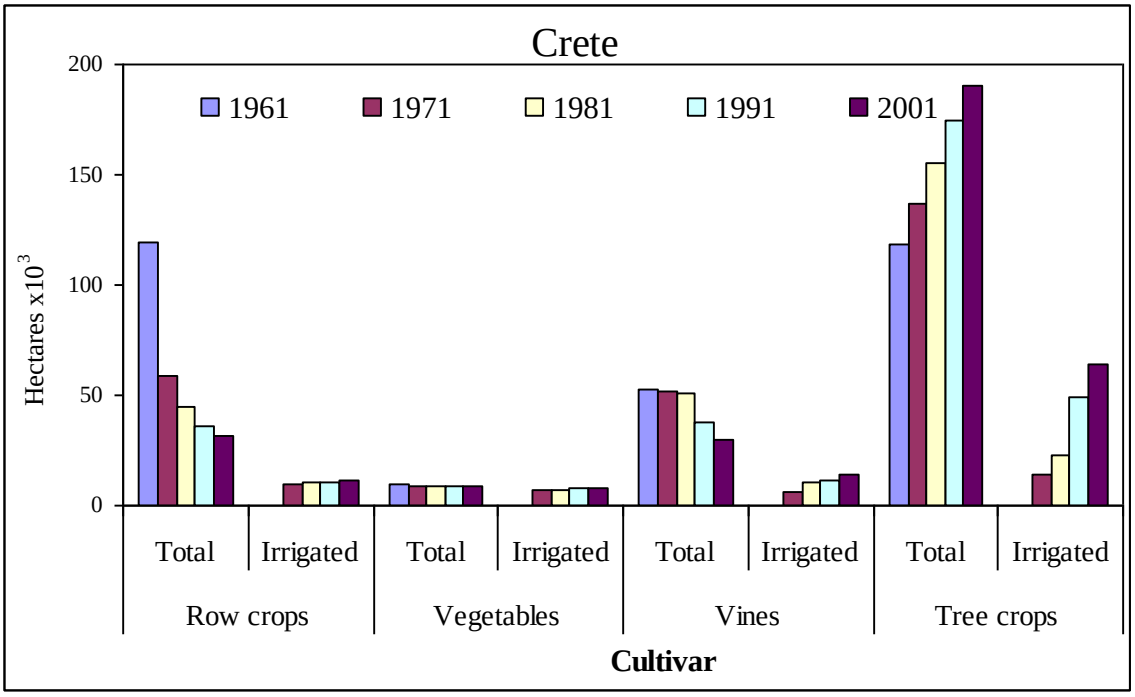

Figure 1.8.1: Area and crops cultivated in Crete in the last 40 years (Source: Hellenic National Statistical Service).

1.8.2 Irrigated area and irrigated crops

Demand for irrigation water is high especially in summer months (agriculture is the major water consumer), adding more pressure on the aquifers, which already suffer from the increased demand for domestic use those months.

In Crete 42% of the available agricultural land is irrigated (RGC, 2002). As shown in Figure 1.8.2 in Crete there was an increase of irrigated land of more than 55% in the last 15 years, while the average increase at the same time in the country was 15% (Fig. 1.8.3.)

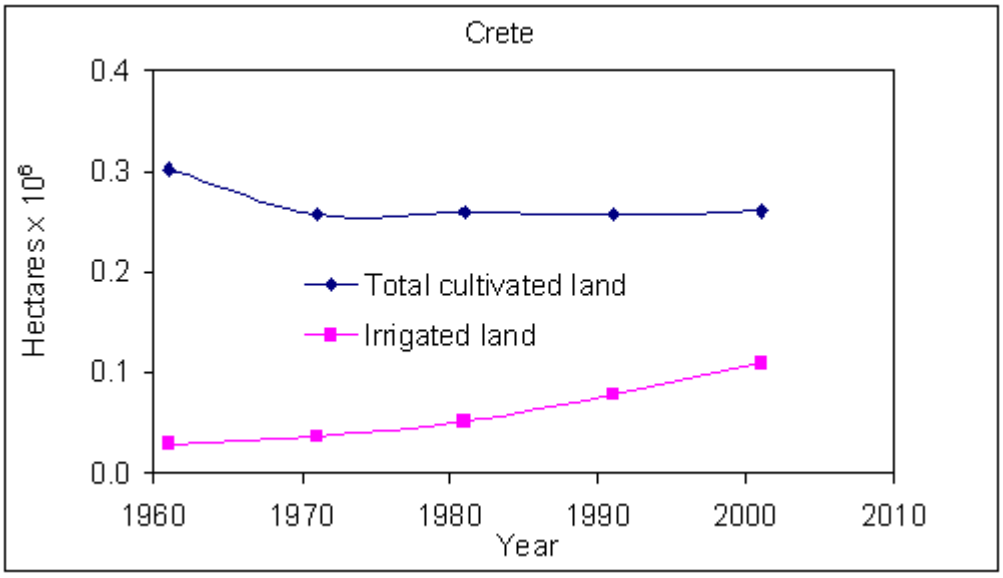

Figure 1.8.2: Total cultivated area and irrigated area in Crete, Hellenic National Statistical Service

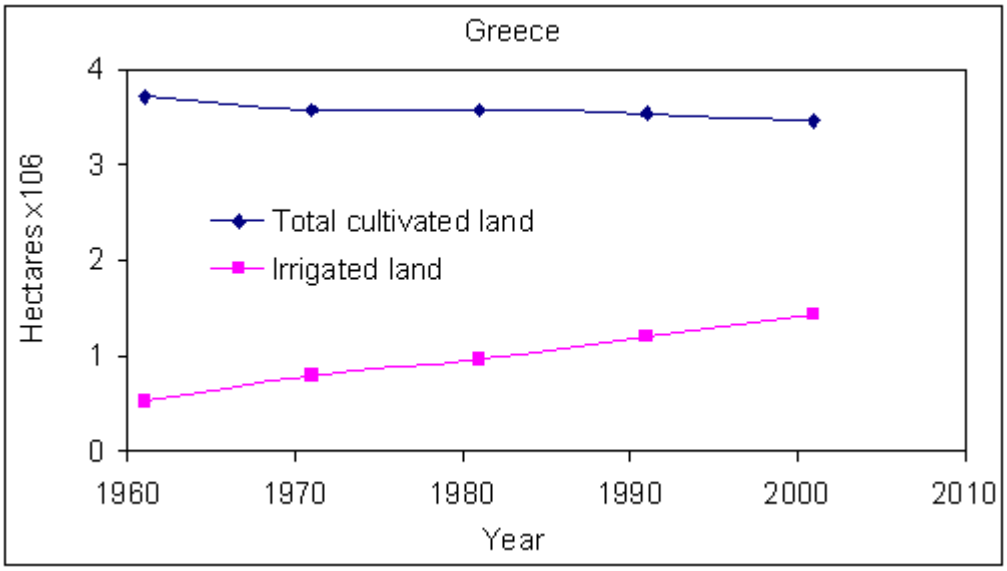

Figure 1.8.3: Total cultivated area and irrigated area in Greece, Hellenic National Statistical Service

The demand for irrigation water is high, while at the same time only 31% of the available land is irrigated, a percentage lower than that of Greece (36.3%). There was an increase in irrigated land by more than 55% within the last 15 years, while the average increase at the same time in the country was 25% (figure 1.8.2). For vegetable crops, more than 92% of the cultivated area is irrigated, while the irrigated percentage in row crops was 36.5%, in fruit trees 38.5% and in vineyards 46.8%. It should be noted that row crops are referred to cereals, fodder plants, industrial plants, melons, watermelons and potatoes while tree crops are olives, citrus, fruit trees, nut and dried fruit trees (Fig.1.8.4) (Hellenic National Statistical Service). Table 1.2.4.1 depicts the irrigated area for each crop group.

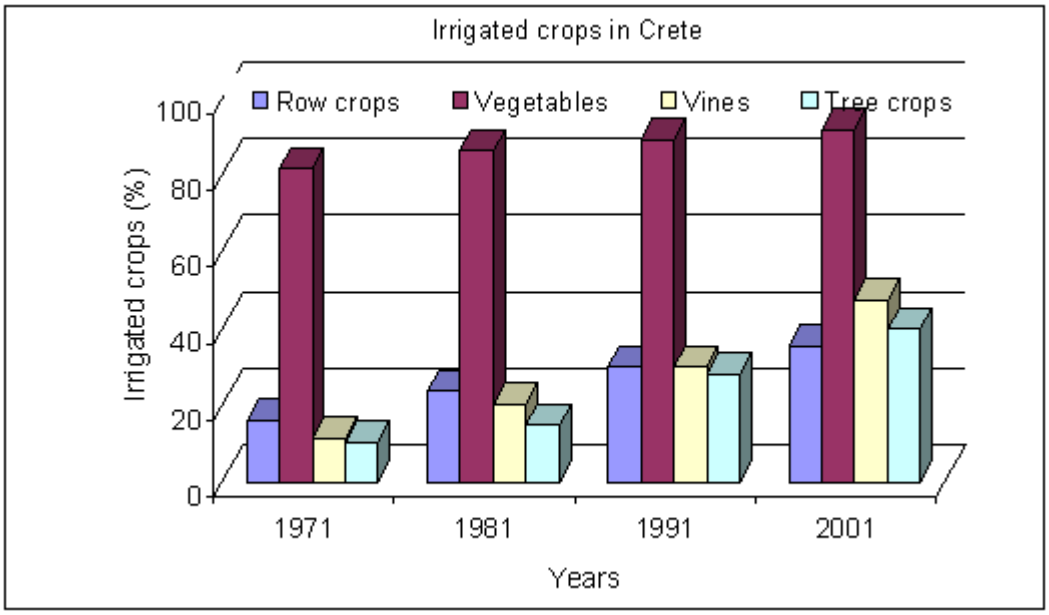

Figure 1.8.4: Irrigated crops (percentage of the total cultivated area in Crete) during the last 30 years

Table 1.8.5: Cultivated and irrigated areas in the prefectures of Crete (RGC, 2002)

Type of crop	Cultivated land (ha x 10^3)	Irrigated land (ha x 10^3)	Percentage of irrigated land	Percentage of crop that is irrigated
Row Crops	32.2	11.74	11%	36.45%
Vegetables	8.8	8.17	7.7%	93%
Tree crops	185.0	71.4	67.4%	38.5%
Vineyards	31.0	14.5	13.9%	46.8%
Total	257.0	107.90	42.0%	

Table 1.8.6 shows an estimation of the irrigation water requirements for a selection of crops in the island of Crete (RGC, 2002). The last column shows an estimation of the actual water applied per crop, which is usually higher than the recommended amount. Irrigation period varies in the island and depends on the microclimatic conditions of each area, the type of crop and the time of plantation. A mean irrigation period is shown in Table 1.8.7.

Table 1.8.6: Crop water requirements (RGC, 2002)

Type of crop	Water required (m^3/ha)	Water applied (m^3/ha)
Vineyards	1780	3000 – 3500
Forage crops	-	7000
Olives	3140	2500
Open field vegetables	5700	4500
Greenhouse vegetables	4350	6500
Orchards	4620	5000
Potatoes	5700	4500
Subtropical trees	-	6000

Table 1.8.7: Irrigation periods per crop type (RGC, 2002)

Type of crop	Irrigation period
Vineyards	1st April – 30th July
Forrage crops	1st April 30 th October
Olives	1st April – 30th October
Open field vegetables	1st Arpil – 30th November
Greenhouses	1st January – 31st December
Orchards	1st April – 30th October
Potatoes	1st April – 30th October
Subtropical trees	1st April – 30th October

Figure 1.8.5 depicts origin of the irrigation water.

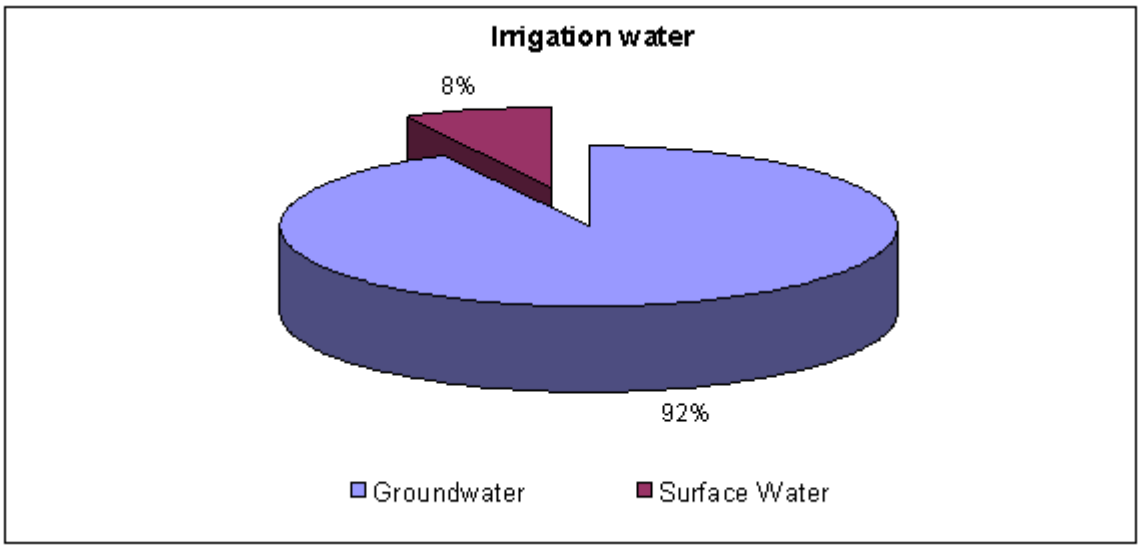

Figure 1.8.5: Origin of irrigation water in Crete

1.8.3 Animal breeding

In a study made by the Region of Crete the current water consumption for animal production in the island was estimated to 6,173,463 m^3. Small animals (sheep, goats, hens and rabbits) represent 99.3 % of the total number of animals and consume 90.5 % of the total water used for animal production. In the same study the future water needs for animal production were estimated (Table 1.8.8). The current trends indicate a significant increase in the production of smaller animals (goats, sheep and rabbits) and a steady production of larger animals (pigs and cattle) during the last decade. The number of sheep and goats was increased by 92 and 82 % respectively, in Rethimno prefecture, while the number of rabbits was in-creased by 42 % in Iraklio prefecture, during a period of 8 years. Based on these trends, the number of small animals is expected to be doubled by 2020, while production of large animals will remain at present levels. Therefore, the water consumption for animal production is estimated to increase about to 8,500,000 m^3/year by 2020 (an increase of 37.7 % compared to current levels).

Table: 1.8.8: Water consumption per animal type in Crete,RGC, 2002

Animal type	Total population	Water consumption (m^3)
Horses/Asses	13,273	265
Cattle	1,906	113
Breeding Boars	1,235	1,235
Sheep	1,258,254	8,808
Goats	545,449	3,818
Rabbits	769,479	2,308
Chickens	1,219,732	366

1.8.4 Irrigation systems

Depending on the size, irrigation projects are constructed by the government, the local authorities or private individuals. The large size irrigation schemes, which involve large hydraulic structures such as dams, conveyors, pumping stations, reservoirs and modern distribution systems, are constructed by the governmental Water Resources Services and/or Agencies. The medium size irrigation schemes of local importance are constructed by the government on behalf of the Local Authority (Prefecture or Community) and usually comprise small dams or stream ponds, or boreholes and modern distribution systems. The government finances the cost of large and medium size irrigation schemes and farmers are charged per unit of water consumed. The small size irrigation schemes, comprising a single borehole, are constructed by individuals at their own cost and are found mostly in areas overlying aquifers.

The irrigation networks are of modern type made of pressurized distribution systems with delivery of water to the farm outlets. The delivery of water to the farm outlets is done on free or modified demand or on rotation with the appropriate pressure for direct use through modern on farm irrigation systems. Although in most cases irrigation water is distributed to fields through closed pipeline networks, there are major losses (seepage, evaporation, leakage, etc.) from water delivered to the agricultural sites for irrigation (Chartzoulakis, Angelakis, & Skylourakis, 1997). It is estimated that, on average, only 65% of water diverted or extracted for irrigation is effectively used by the crop (Fig. 1.8.6). In some cases, the losses are estimated to be as much as 50% of the delivered water (Dialynas, Diamadopoulos, & Angelakis, 1995).

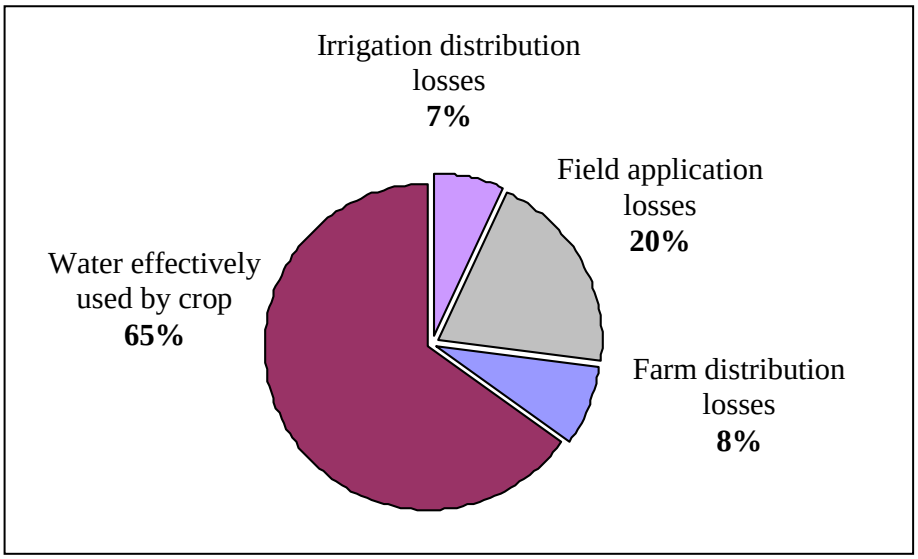

Figure 1.8.6: Average irrigation water losses in the island of Crete

Irrigation scheduling is another aspect of utmost importance for the appropriate irrigation of horticultural crops. It consists of a set of procedures which allow one, for a given crop, to find out when and how much to irrigate. Irrigation scheduling methods are based on environmental, physiological and soil parameters. For vegetables, especially in greenhouses, the analysis of soil moisture (by tensiometers, gypsum blocks or gravimetrically) is the most common method used for irrigation scheduling in Crete, since it assures low cost, simple operation and reliable estimation of soil water status. For tree crops, irrigation scheduling is mainly based on meteorological parameters

(mainly Class A pan evaporation and Reference evapotranspiration ET0). Irrigation scheduling is also done empirically using soil and plant appearance. Drip irrigation systems are used for the irrigation of vegetables, vineyards and tree crops. Sprinklers are used for forrage crops and vegetables and furrow for vegetables.

1.8.5 Price of irrigation water

The price of water per cubic meter varies greatly between catchment areas and even within the same catchment area, depending mainly on the managing agency. Cretan farmers operating in publicly developed irrigation projects still do not fully cover operation and maintenance (O&M) or capital replacement costs. So in the large irrigation project of West Crete the price is as low as 0.07-0.08 euros, whereas in community projects it reaches 0.10 – 0.12 euros and in some private projects it reaches 0.23-0.35 euros (Chartzoulakis et al., 2001). These prices are much higher than in Portugal or in some regions in Spain (OECD, 1999).

1.9 Socio-economic situation

Data presented in this paragraph are for Crete and come from the Hellenic National Statistical Service. Production is divided in primary, secondary and tertiary sector. Primary sector in Greece contributes 14.1% to Gross Domestic Product (GNP), secondary sector 26.4% and tertiary sector 59.4%. The largest percentage is occupied by the tertiary sector due to inclusion of tourist services in it. Twenty seven percent of the contribution of Crete to GNP is due to primary sector, a percentage higher than that of Greece (figure 1.9.1). The industrial and commercial sectors are not as developed as in the rest of Greece, while tertiary sector seems to have the same contribution to GNP for Greece and for Crete.

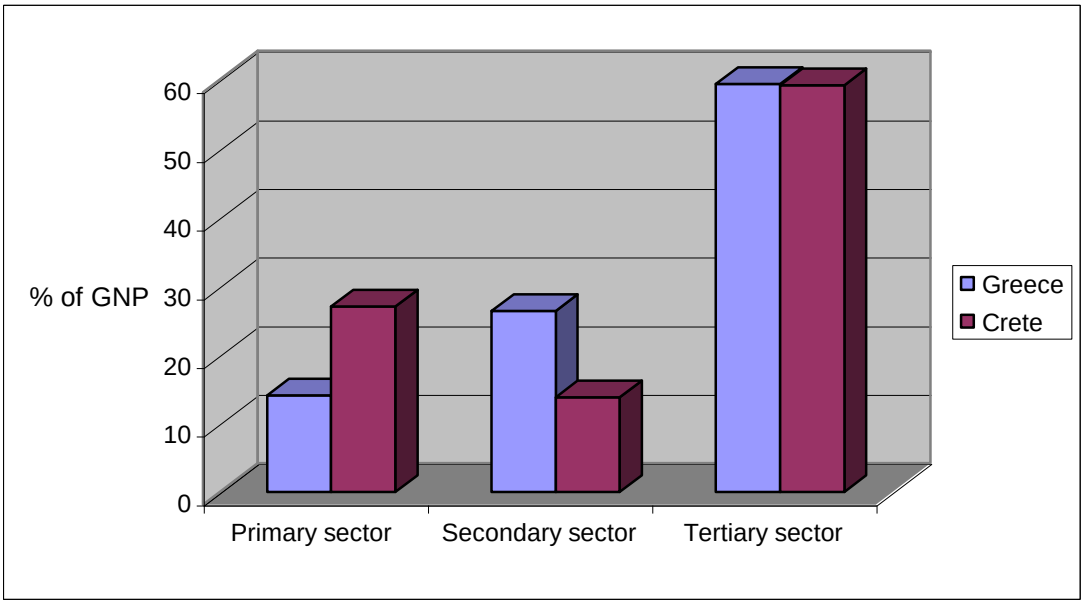

Figure 1.9.1: Production structure for Greece and Crete

The contribution of each prefecture of Crete to the primary, secondary and tertiary sector in Crete is depicted more precisely in figure 1.9.2. Thus, of the total contribution of Crete to the primary sector of Greece the prefecture of Iraklion contributes 52.2%, the prefecture of Lasithi 10.6%, the prefecture of Rethymnon 8.2%.

The fluctuations of GNP for Greece for the years 1993 to 2000 are show in figure 1.9.3. All % changes are computed for steady values reduced to year 1994. More detailed data for Crete is shown in figure 1.9.4. This figure shows per capita GNP for Crete and for different prefectures for the period 1981 to 1998.

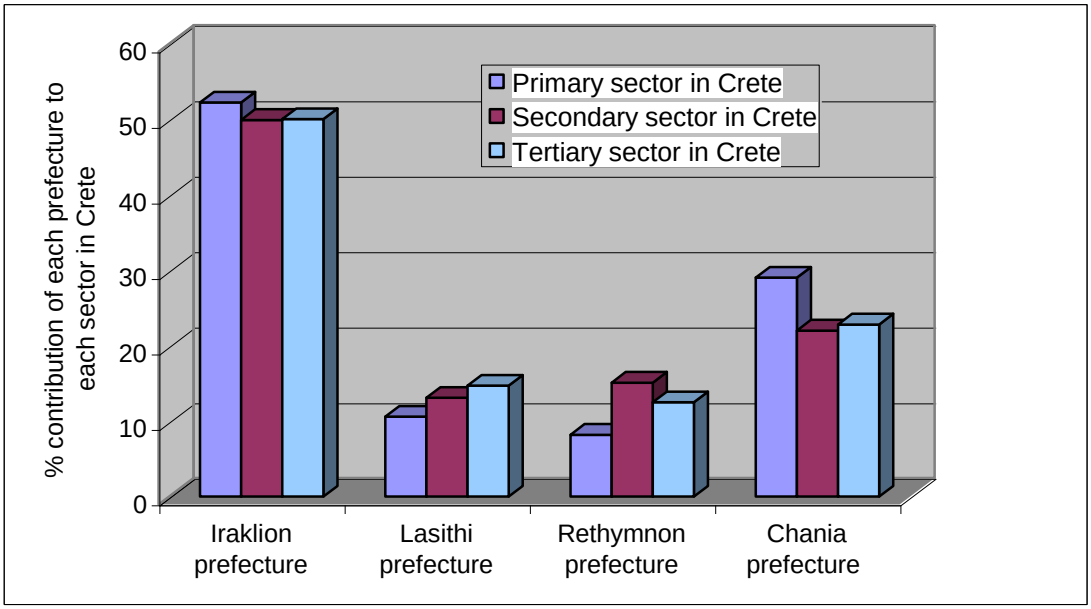

Figure 1.9.2: Production structure for different prefectures in Crete

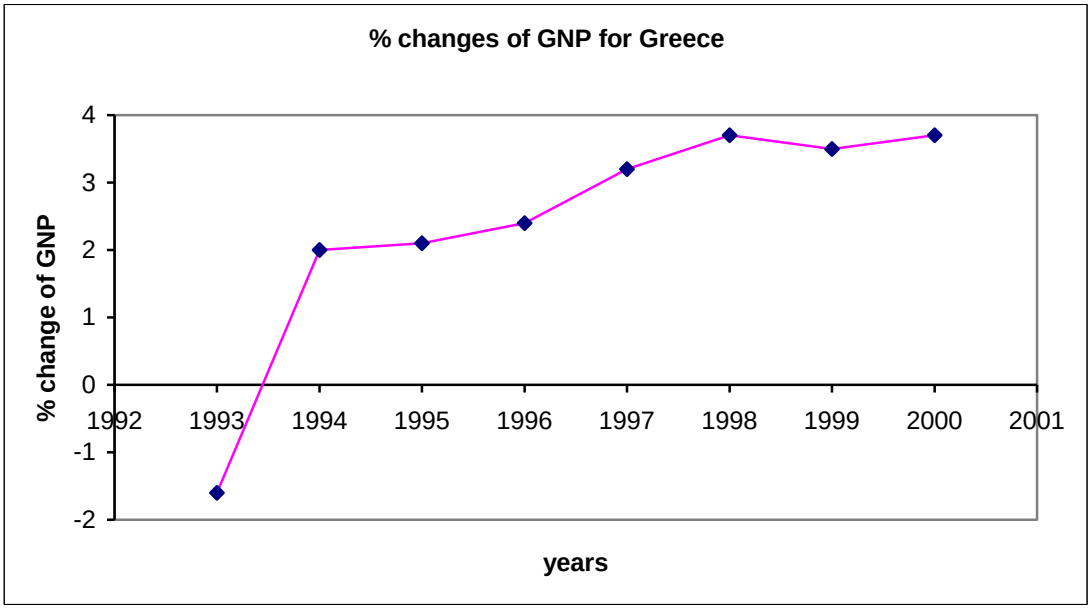

Figure 1.9.3: % changes of GNP for Greece

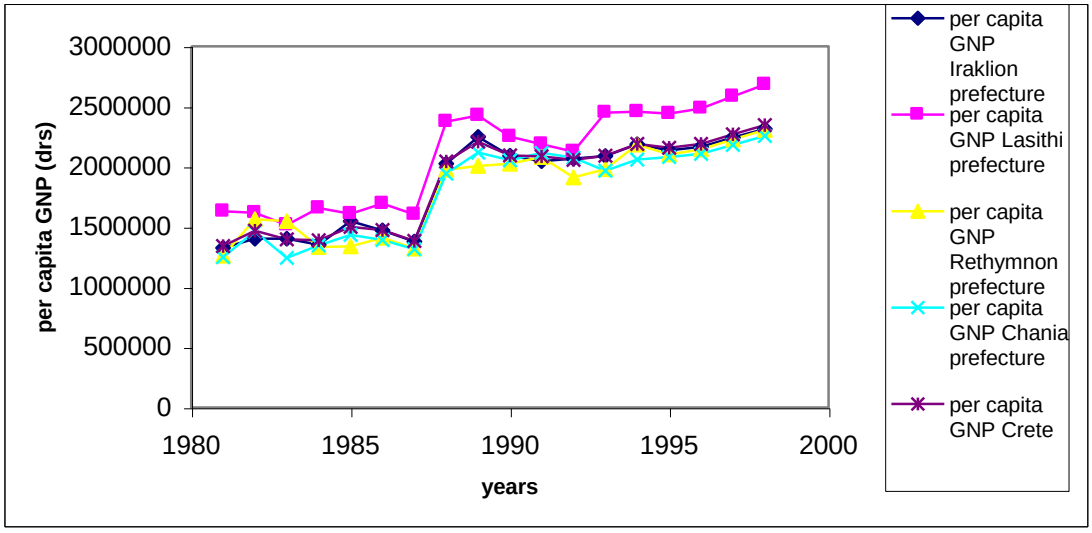

Figure 1.9.4: Per capita GNP for Crete (reference year: 1994)

Private investments in Greece showed an increasing trend since 1994. The rate of change increased from 1994 till 1997 and seems to fall after 1997 and until 1999. From 1999 to 2000 there was an increase in private investments of 8.5% (figure 1.9.5). Public investments in Greece are increasing since 1994; the rate of increase seems to fall since 1998 though (figure 1.9.6).

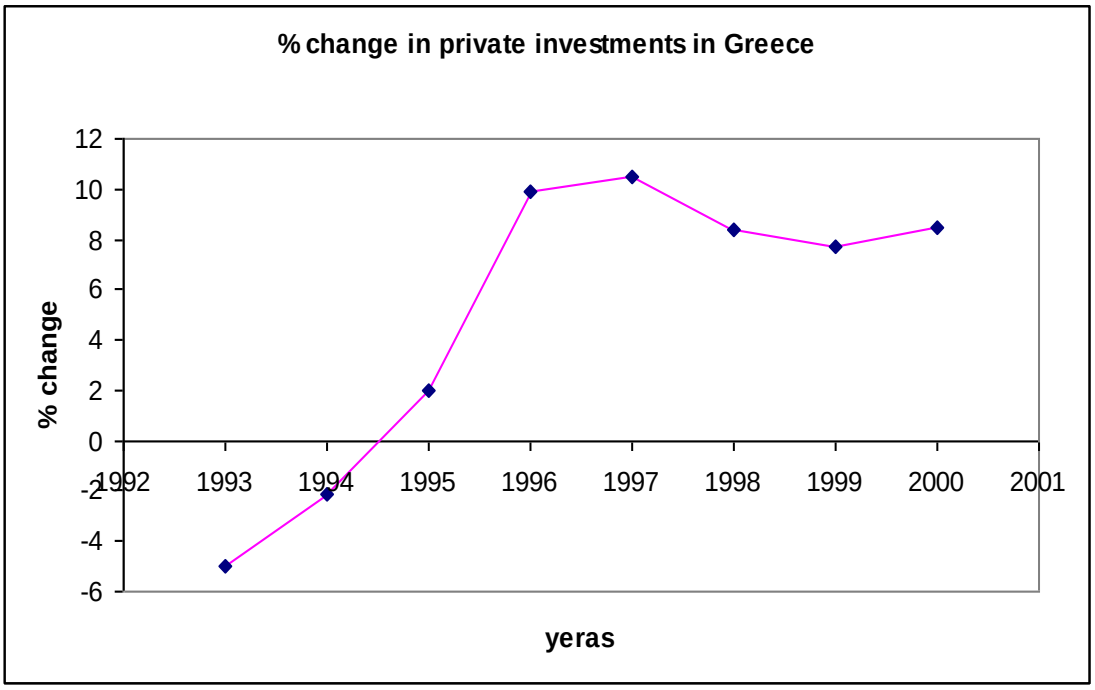

Figure 1.9.5: Private investments in Greece

The trends in private and public investments for the different prefectures in Crete are shown in figures 1.9.7 and 1.9.8.

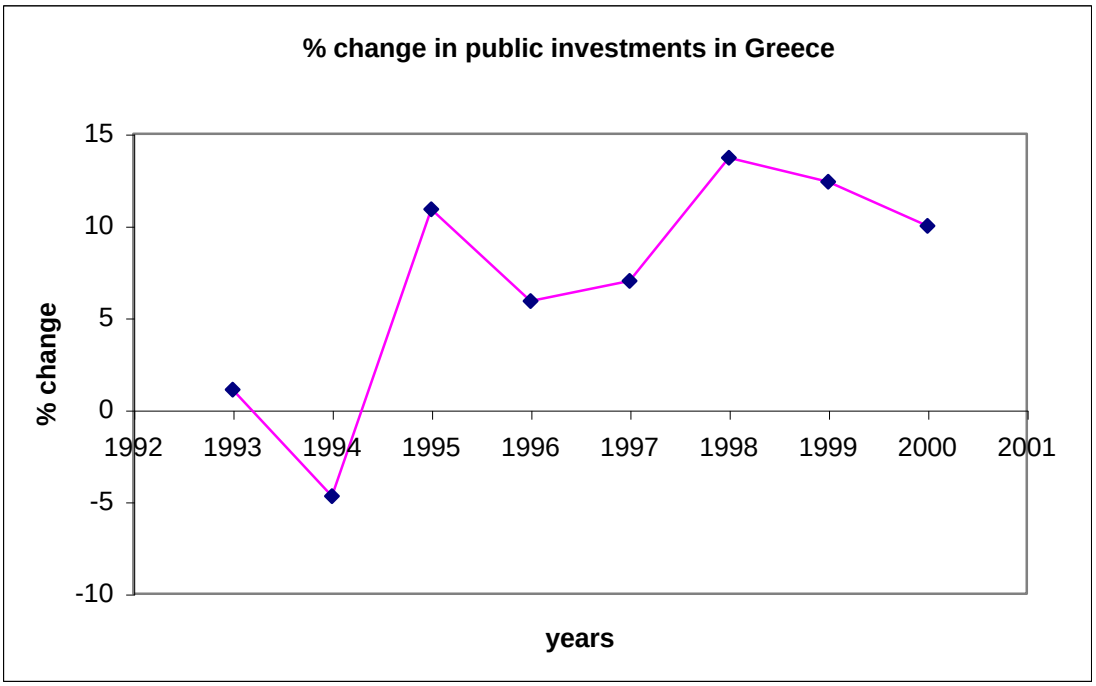

Figure 1.9.6: Public investments in Greece

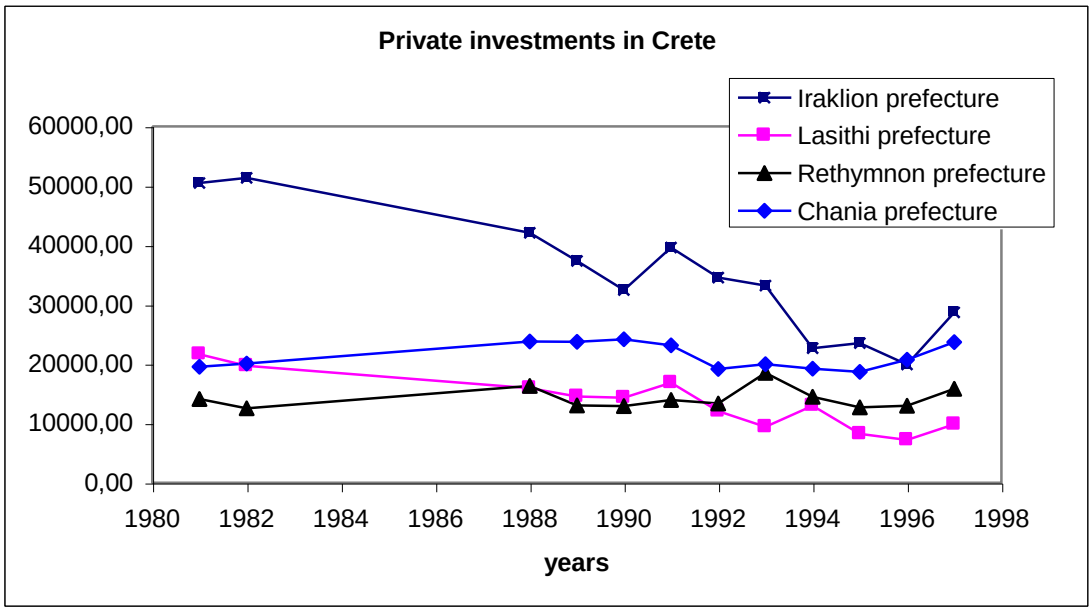

Figure 1.9.7: Private investments in Crete

Tourism is an important economic branch in Crete and in Greece generally. The total number of tourists in Crete in the year 1999 exceeded two million. The total number of tourists in different prefectures and in Crete is depicted in figure 1.9.9. Figure 1.9.10 shows the number of beds in the four prefectures and in Crete for the years 1981 to 1999. There is an obvious increase in the number of beds offered to tourists, which shows a growing interest for tourism.

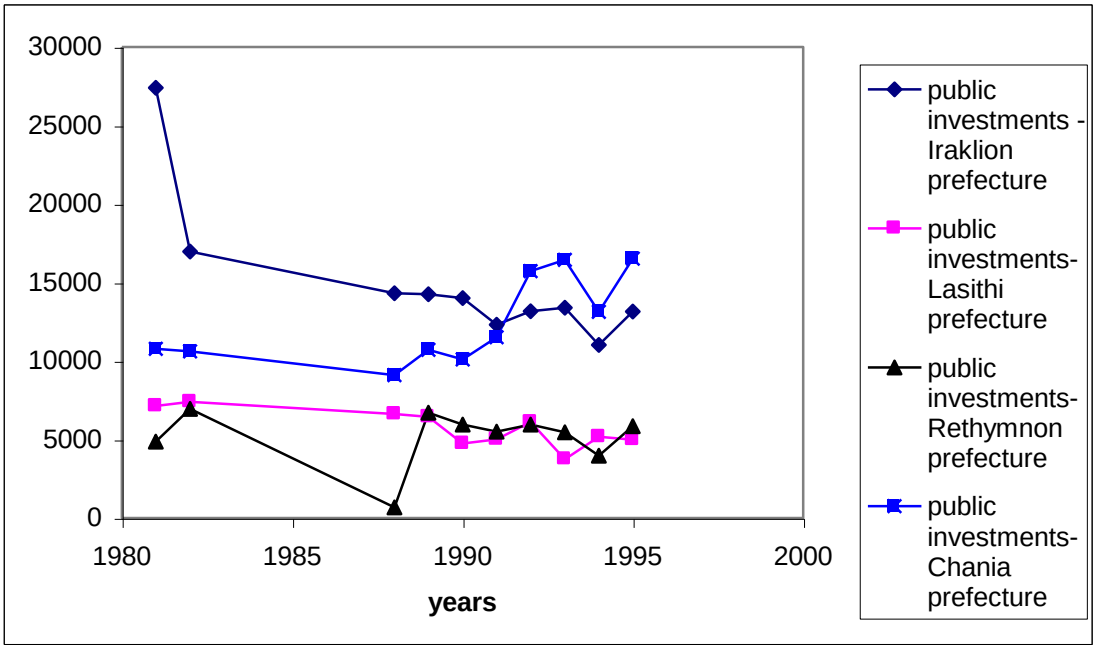

Figure 1.9.8: Public investments in Crete

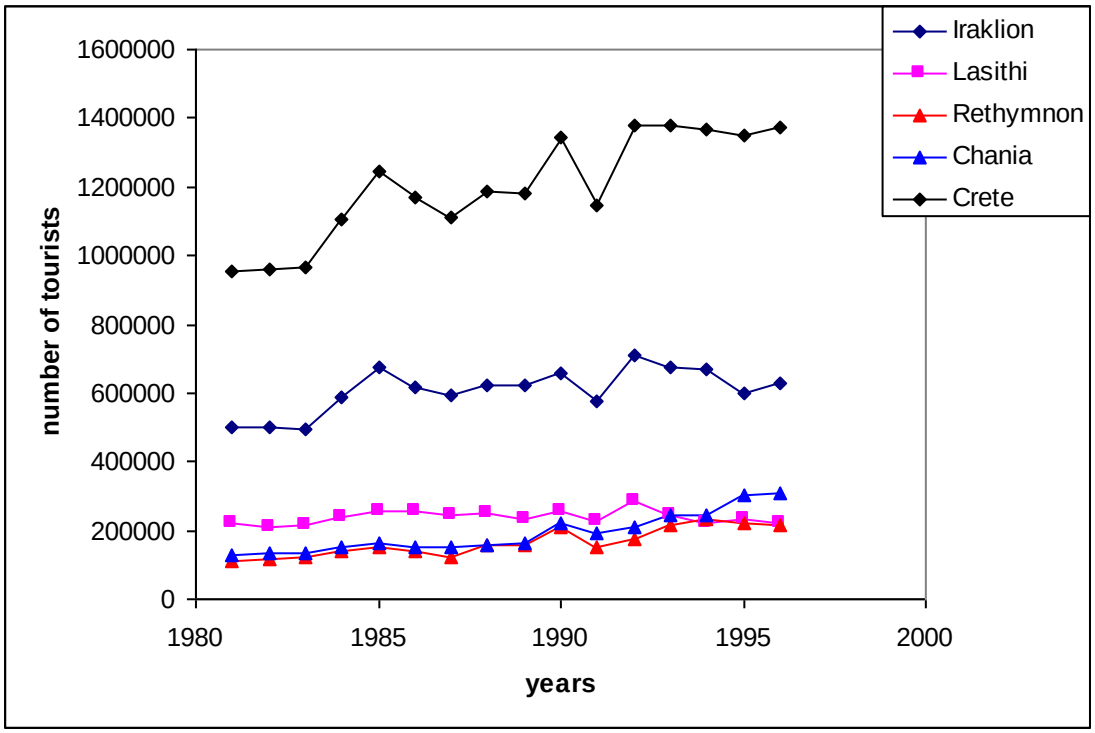

Figure 1.9.9: Number of tourists in Crete

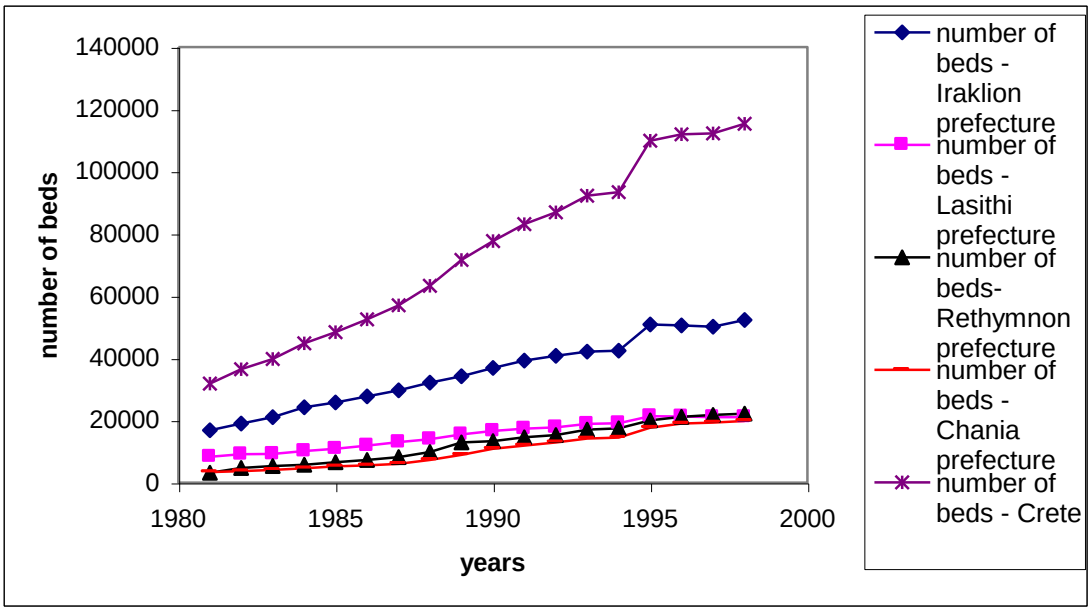

Figure 1.9.10: Number of beds in Crete

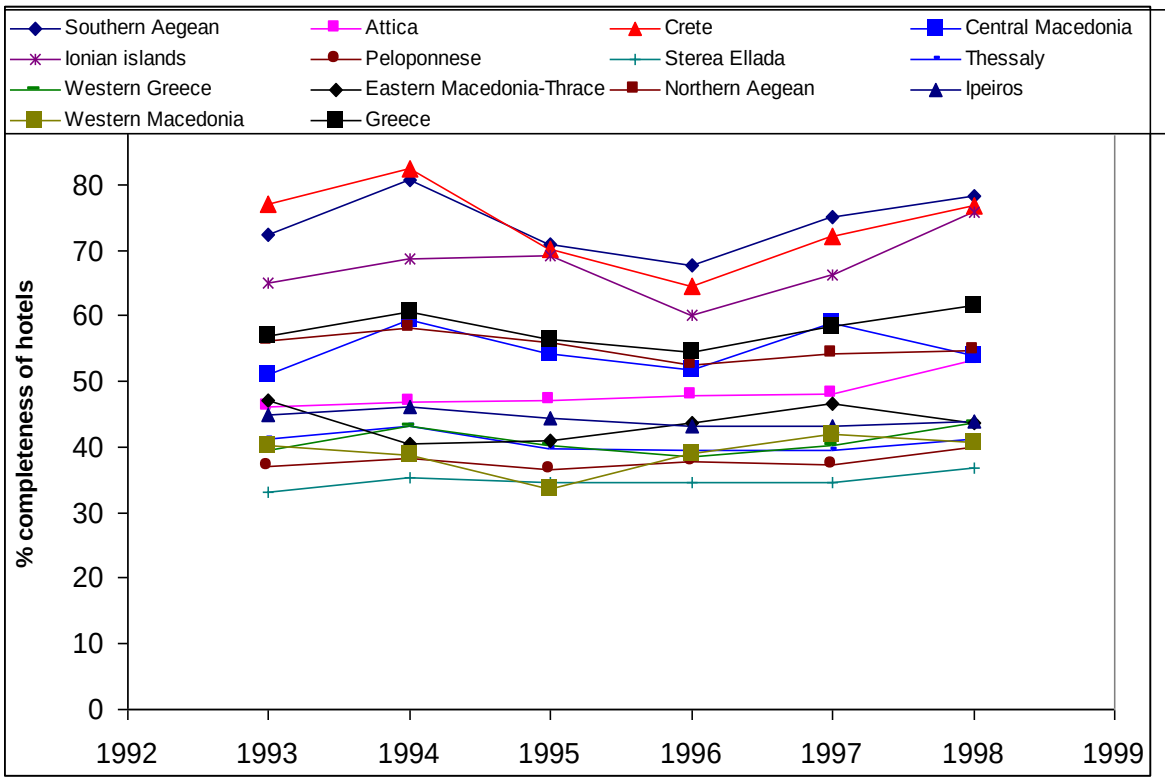

Figure 1.9.11: % of completeness of hotels in Greece

As shown in figure 1.9.11, Crete and Southern Aegean show the highest percentages of completeness of hotels during the period 1993 to 1998.

The percentages of unemployment in Greece for years 1997 to 2000 are shown in figure 1.9.12.

Figure 1.9.12: % Unemployment in Greece

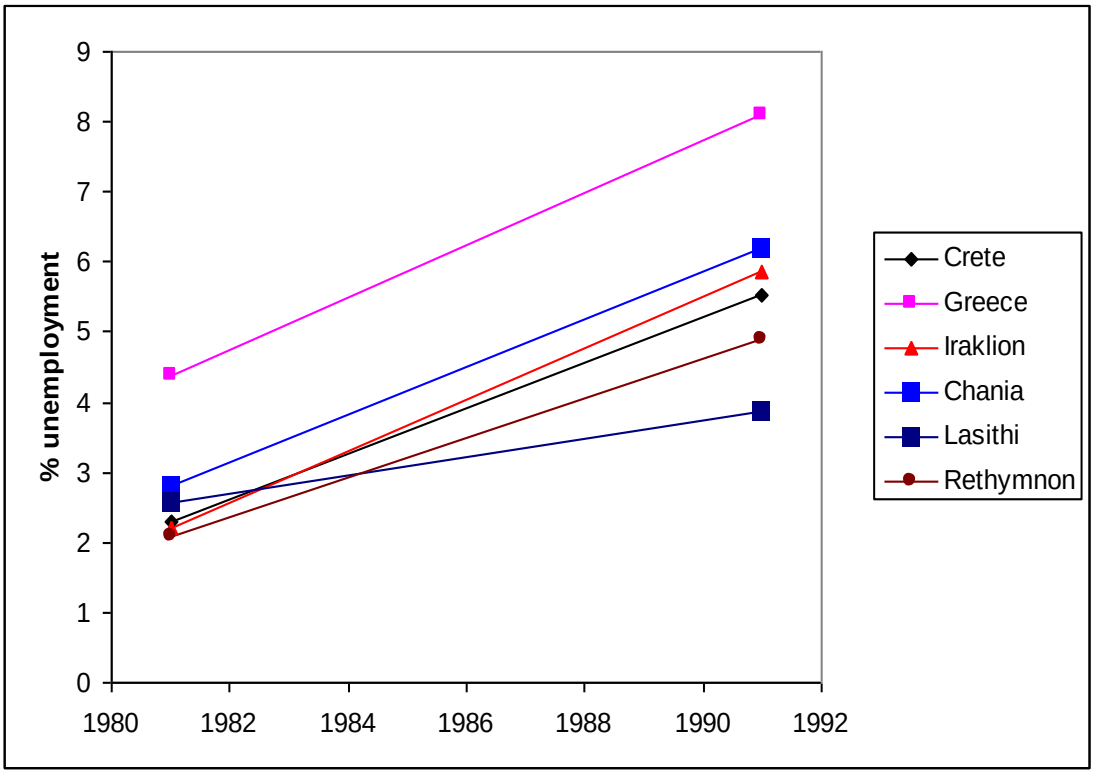

Figure 1.9.13: Unemployment in Crete.

Figure 1.9.13 shows that unemployment in Crete is substantially lower than in Greece.

The last two figures (1.9.14 and 1.9.15) give a picture of the number of students and doctors in the island.

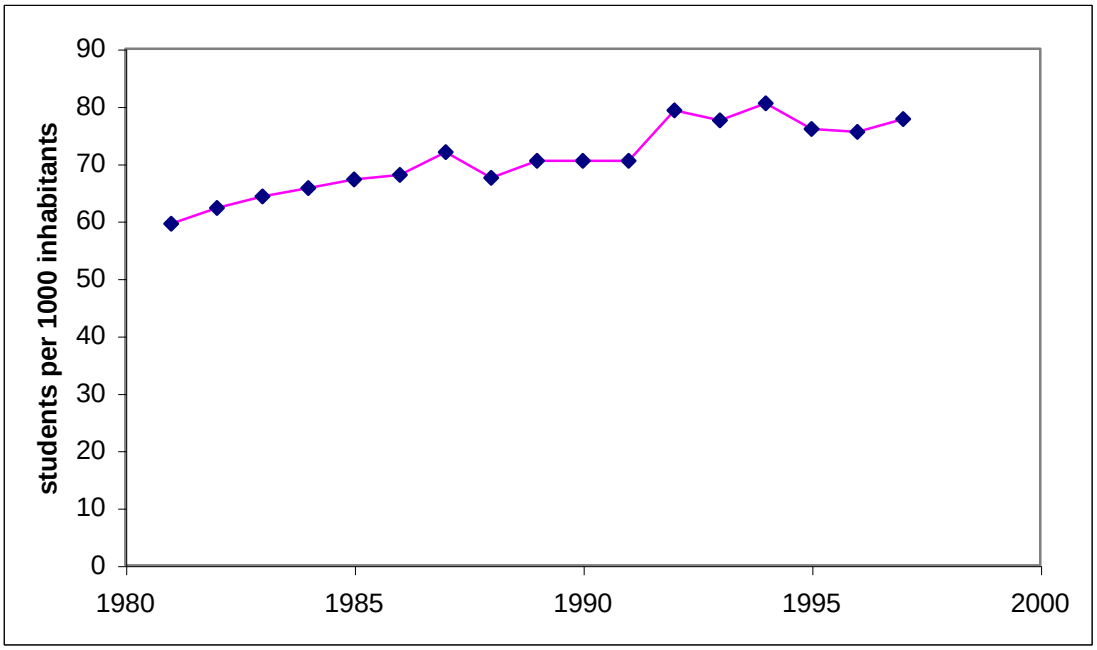

Figure 1.9.14: Average number of students in Crete

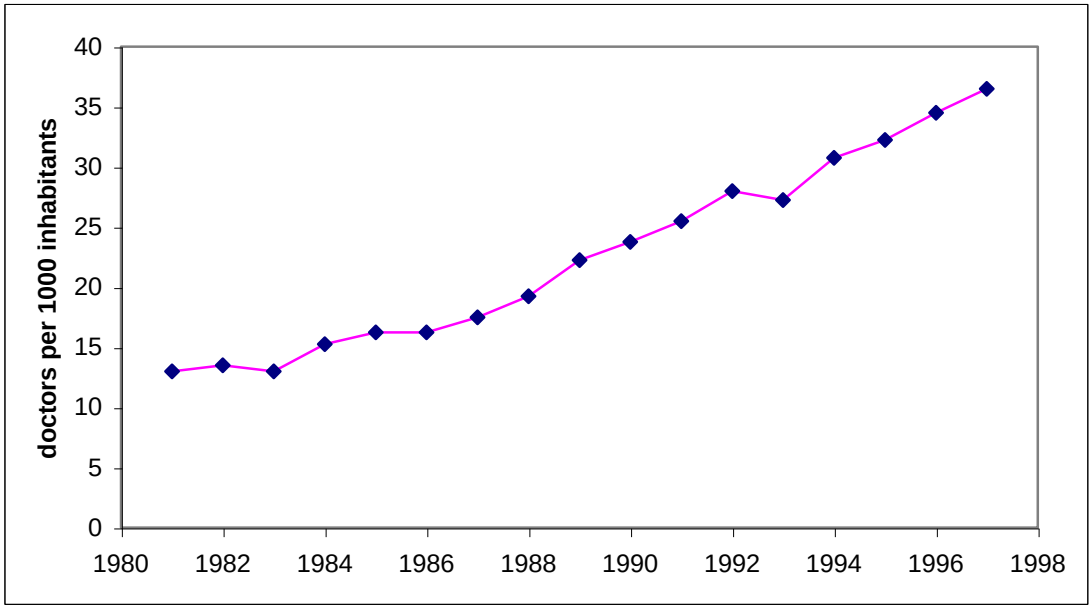

Figure 1.9.15: Average number of doctors in Crete

1.10 Conclusions

Crete is considered a semi-arid region. Although precipitation is high, only 20% of rainfall goes to recharging the aquifers and 70% is lost to evapotranspiration. This situation may worsen in the future due to climatic change. The major water use in the island is irrigation for agriculture (83%). Another sector related to water use is tourism (domestic and international), an important economic activity in Crete, which is still growing. The total number of tourists in Crete in 1999 exceeded two million, and this number may double in 2025. The tourism industry requires huge quantities of water supply, with peak consumption during the high season and excess capacity in the low season. Water availability in Crete in general is not the limiting factor. The real water used, 87% of which comes from subterranean sources is 384 Mm^3 per year while the potential water resources are 2,650 Mm^3 per year. Much more important are the significant regional and seasonal variations which Crete shows in water availability and demand. Seasonal variations in water availability are created by the seasonal pattern that rainfall exhibits in Crete. About 60-70% of annual rainfall occurs in three to four months, while summers are usually long and dry. In addition, rainfall is not uniformly distributed throughout the island. Precipitation decreases from west to east. This situation is further worsened by a seasonal and regional variation in water demand. Both, agriculture and tourism require increased supplies in late spring, summer and early autumn, when water is less abundant. Also, domestic use of water increases during dry and hot periods. Demand for water for irrigation and tourism is higher in eastern than in western Crete. This results in a situation where western Crete shows high water availability and low demand and eastern Crete low water availability and high demand.

Spatial and temporal variations of rainfall events combined with seasonal and spatial variation in water demand constituting water resources management as a key issue on the island. The lack of the local people's understanding of the objectives of a water resources management plan and the farmers' belief that the higher the irrigated water volume is, the higher is the resulted farming production respectively, created significant frictions on the local scale. The misconception of water resources ownership status from people on local scale is the main reason for such frictions. This leads to water resources overexploitation, reduction of the water resources potential and failure of existing infrastructure and results in deteriorated water quality. Contaminative human activities intensify the pressure for a sound water resources management.

Given the severe limitations of exploiting new water resources, the only solution in meeting water requirements is to use water more efficiently. Although several important advances have been made over the last several years, significant challenges still remain in the areas of technological, managerial, policy innovation and adaptation, human resources management, information transfer and social environmental considerations. The issues mentioned concern the Island of Crete, but applicable to most Mediterranean countries.
They are:

(a) Water conservation and efficient use. Since agriculture is by far the largest water user, efficient irrigation management will undoubtedly be a major conservation option for the future. It can be achieved through irrigation requirements and irrigation scheduling

techniques, the use of localized irrigation systems, salinity management techniques, and a reduction of losses from water conveyance systems.

(b) Water sectorial use. Any amelioration of conflict and competition among water users will have positive effects on improving efficiency and productivity. Greater efforts are urgently needed to integrate irrigation planning and management with other sectors of economy that impinge on water use.

(c) Water pricing and cost recovery. The most important recommendation we can make is the adoption of full-cost pricing of water use and services. It will be the basis for promoting conservation, reducing losses and mobilizing resources. Furthermore, pricing could affect cropping patterns, income distribution, efficiency of water management, and generation of additional revenue, which could be used to operate and maintain water projects.

(d) Wastewater reuse. Water resources shortage and environmental concerns have already led to wastewater reuse for irrigation. Since wastewater reuse has multidisciplinary interlinkage with different sectors such as environment, health, agriculture, water resources, etc., it is necessary that the administrative responsibility for reuse activities is taken and reuse regulations are being well defined.

(e) Water quality management and use of saline water. The issue is becoming increasingly as important as water quantity, and is a far more complex task than quantity monitoring. Research has provided much knowledge on the specific interactions of saline waters on soil and plant and various strategies and criteria have been developed for the safe use of such waters for crop production.

(f) Other cost-effective technologies. Besides technologies in current use, such as reclamation and reuse of marginal waters, other cost-effective technologies, such as artificial recharge of groundwater, should be considered.

(g) Technology transfer. The availability of improved technologies or techniques is however no guarantee for their application. Farmers will play a key role in adopting more efficient and sustainable water management practices. Factors that provide the favorable conditions under which farmers may accept and adopt better and more efficient water use practices are: Clear benefits from efficient water use, investment support, adequate legislation, simple, practical and cost-effective technologies, guidance and advice in introducing new, more efficient technologies.

(h) Education and training. Extensive educational programs should be instituted at all levels of society to promote prudent use and conservation of water as one of the indispensable natural resources. The institutional framework for supporting services and the training of the staff involved in irrigation development will be the key to the introduction of new technologies in irrigation.

(i) Development of an integrated water resources plan. It is of high importance to apply a policy for water resources management, which will cover the present requirements but which will also ensure future needs (Chartzoulakis et al., 2001).

CHAPTER II

Selection of representative catchments

Four representative catchments are selected in Crete, one in each prefecture. The location of these catchments is shown in figure 2.1. West Messara Valley catchment is located in the southern part of Iraklion prefecture and represents the most important agricultural region in the island. Kissamos catchment lies in the northwestern part of Crete and constitutes another very important agricultural region on the island. Platys catchment lies next to Messara Valley in Rethymnon prefecture and is mostly cultivated with olives. Patelis catchment in the northeastern part of Crete is mostly cultivated with vines. It is an important catchment because 90% of the area is cultivated and irrigation creates peak demands in the summer in an area where precipitation is low and water demand is high, especially during the summer.

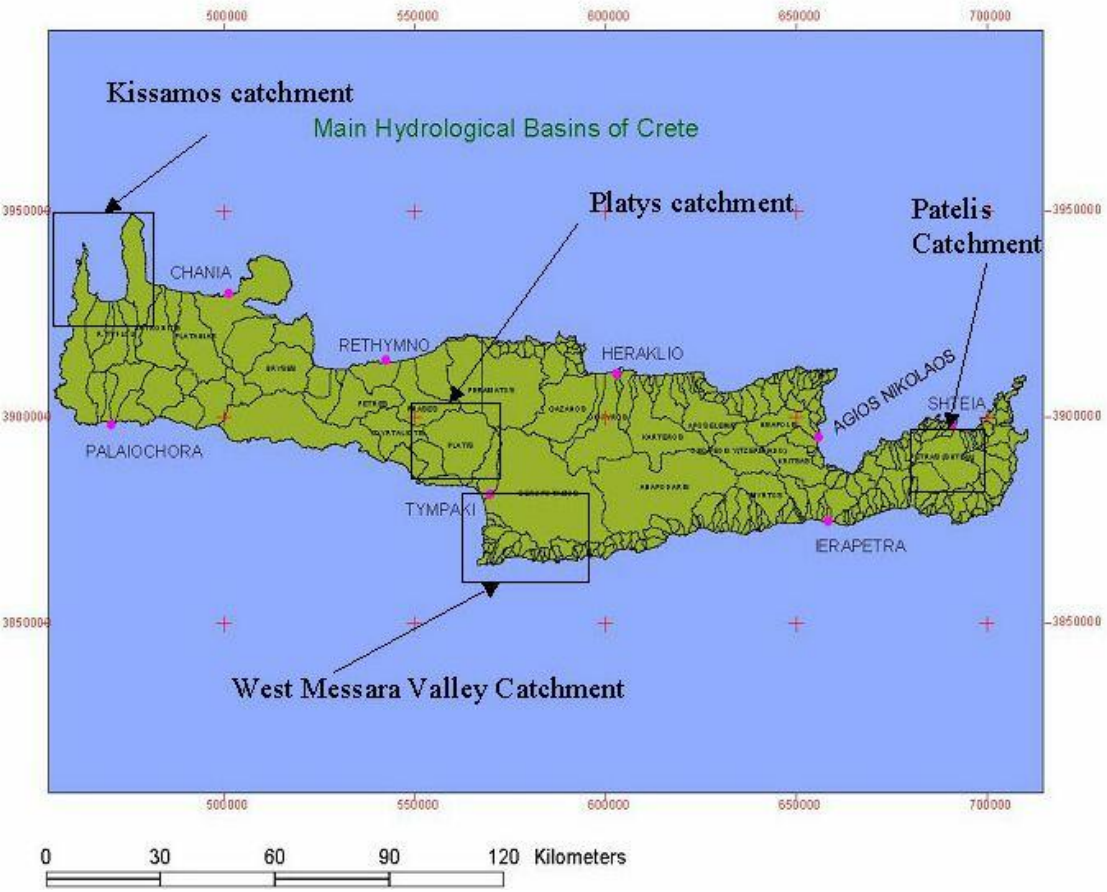

Figure 2.1: Main hydrological basins of Crete

2.1 West Messara Valley Catchment

Messara valley catchment covers an area of 398 km^2 and is located in the central-southern part of Crete, about 50 km south of the city of Heraklion (figure 2.1.1). The valley constitutes the most important agricultural region of Crete. It is also the site of the Minoan palace of Phaistos and the Roman city of Gortys. About 250 km^2 of the total

Valley area of 398 km^2 are cultivated. The main land use activities are olive-growing and grape vine cultivation. The remainder of the land is used for vegetable, fruit and cereal growing. The Messara valley has remained rural with a small population of about 40,000 inhabitants. The main source of irrigation water is groundwater as there is little surface water flow outside the winter months.

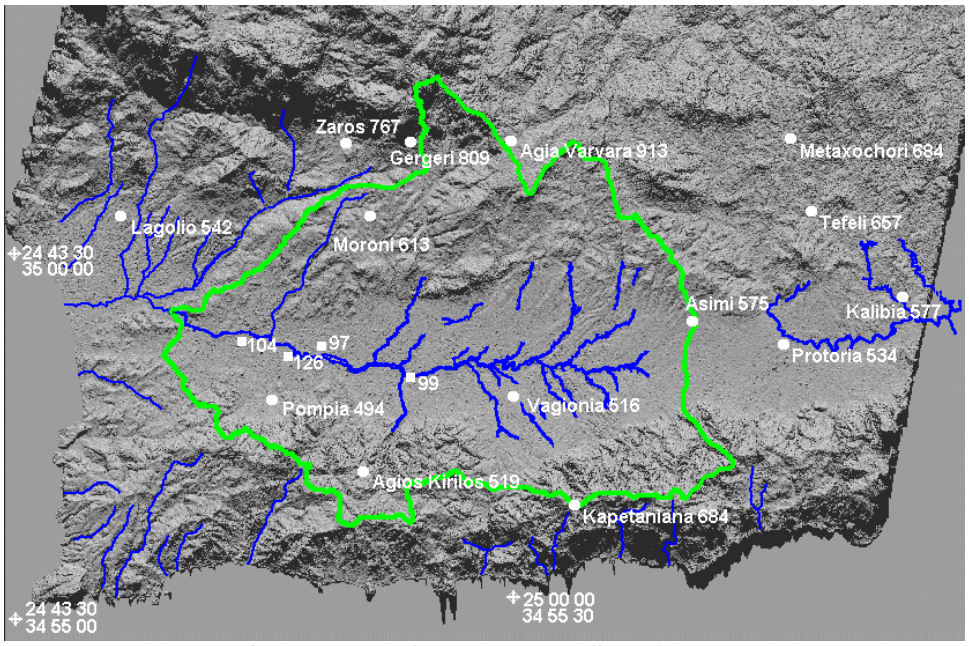

Figure 2.1.1: The Messara Valley of Crete

Shown are the sites of rainfall gauge stations, with means annual precipitation following the name of each site. The Valley's river outlet is at the Phaistos constriction in the west, beyond which is the small coastal Timbaki plain. Boreholes 97, 99,104 and 126 are shown near the Geropotamos River (Source: Vardavas et al., 1996, by permission Department of Geography, University of Cambridge).

Groundwater is the key resource controlling the economic development of the region; it is also a component of the environment under siege as water demand has increased dramatically within the last ten years. The groundwater level is thus an important index for assessing both anthropogenic and climatic causes of desertification in the Valley.

Following the detailed agricultural development study conducted by the UN Food and Agriculture Organisation in 1972 (FAO, 1972) on the exploitation of the Valley's water resources, an extensive network of pumping stations has been installed since 1984, which has converted what used to be dry cultivation of olive trees to drip-irrigated cultivation. The consequences are a rise in productivity and a dramatic drop of 20 m in the groundwater level.

Relief and Geology

The West Messara Valley catchment covers an area of 398 km^2 comprising an east-west plain of 112 km^2 about 25 km long and about 3 km wide with steeply rising mountains on the north and the south side. To the north, the divide varies from 1700 m to 600 m from west to east, with the highest point being part of the Idi mountain range (peak at 2540 m), which is a limestone massif. To the south there is the Asterousia mountain chain, which rises from 600 m in the west to 1200 m in the east and

constitutes the most southern mountain range of Europe. At the Phaistos constriction in the west, the catchment outlet of the Geropotamos River is at 30 m above sea level (ASL).

The catchment area of the northern slopes covers 160 km^2 while the southern slopes constitute a catchment area of 126 km^2.

Mainly quaternary alluvial clays, silts, sands and gravels with thickness from a few meters to 100 m or more, cover the plain. The inhomogeneities of the plain deposits give rise to great variations in the hydrogeological conditions even over small distances. The northern slopes are mainly silty-marly Neogene formations while the southern slopes are mainly schists and limestone Mesozoic formations. The outlet of the catchment is narrow, confined to a channel cut into an impermeable barrier of lower Tertiary near Phaistos. The geology of the catchment is shown in figure 2.1.2.

The study area encompasses the Mires basin and the up thrown Vayionia block. The major groundwater basins and surface water catchments are depicted in figure 2.1.3. The Mires basin is a down faulted trough roughly 14 km long and an average of 3 km wide. The trough is filled with alluvial sediments of Quaternary to Recent age, which form an extremely variable and complex inter-bedded sequence of gravels, gravely sands, sands, silts, silty sands and clays. This gives rise to a multi-aquifer system in which permeable sand and gravel horizons are locally separated both laterally and vertically by less permeable clays and silts. An area of particularly coarse gravel is present in the trough at the point where the Litheos River discharges into the valley. Material derided from adjacent sandstone (Flysch) has been deposited as a fan, 3 km long and 1.5 km wide. These gravels are productive aquifers. Other smaller fan deposits occur in several bay-like depressions at the foot of the Asterousia Mountains to the south, but these are not as extensive or important as the Litheos fan.

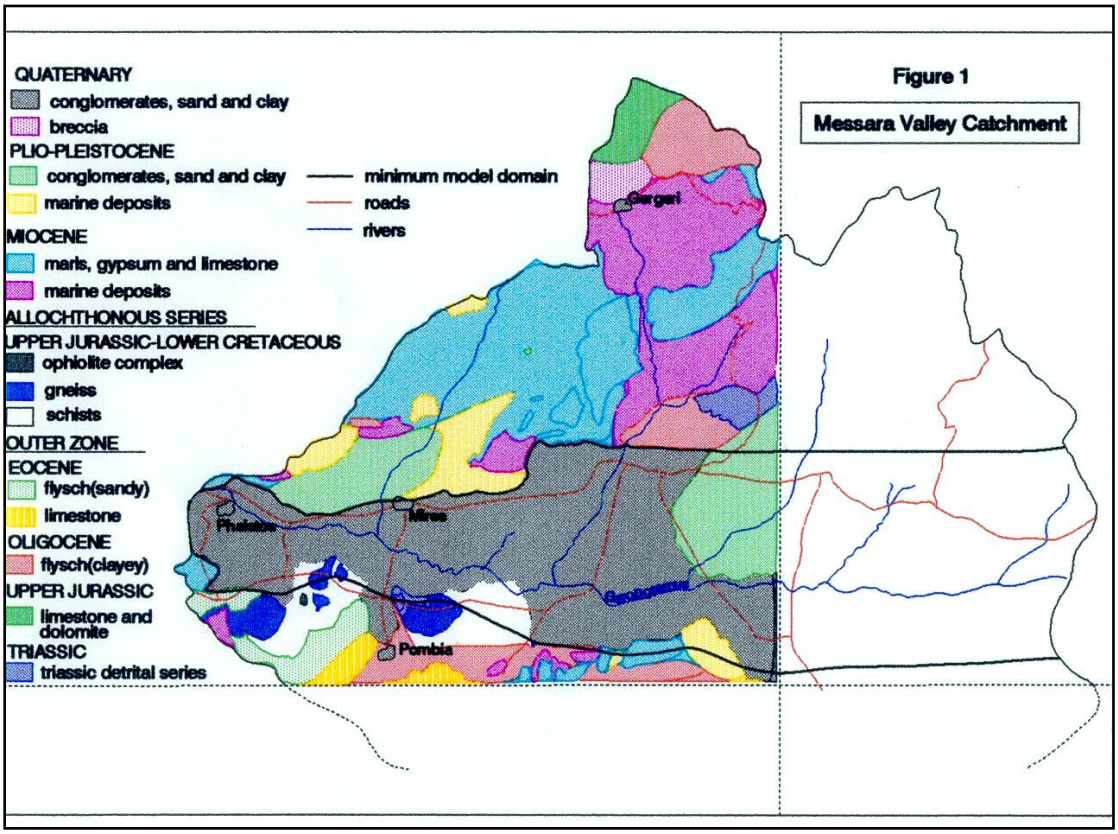

Figure 2.1.2: Geological map of Messara Valley

Geophysical surveys have revealed the flanks of the Mires basin to be steep-sided, which may reflect the presence of E-W trending step faults, or the bank of an erosional channel cut into the underlying lower Pleistocene sediments. Whatever is the true nature of the trough boundaries, extensive faulting parallel to and across the valley is present and has resulted in a variable thickness of alluvium throughout the basin. The elevation of the base of the alluvium-lower Pleistocene aquifer ranges from –50 to +100 m A.O.D., the lowest points of the elongated trough being to the NE of Petrokefali and N of Koustouliana. This surface is based on the elevation of the lowest permeable unit identified from borehole logs. The saturated thickness ranges from less than 20 m to over 100 m in the lowest part of the trough. The aquifer unit as a whole comprises an alternating sequence of clays, silts, sands and gravels; the thickness will inevitably include a substantial proportion of impermeable material (An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996).

The Vayionia block is an up-faulted block of lower Pleistocene-upper Pliocene age, which extends eastward from the longitude of Agioi Deka to the surface water divide near Asimi. The block is 12 km long and 5 km wide. In this region the ground surface is much more undulating than the Mires basin, and the gradient of the Valley floor increases from 1:150 to 1:75. The lithology is complex and comprises a variable sequence of fluvial and lacustrine conglomerates, sandstones, siltstones and silty clays with a thin mantle of alluvial sediments covering the southern half of the region. Drilling and pumping tests showed the region to be poorly productive. The lithology is dominantly clayey or marly with sandstone and conglomerate horizons being thin and few in numbers. Moreover, surface cementation is widespread and infiltration is severely

inhibited. Nevertheless, under natural conditions there is sufficient water in storage to supply a number of perennial springs, which provide some base flow to the Geropotamos River in the dry season. The base of aquifers in the Vayionia block is difficult to determine, partly because borehole records are scant and partly because in some cases it is difficult to recognise any aquifer at all. Saturated aquifer thickness ranges from less than 20 m to over 70 m (An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996). A simplified geology of the west Messara catchment is shown in figure 2.1.4.

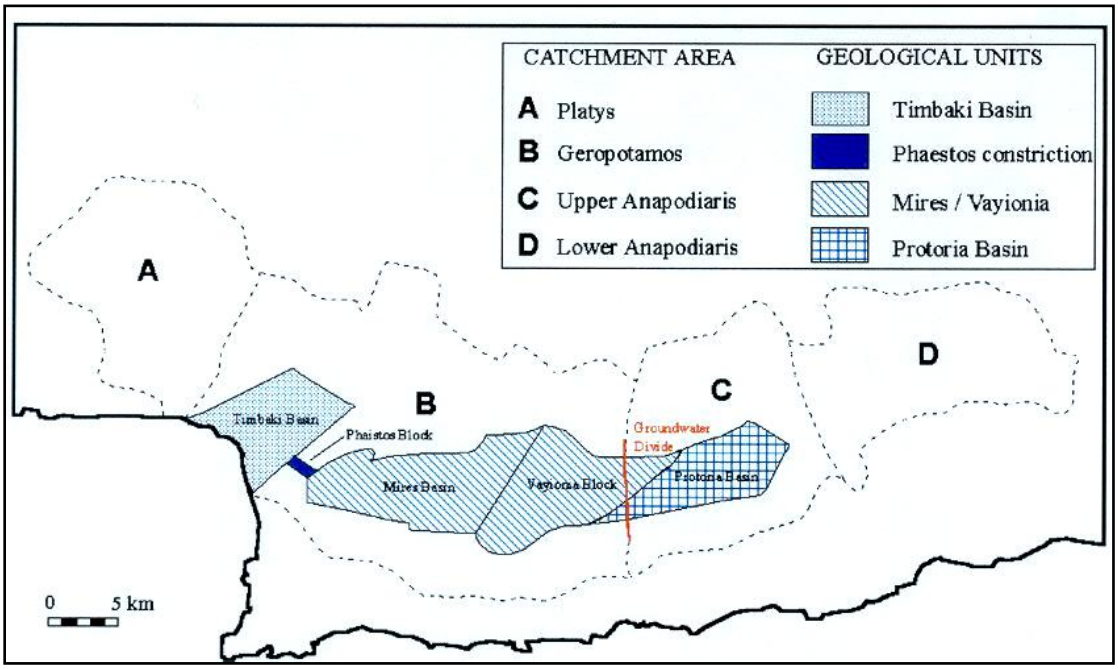

Figure 2.1.3: The major groundwater basins and surface water catchments (Source: An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996)

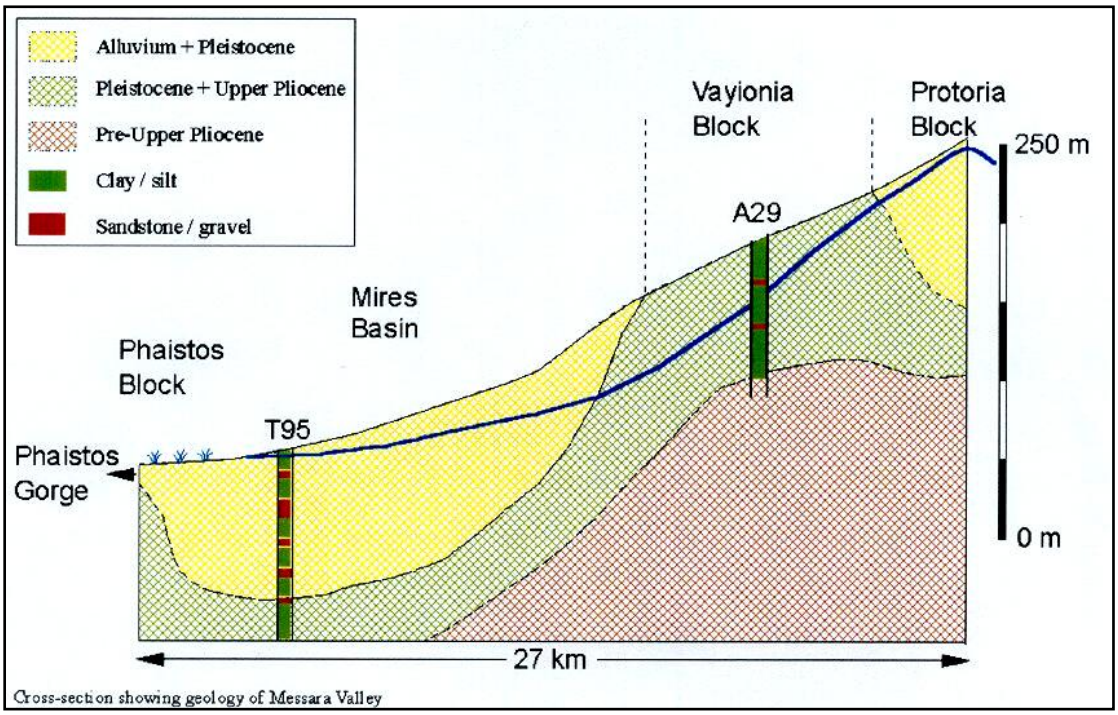

Figure 2.1.4(a): Simplified geology of the West Messara catchment
(Source: An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996).

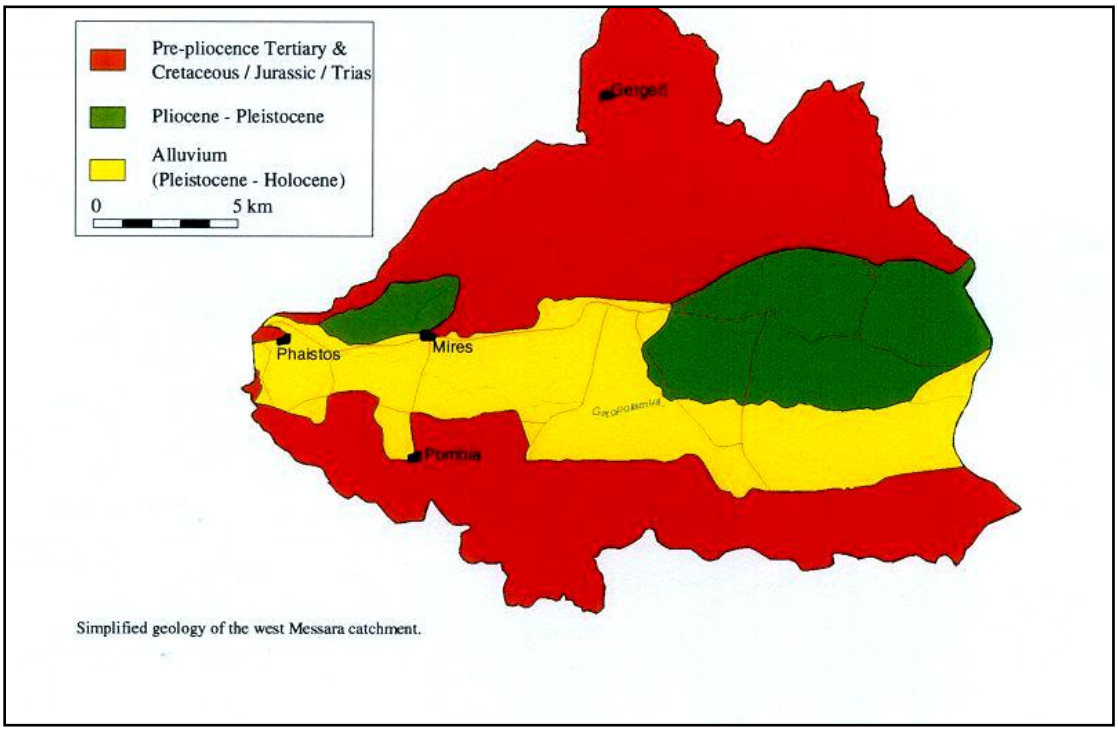

Figure 2.1.4(b): Simplified geology of the West Messara catchment
(Source: An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996).

Climate and Hydrology

The climate of the Valley is sub-humid with mild, moist winters and dry, almost cloud-free, hot summers. The hydrological year may be divided into a wet and dry season.

About 40% of precipitation occurs in the months of December and January while from June to August there is negligible rainfall. Although the valley receives on average of 600 mm of rainfall per year it is estimated that about 65% is lost to evapotranspiration, 10% as runoff to the sea and only 25% goes to recharging the groundwater store. Pan evaporation is estimated at 1500 ± 300 mm per year while the winds are mainly westerly. The potential evaporation is estimated at 1300 mm per year (Vardavas, 1994) and so the ratio of mean annual rainfall to potential evaporation for the valley is about 0.5 and it is hence classified as dry sub-humid according to UNCED (1994) definitions. The average winter temperature is 12°C while for summer it is 28°C. Relative humidity in winter is about 70% while in summer it is about 60%.

The Department of Agriculture in Crete has monitored the valley's water resources for around thirty years. There are daily measurements of rainfall from 15 stations. The mean annual rainfall for the different stations in Messara valley is shown in figure 2.1.5

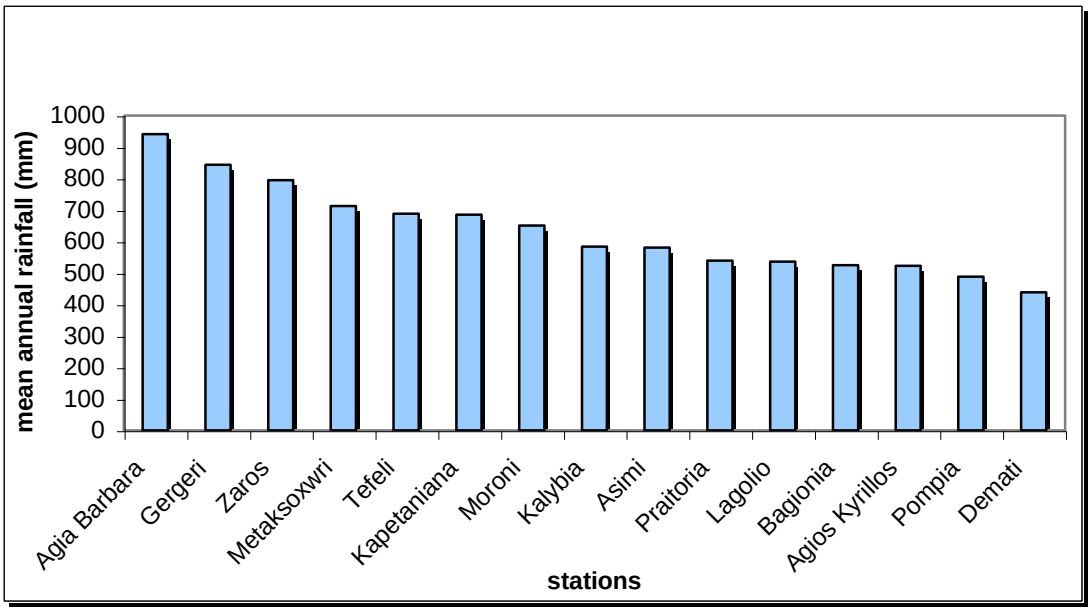

Figure 2.1.5: Rainfall distribution in Messara Valley

Rainfall increases with elevation from about 500 mm on the plain to about 800 mm on the valley slopes and 1100 mm on the Asterousian Mountains. There is a variation in the measured rainfall with increasing elevation. Figure 2.1.6 shows the total rainfall for 1970 for the 15 stations plotted against their elevation. The south side of the catchment clearly has a lesser dependence of rainfall with elevation compared with the north side. For the north and south side, the rainfall shows a linear trend with elevation, with the fits being, respectively:

$P_i = 361 + 0.94z_i$

$P_i = 470 + 0.19z_i$

P_i and z_i = rainfall (mm) and the elevation (m) of a particular location in the catchment

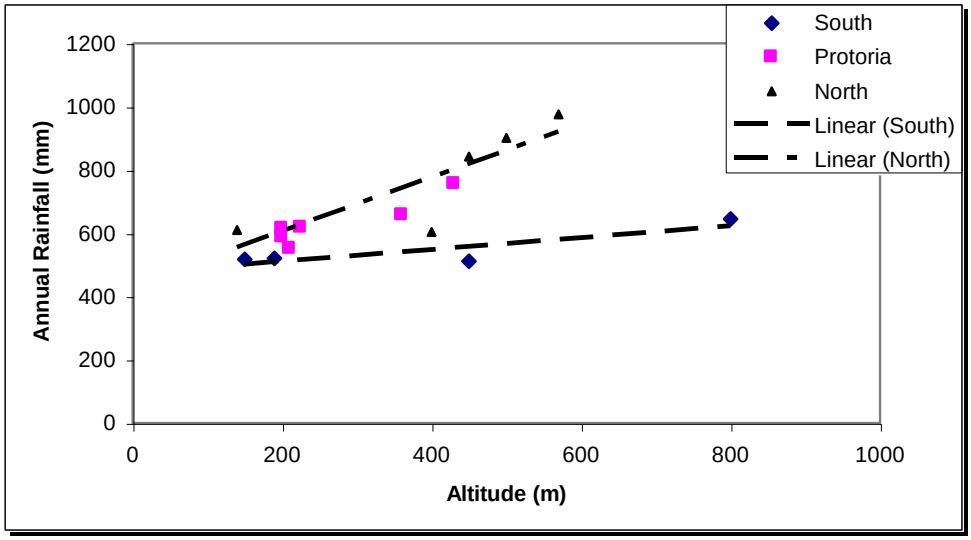

Figure 2.1.6: Rainfall for each of the 15 stations plotted against elevation
Data from three regions are shown: north and south of the catchment, and in the neighboring Protoria basin (which closely matches the distribution for the north of the catchment).

Demati is one of the rainfall stations showing lowest mean annual precipitation of the existing stations in Crete. Figure 2.1.7 shows the mean annual rainfall for Messara for the years 1969 to 1998. As shown in the figure, the driest year was the hydrological year 1989-1990 and the wettest year was the hydrological year 1977-1978.

Figure 2.1.8 depicts the mean monthly rainfall for the catchment. The wet season lasts from November to March or April while the dry season extends form June till October.

There are five stations measuring pan evaporation in Messara Valley. For these stations daily pan evaporation values exist since 1969. The mean annual measured pan evaporation for each of these stations is shown in figure 2.1.9. The mean annual pan evaporation for Messara Valley is depicted in figure 2.1.10. Pan evaporation is estimated at 1500 ± 300 mm per year.

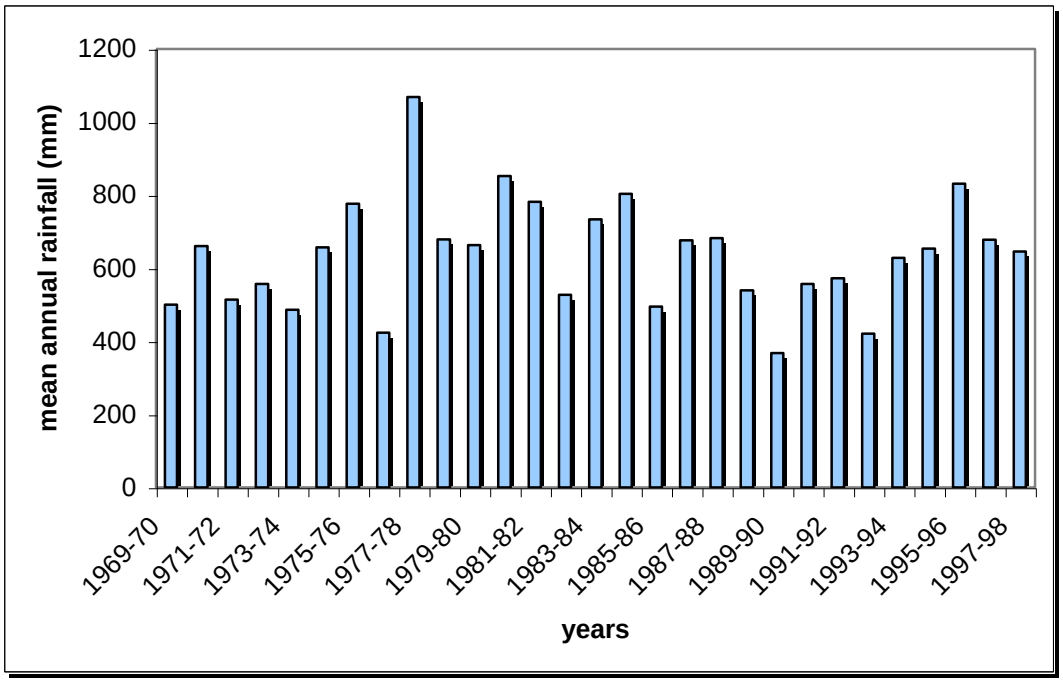

Figure 2.1.7: Mean annual rainfall for Messara Valley

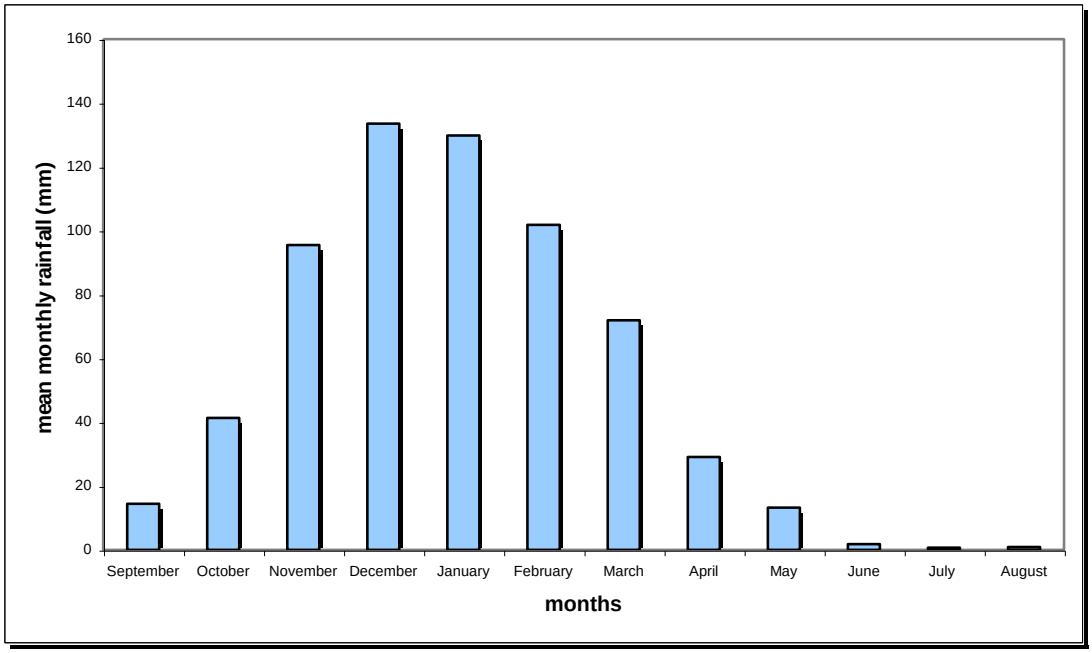

Figure 2.1.8: Mean monthly rainfall for Messara Valley

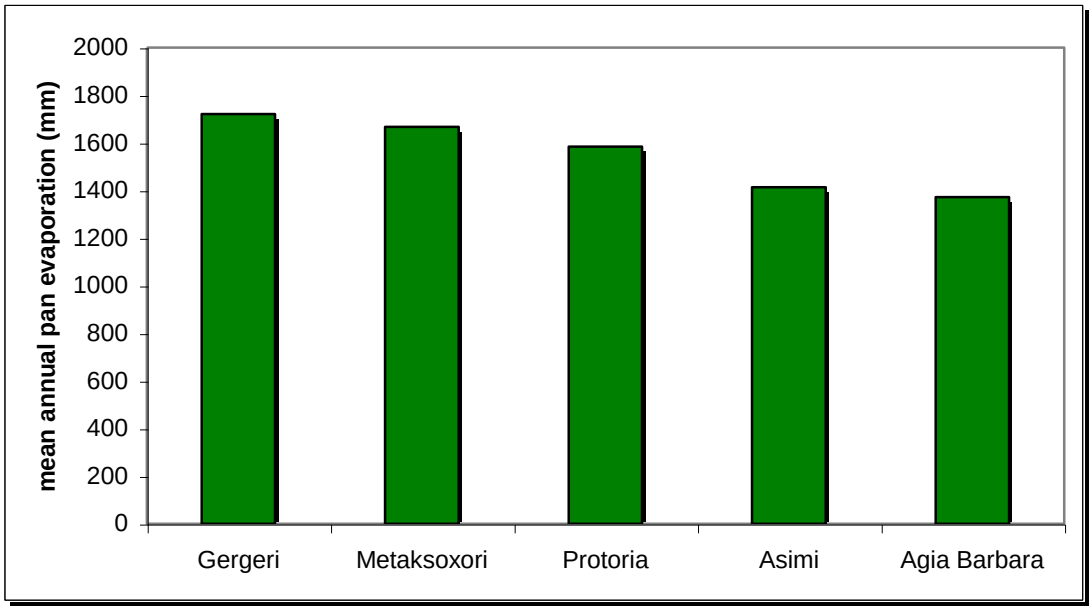

Figure 2.1.9: Pan evaporation for different stations in Messara Valley

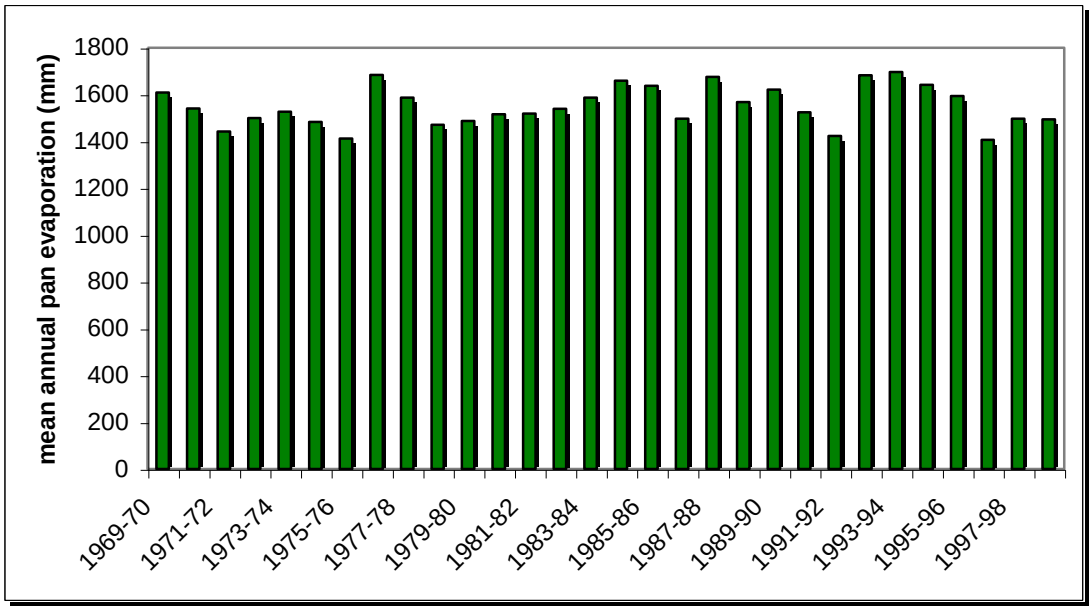

Figure 2.1.10: Pan evaporation for Messara Valley

The highest values of pan evaporation are observed in July while the lowest occur in December and January. Pan evaporation ranges form 38 mm in January to 270 mm in July. Gergeri station shows the greatest range between lowest and highest pan evaporation values within a year, with an average pan evaporation ranging from 304.5 mm in July to 42.3 mm in January. Mean monthly pan evaporation for Messara Valley is shown in figure 2.1.11.

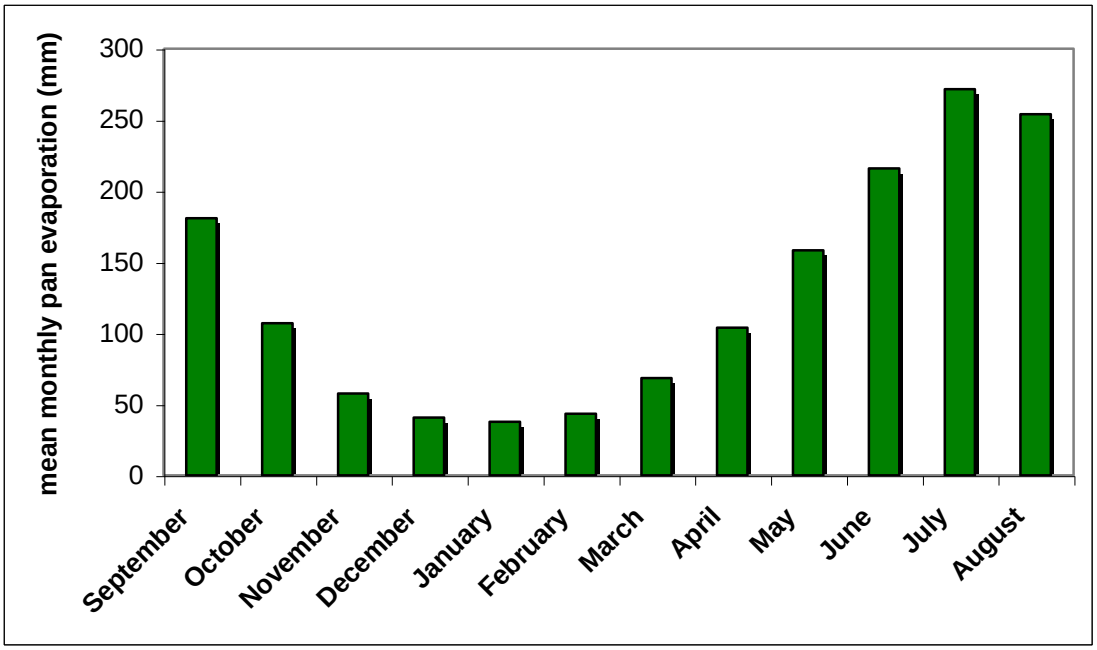

Figure 2.1.11: Mean monthly evaporation for Messara Valley

Potential evaporation is estimated from data of the five pan evaporation stations and using monthly mean lake-to-pan coefficients estimated from the potential evaporation via the Penman equation, which requires meteorological and surface radiation budget data. A comparison between the monthly mean Penman evaporation and the mean pan evaporation data available for the catchment, gives an estimate of the monthly variation

of the pan coefficient. Vardavas et al., 1997, have estimated the mean monthly pan coefficients for Messara Valley (figure 2.1.12)

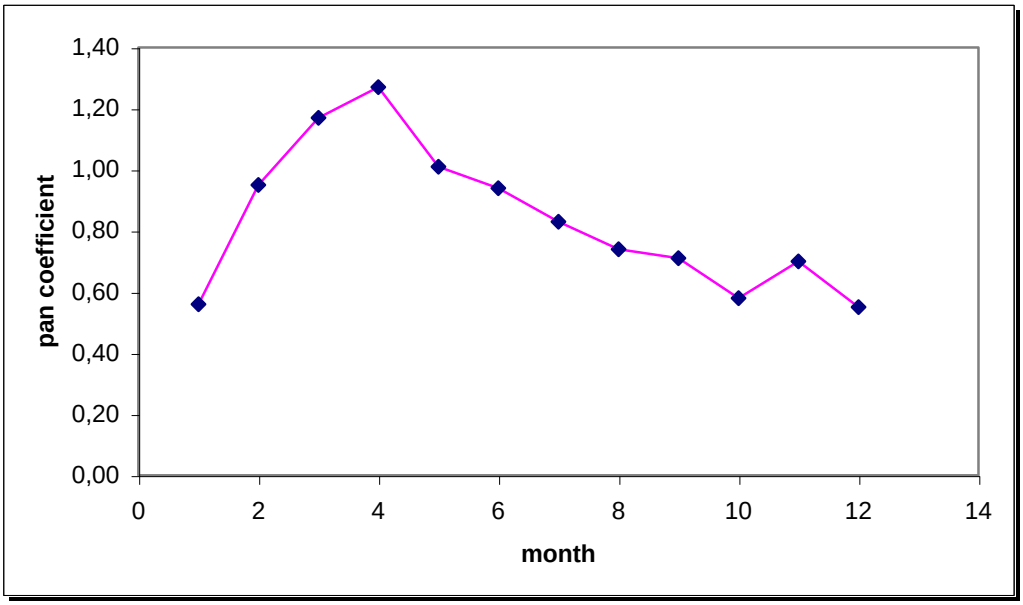

Figure 2.1.12: Monthly mean pan coefficient

The mean annual temperature for Messara Valley is estimated at 17 $\pm 2^{o}$C. Temperature is measured in three different stations in the valley. The mean annual temperature for the different stations and the valley are shown in figures 2.1.13 and 2.1.14.

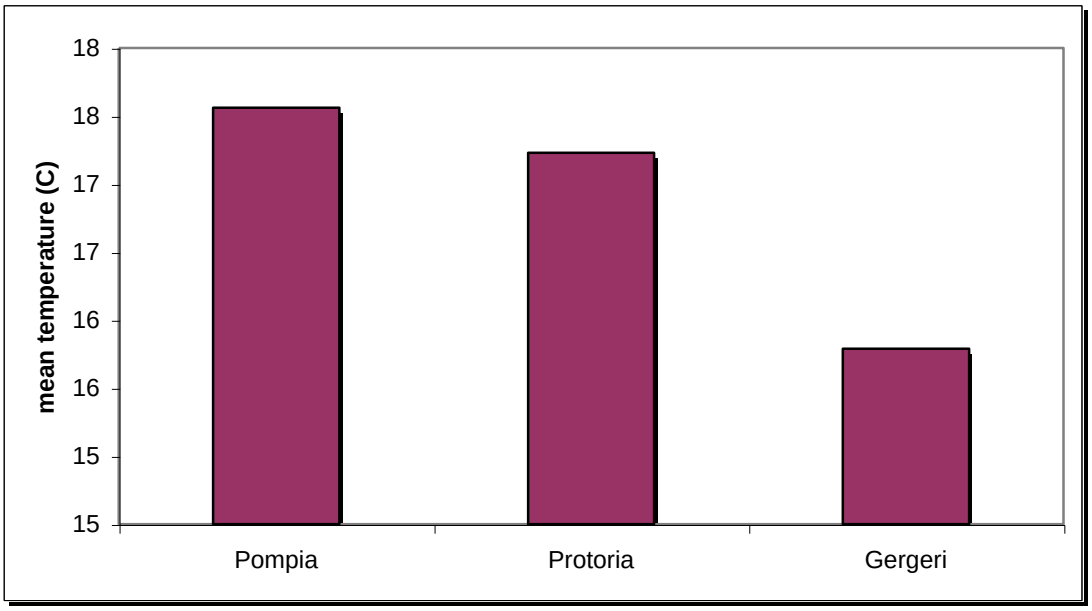

Figure 2.1.13: Mean annual temperature for different stations in Messara

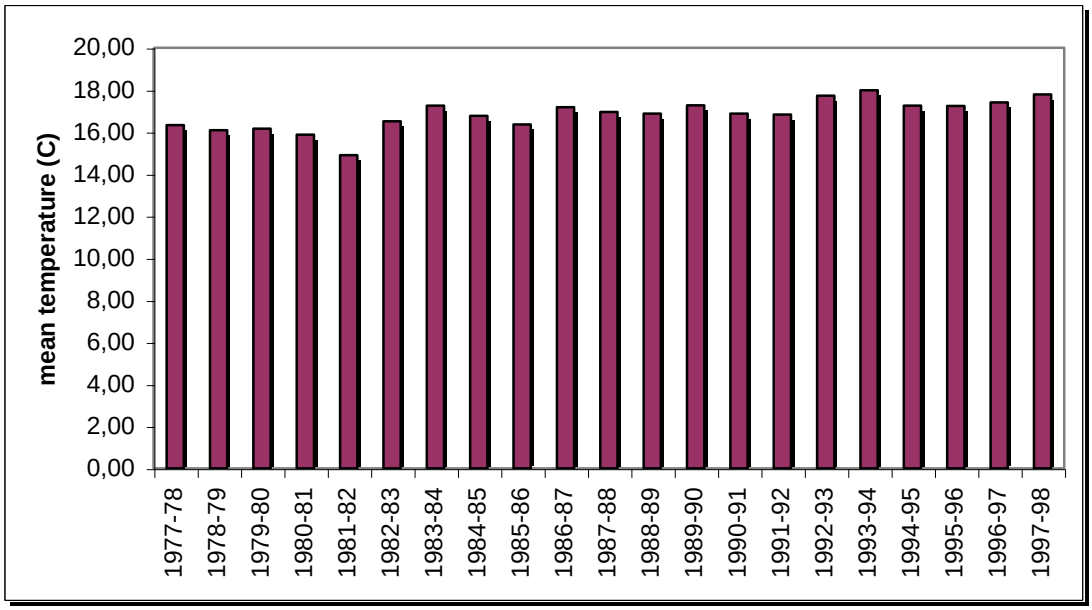

Figure 2.1.14: Mean annual temperature for Messara valley

The lowest mean monthly temperatures are observed in January and February (9.6^{o}C) and the highest in July and August (25-26 ^{o}C). The average winter temperature is 12°C while for summer it is 28°C. The mean monthly temperature for the valley is shown in figure 2.1.15.

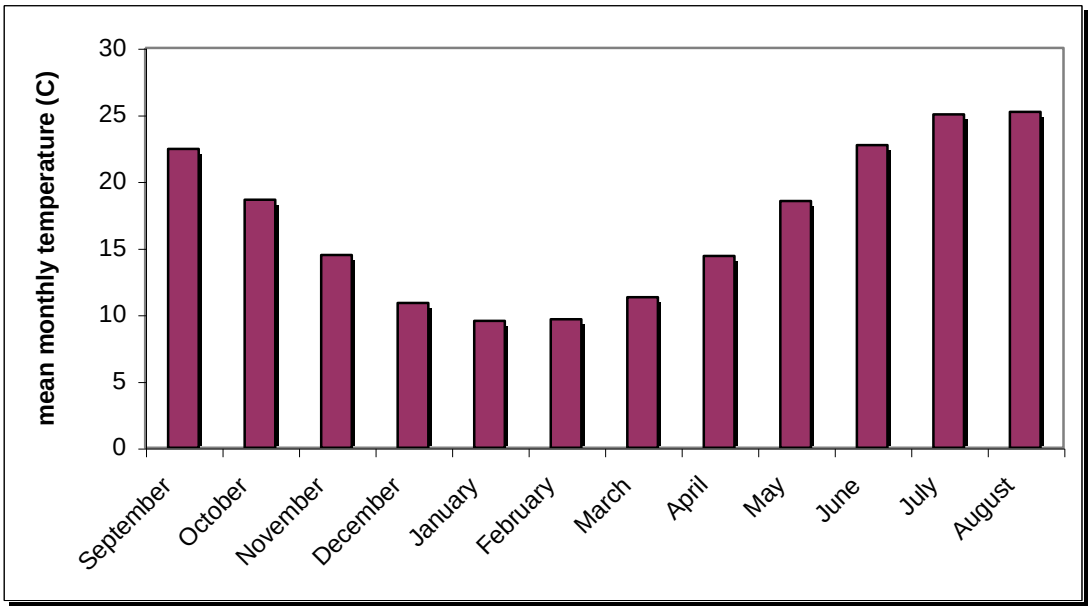

Figure 2.1.15: Mean monthly temperature for Messara valley

Surface water

The main outlet of the catchment is the Geropotamos River at the Phaistos constriction in the west. The catchment outlet of Geropotamos River is at 30 m above sea level (ASL). In addition, the outlet of the catchment is narrow, confined to a channel cut into an impermeable barrier of lower Tertiary near Phaistos. In its natural state, the Geropotamos River of the Messara Valley flowed continuously, and there was a wetland located near the catchment outlet.

The drop in the groundwater level has resulted in the wetland drying up, with no flow in the river in the dry season through the 1990 and even in the wet season of 1992. During the hydrological year 1992-1993 there was no river flow out of the Valley. This was the first time that the main riverbed remained dry according to the records. There are daily measurements of runoff at the Valley's outlet at Phaistos. The mean annual runoff is shown in figure 2.1.16. The mean annual runoff observed is 16.88 Mm^3. The mean monthly runoff for Geropotamos River, compared to other streams in Iraklion prefecture, is depicted in figure 2.1.17. The highest mean monthly runoff is observed in January and February and the lowest in July and August (figure 2.1.18).

The mean annual runoff coefficient for the valley is shown in figure 2.1.19. The mean runoff coefficient for the valley is 0.07 with a standard deviation of 0.05. This value of a runoff coefficient can be observed in catchments where pumping takes place.

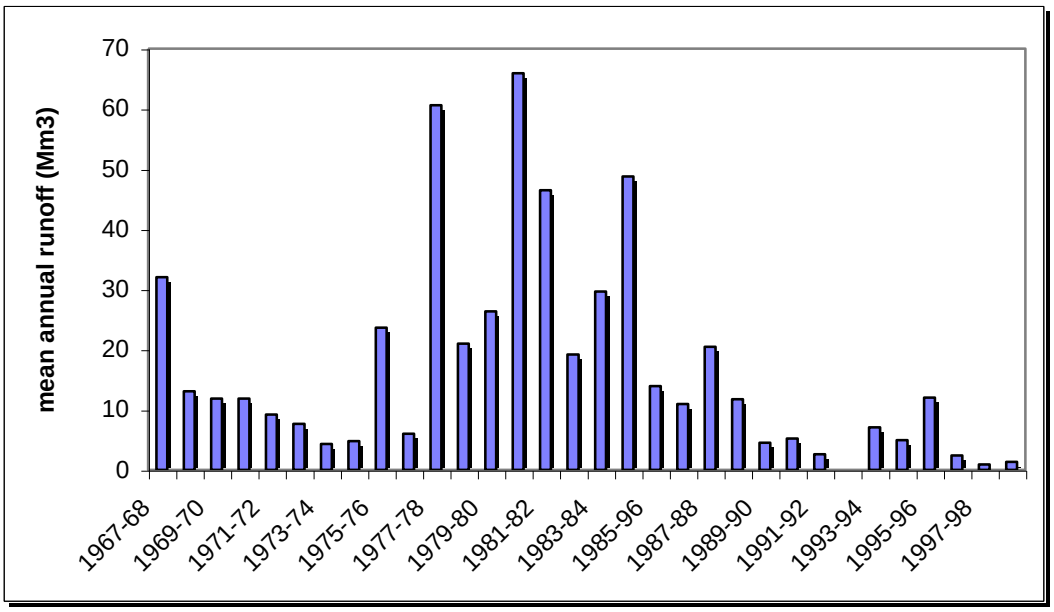

Figure 2.1.16: Mean annual runoff for Geropotamos River

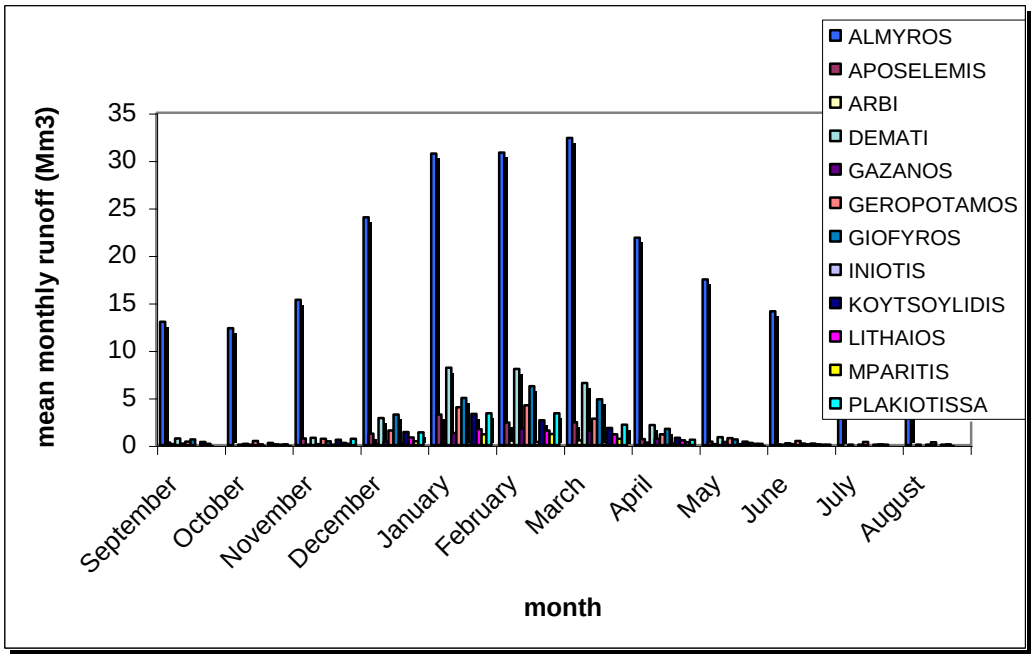

Figure 2.1.17: Geropotamos River compared to other rivers in Iraklion prefecture

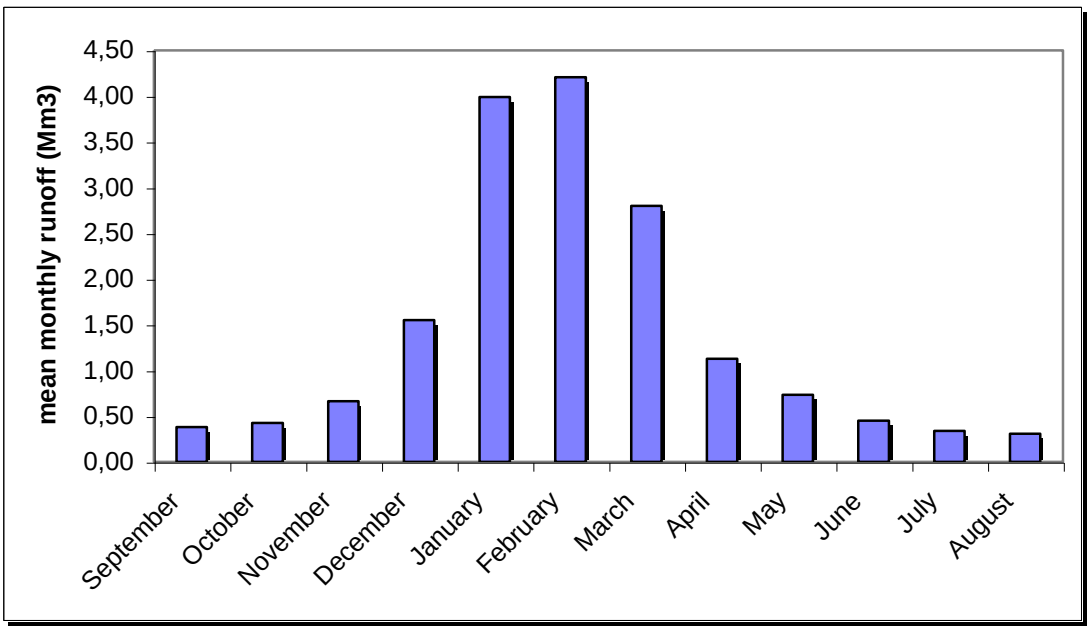

Figure 2.1.18: Mean monthly runoff for Geropotamos River

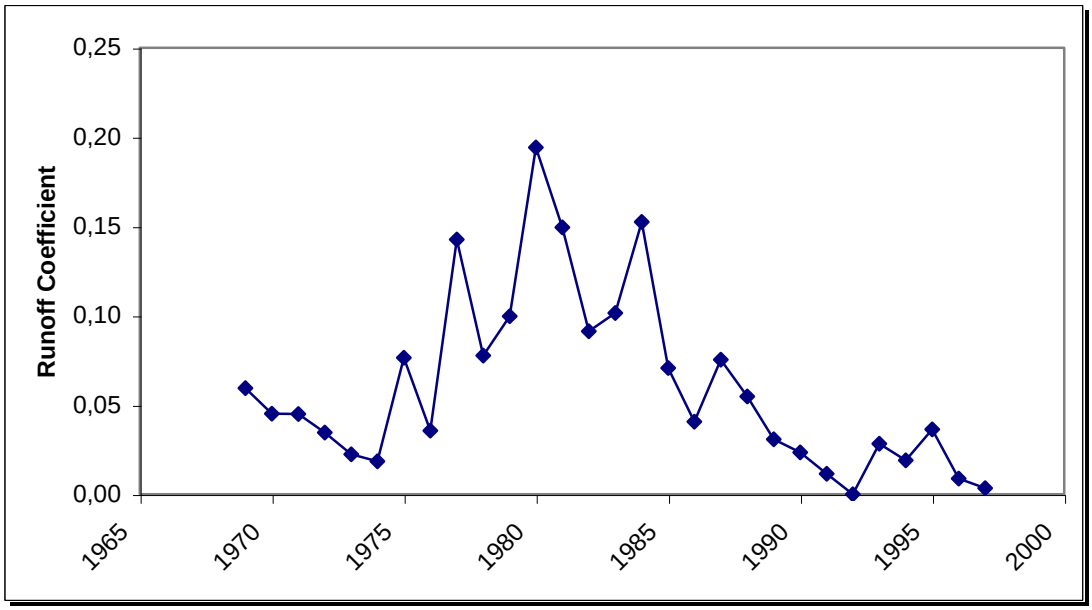

Figure 2.1.19: Annual runoff coefficient for Messara Valley for the period 1969 to 1997

Groundwater

The plain contains several aquifers and aquicludes of complex distribution and properties. There are monthly measures of groundwater levels for over 25 sites. Groundwater levels are maximum in March or April with long recessions until recharge occurs in winter. Figure 2.1.20 shows the groundwater levels within a year for a selected borehole in the Mires basin. The aquifers were high yielding with discharge rates as high as 300 m^3/hr in the early seventies but now are reduced to about one tenth of this. From pumping tests, the specific yield ranges between 0.1 and 0.2 while the horizontal transmissivity ranges between 0.1 and 0.01 m^2/s.

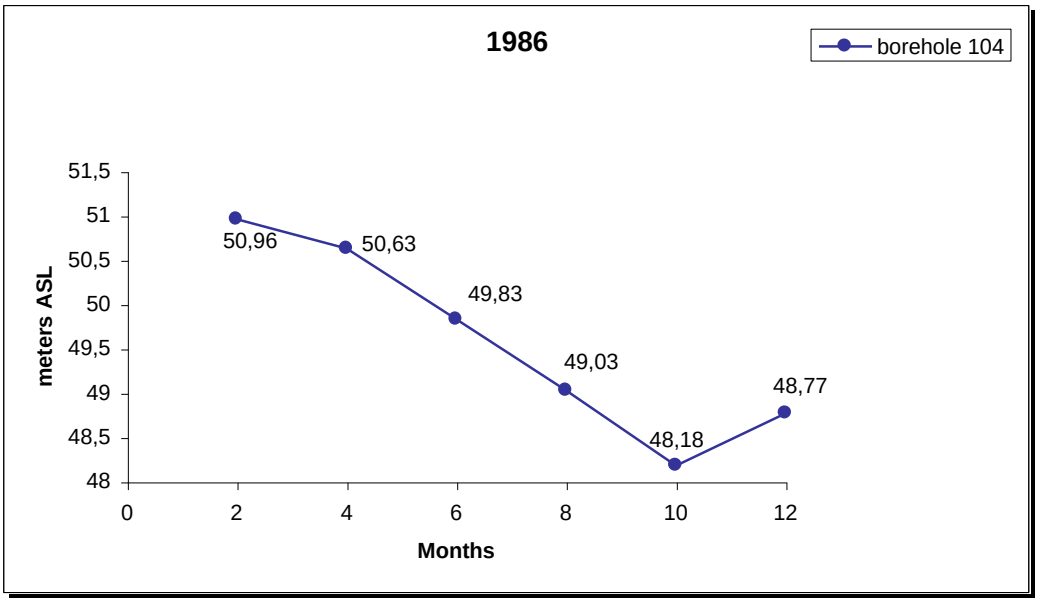

Figure 2.1.20: Annual variation of groundwater levels for borehole 104

Lateral groundwater outflow from the valley is small compared with the vertical groundwater outflow. An extensive network of pumping stations has been installed since 1984, which has converted what used to be dry cultivation of olive trees to drip-irrigated cultivation. It is estimated that around 10 Mm^3 of groundwater were pumped from the aquifer before the installation of the network, while after the installation of the network around 40 Mm^3 are being pumped per year. The consequences are a rise in productivity and a dramatic drop of 20 m in the groundwater level. At present, there is little surface runoff and the groundwater store is being depleted rapidly. Before the installation of the groundwater irrigation system, the average discharge out of the Valley was about 20 Mm^3/a corresponding to 50 mm of the annual rainfall lost as runoff to the sea. It is estimated that the annual recharge of the groundwater store was about 60 Mm^3/a (150 mm) and evapotranspiration loss was about 160 Mm^3/a (400 mm). The interannual variation in the groundwater level for a selected borehole can be seen in figure 2.1.21. The pattern of water level change is the same at each site; a period of declining water levels took place from 1971 to 1977, which is followed by a recovery until 1985 when water levels once again began to decline, a trend, which has persisted until the present day.

Most subsurface geological information is drawn from the logs of 26 exploration boreholes drilled in the area by FAO between 1968 and 1970. (Source: An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996). Most of the higher values of permeability are concentrated in the Mires basin, where permeabilities between 10 and 120 m/d reflect the presence of a large number of gravel and sand horizons in the alluvial sequence.

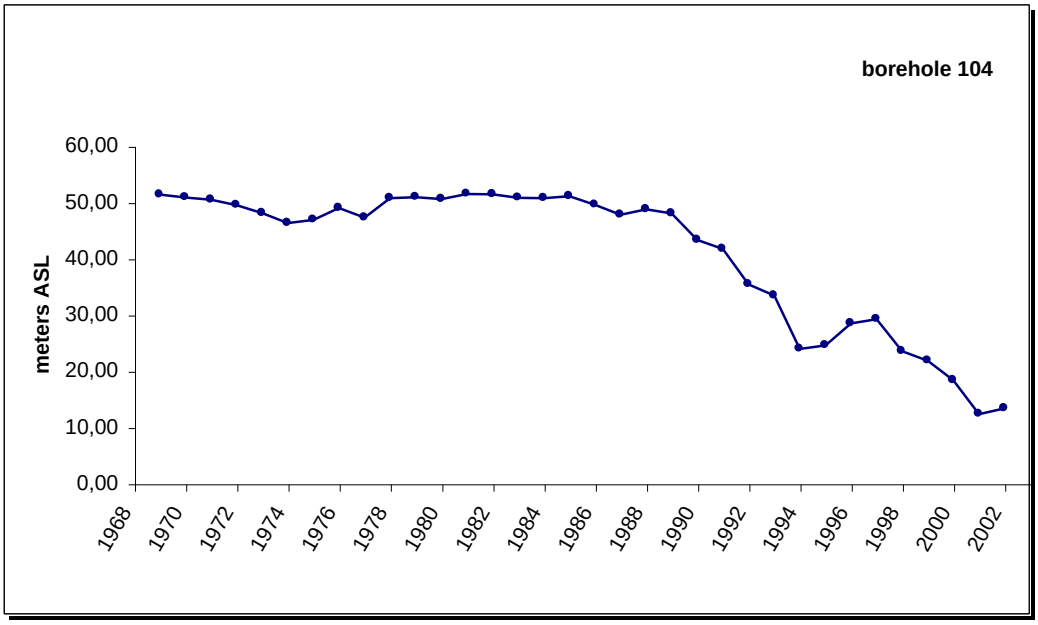

Figure 2.1.21: Interannual variation of groundwater level for borehole 104 for the years 1969 to 2002

The least permeable areas are in the Vayionia block, where the paucity of gravel and sand means that values are reduced to an average of only 1 m/d. Lower values also occur on the northern side of the Mires basin, where lower Pleistocene rocks, similar to those of the Vayionia block, crop out. Two regions of higher permeability occur in the eastern part of the area. The first is at the eastern boundary, where values increase locally to 40 m/d. A second area of high permeability is located in the southern part of the Vayionia block at the foot of the Asterousia Mountains. In this area permeabilities of up to 200 m/d are probably related to the presence of a small fluvial fan carrying a high percentage of coarse gravel (Source: An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996).

Aquifer storage coefficients have also been obtained from FAO pumping tests. Results from these tests and the nature of the water table show that although heterogeneous and locally confined, the aquifer at a regional scale behaves as an unconfined unit.

Agricultural situation

Messara Valley constitutes the most important agricultural region of Crete. About 250 km^2 of the total valley area of 398 km^2 are cultivated. Of the total area cultivated 56% are Tree crops (mostly olives cv Koroneiki), 10% are vines, 11% are row crops and 7% are vegetables (mostly in open fields and some greenhouses) (HNSS, 1999). Olives occupy mostly areas of flat land and show a steady increase in density of cover as one moves east along the Geropotamos River. Density also diminishes as slopes become steeper on the northern edge of the Timbaki and Mires plains. Vines are less widespread with two main concentrations to the south east of Mires and in extreme north east of the catchment. The distribution of arable farming is predominant in the area to the south and east of Mires and on flat ground in the vicinity of Gortyna. Glasshouses and market gardening dominate the Timbaki plain. The forest classes exist only in relatively inaccessible parts of steep gorges, which are not suitable for olives or farming and where water is accessible from river channels. The quite large areas of forest to the south and east of Psiloritis are protected by legislation. Vegetation on the upper slopes of Psiloritis is extremely sparse in a very rocky landscape (Source: An integrated Monitoring and Modelling study of Desertification and Climatic change Impacts in the Messara Valley of Crete, final scientific report, 1996).

Drip irrigation is used for olive orchards and tree crops, micro-sprinklers for potatoes and drip irrigation for the rest of the vegetables. The amount of the water applied is empirically defined. Empirically, various forms of N-fertilizers are applied during the winter, after harvest. Weed control is performed with tillage (80%), while herbicides are used rarely.

Cultivated crops and cultivated land

Of the total crops cultivated more than 50% are olives (cv Koroneiki), 10% is vines, 2% are citrus and 7% are vegetables (mostly open field and some greenhouses) (Fig. 1.2.7.4). Olives occupy most areas of flat land and exhibit a steady increase in density of cover as one moves east along the Geropotamos River. Density also diminishes as slopes become steeper on the northern edge of the Timbaki and Mires plains. Vines are less widespread with two main concentrations to the south east of Mires and in extreme north east of the catchment. The distribution of arable farming is predominant in the area

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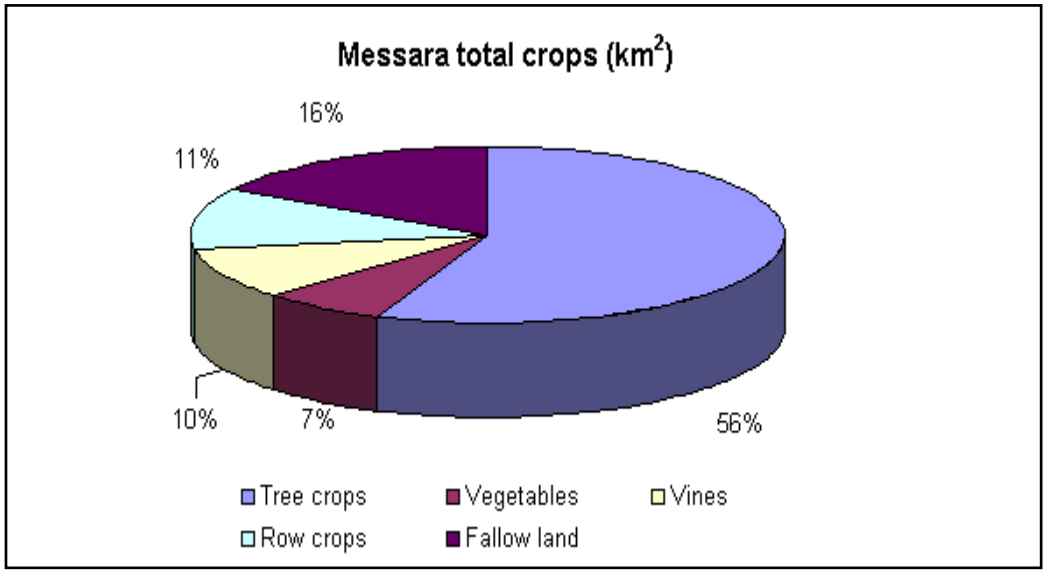

Figure 2.1.22: Crops cultivated in Messara catchment (HNSS 1999)

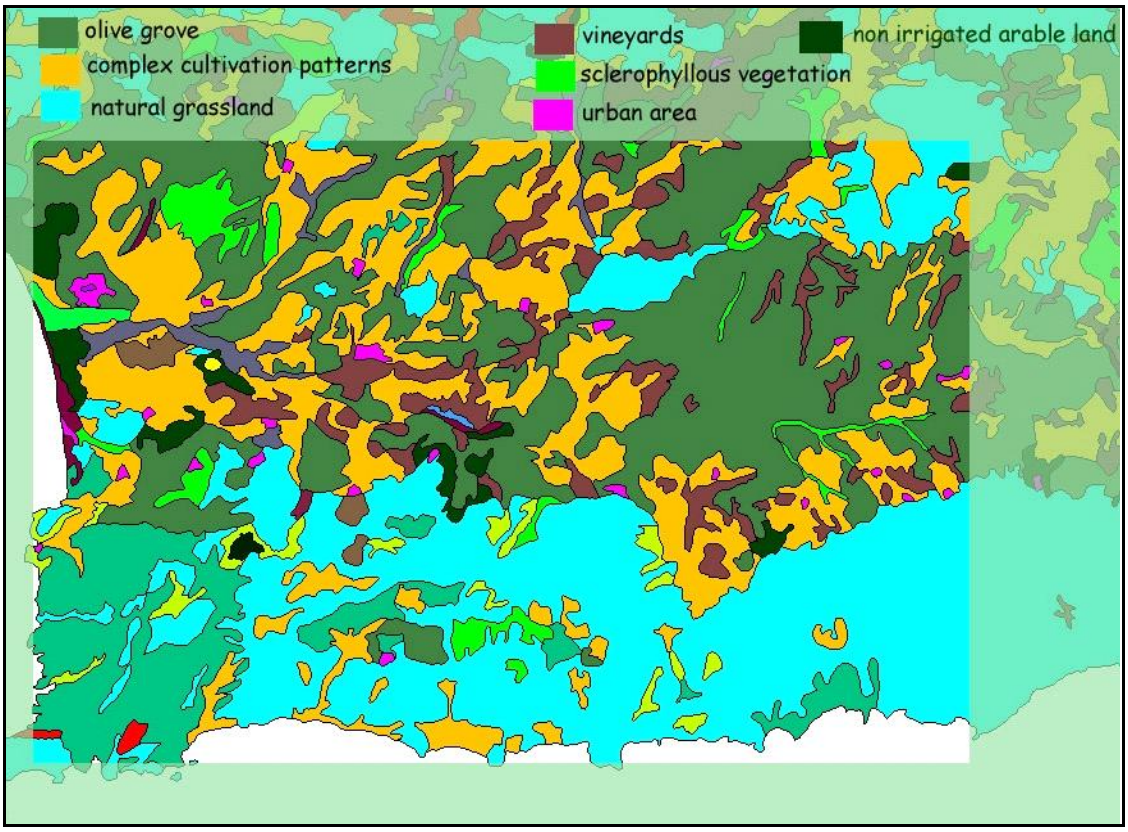

Figure 2.1.23: Landcover classification in Messara Valley (CORINE)

Irrigation systems and scheduling

Drip irrigation is widely used for olive orchards and tree crops, micro-sprinklers for potatoes and drip irrigation for the rest of the vegetables. Modern type irrigation systems are used the last decade increasing the water use efficiency. The amount of the water applied is empirically defined and it comes from drills. Messara valley is separated into 4 irrigation zones and water price varies from 0,10 – 0,13 €/m^3. The biggest TOEB (Local Board of Water Management) in Messara that irrigates 350000 ha, has set limitations in water use for each crop and any exceeding of this limit, has financial penalty for the farmer.

Crop water requirements

Reference evapotranspiration was estimated in three stations in Messara catchment for the period 1975 - 2001 (Pombia at southern part of the catchment, Zaros at north and Protoria at the eastern part). The average reference evapotranspiration of the three stations was used in order crop evapotranspiration to be estimated for Messara catchment using the Penman – Monteith (FAO 56) method. Missing data were filled from Gergeri and Timbaki stations. Crop water requirements for the main crops in the catchment are presented on Table 1.2.7.1. In estimating crop water requirements for greenhouses, the water required for salt dilution and percolation, is not taken into account.

Table 2.1.1. Crop water requirements in Messara catchment

Crop	Crop water requirements (m^{3}x10^2/ha)												
	J	F	M	A	M	J	J	A	S	O	N	D	**SUM**
Olives	-	-	-	-	3.5	6.0	7.5	7.0	4.0	(1.0)*	-	-	**28.0 (29.0)***
Citrus	-	-	-	-	7.5	11.0	14.0	12.5	8.0	4.0	-	-	**57.0**
Table vines	-	-	-	-	-	9.0	11.5	10.0	(6.5)*	-	-	-	**30.5 (37.0)***
Vines for wine	-	-	-	-	-	9.0	11.5	-	-	-	-	-	**20.5**
Greenhouse tomato (Oct – May)	2.0	2.0	3.5	5.5	11.0	-	-	-	-	3.5	2.5	2.0	**32.0**
Greenhouse cucumber (Aug – Nov)	-	-	-	-	-	-	-	4.5	10.0	9.0	6.0	-	**29.5**
Greenhouse cucumber (Mar – Jun)	-	-	3.5	7.0	9.5	10.0	-	-	-	-	-	-	**30.0**
Watermelon (Mar – Jun)	-	-	1.5	5.0	10.0	14.0	(18.0)*	-	-	-	-	-	**30.5 (48.5)***
Watermelon (May – Aug)	-	-		-	7.0	12.0	18.0	15.0	-	-	-	-	**52.0**
Melon	-	-	1.5	5.0	9.5	13.0	-	-	-	-	-	-	**29.0**
Potatoes (spring)	-	-	2.0	5.5	9.0	13.0	-	-	-	-	-	-	**29.5**
Tomatoes open (Jun – Oct)	-	-	-	-	-	8.0	12.5	14.5	10.0	5.0	-	-	**50.0**
Tomatoes open (Aug – Nov)	-	-	-	-	-	-	-	9.0	7.5	5.0	1.5	-	**23.0**

* Additional irrigation due to low rainfall and/or high temperatures and/or extended crop

Taking into account the estimated crop water requirements, citrus is the most highly water demanding crop in Messara catchment, followed by watermelon and vegetables (open field tomatoes). Table vines seem to need a significant amount of water but the area they take among the other crops is not very large.

Fertilisers

Various forms of N-fertilizers applied empirically during winter, after harvest is over, are used. Of the four catchments in Crete, fertigation (application of fertilizers through the irrigation system) is more frequent in Messara and it is usually applied in vegetables crops.

Weed control

Weed control is mostly done with tillage with milling machinery, while herbicides are used in some areas usually in addition to tillage when needed and rarely as a sole weed control technique.

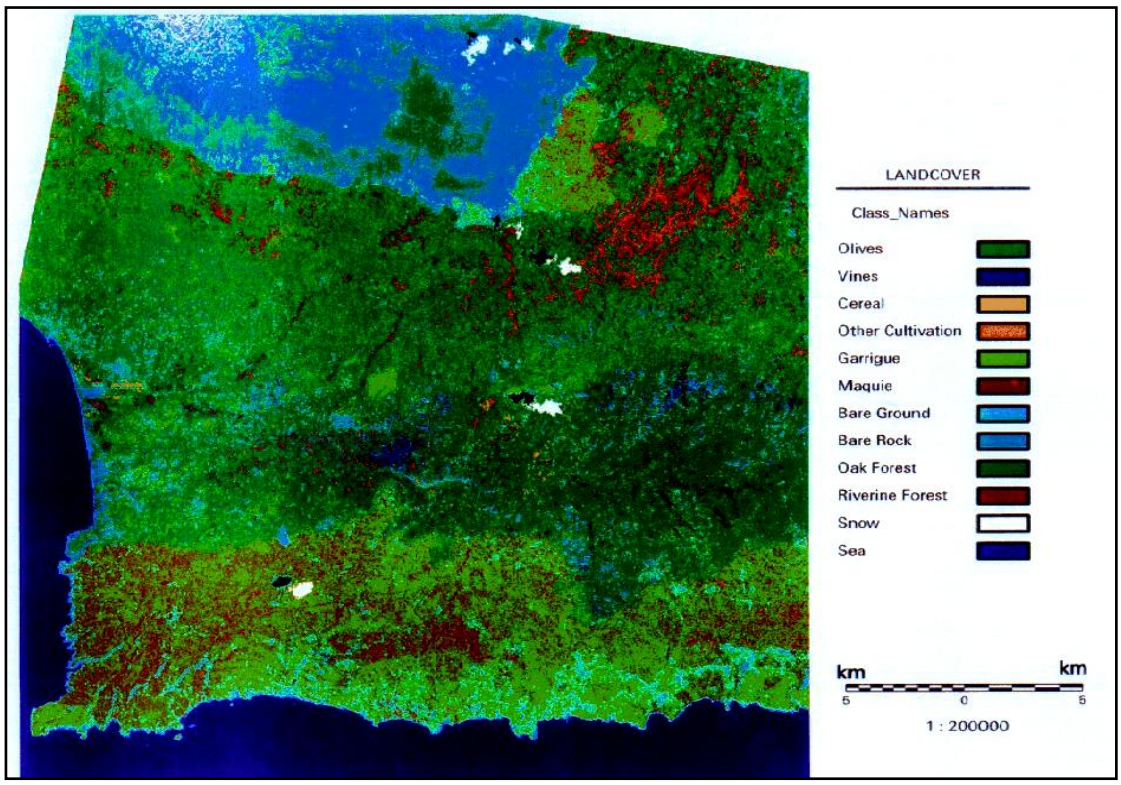

Figure 2.2.1: Land cover classification in Messara Valley

2.2 Patelis Catchment

Patelis catchment lies in the north-eastern part of Crete in the prefecture of Lasithi. The catchment covers an area of 123 km^2 comprising a north-south plain with steeply rising mountains on the east and the west side. The catchment receives a mean yearly rainfall of 650 mm. Around 90% of the total catchment area is cultivated. The main land use activities are grape vine cultivation (50%) and olive growing (20%). The remainder of the cultivated land (19%) is used for horticultural crops.

The main source of irrigation water is groundwater. The pumping stations that have been installed have allowed drip-irrigated cultivation of olive trees and vines.

Relief and Geology

The catchment comprises a north-south plain with steeply rising mountains on the east and west side. The mountains on the west side rise up to 900 m, on the east side up to 800 m. The valley extends at elevations between 200 and 50 m. The main outlet of the catchment is Patelis River in Siteia constriction at the north of the catchment. The mean elevation of Patelis riverbed is 460 m with a minimum elevation of 64 m. Patelis catchment has tectonic origin of trench type. By the slopes, two large fault systems extend almost from the north to the coast of the prefecture. The valley slopes consist of Neogene marly deposits and sandstone conglomeratic deposits. The west slope is mainly covered by clay, which is 1-1.5 m deep. The east slope is mainly covered by rocky conglomerate formations with an average depth of 2.5 m and layers of limestone and marly deposits. The west slope corresponds to a possible fault active during Middle Pleistocene. The valley consists of stream deposits of Patelis River, which have a rather large thickness (> 5m). They consist of sandstone and conglomerates.

Generally, the valley consists 50% of marly deposits, clays and conglomerates and 50% of Quaternary alluvial and silty deposits. Alluvial deposits consist of silty clay with conglomerates.

The geophysical map of the catchment with the rainfall gauges is depicted in figure 2.2.1. The geological map of the area is shown in figure 2.2.2.

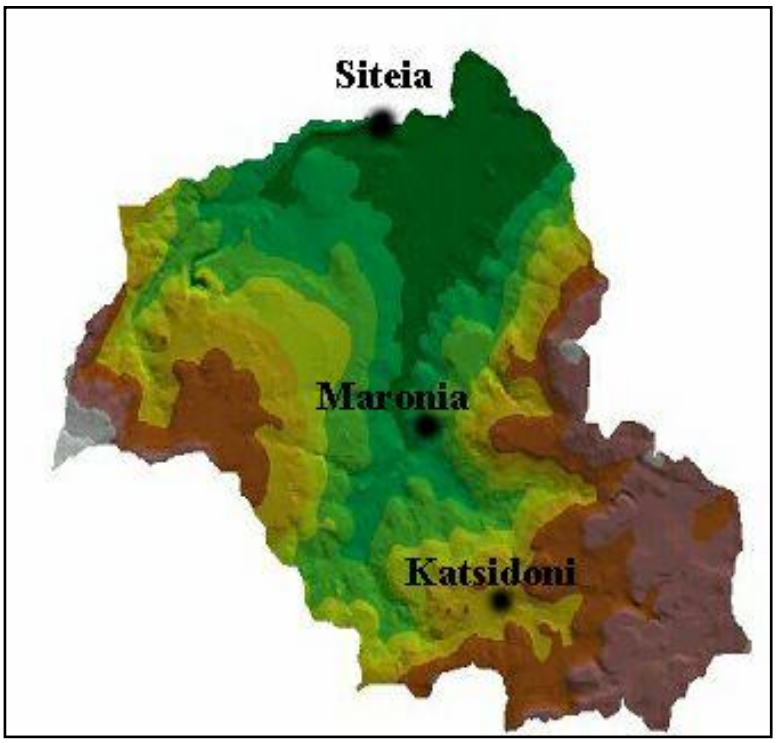

Figure 2.2.2: Geophysical map of Patelis catchment

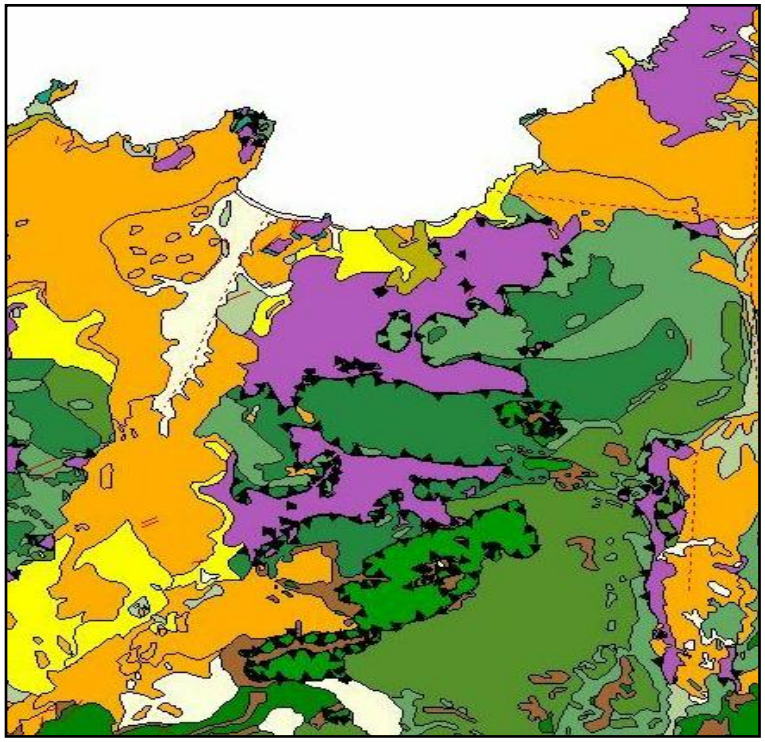

Figure 2.2.3: Geological map of Patelis catchment

Climate and Hydrology

The climate is sub-humid Mediterranean with mild moist winters and hot and dry summers. The catchment receives mean annual precipitation of 650 mm. The hydrological year may be divided into a wet and dry season. About 40% of precipitation occurs in the months of December and January while from June to August there is negligible rainfall. The average winter temperature is 13°C while for summer it is 25°C. The Department of Agriculture in Crete has monitored the valley's water resources for more than thirty years. There are daily measurements of rainfall from 3 stations. The mean annual rainfall for the different stations in the Patelis catchment is shown in figure 2.2.3. There is a dependence of rainfall and elevation. For the Patelis catchment the rainfall shows a linear trend with elevation with the fit being:

$$P_i = 437.48 + 0.8827z_i$$

P_i and z_i = rainfall (mm) and elevation (m) of a particular location in the catchment

The correlation coefficient R is 0.85 as shown in figure 2.2.4.

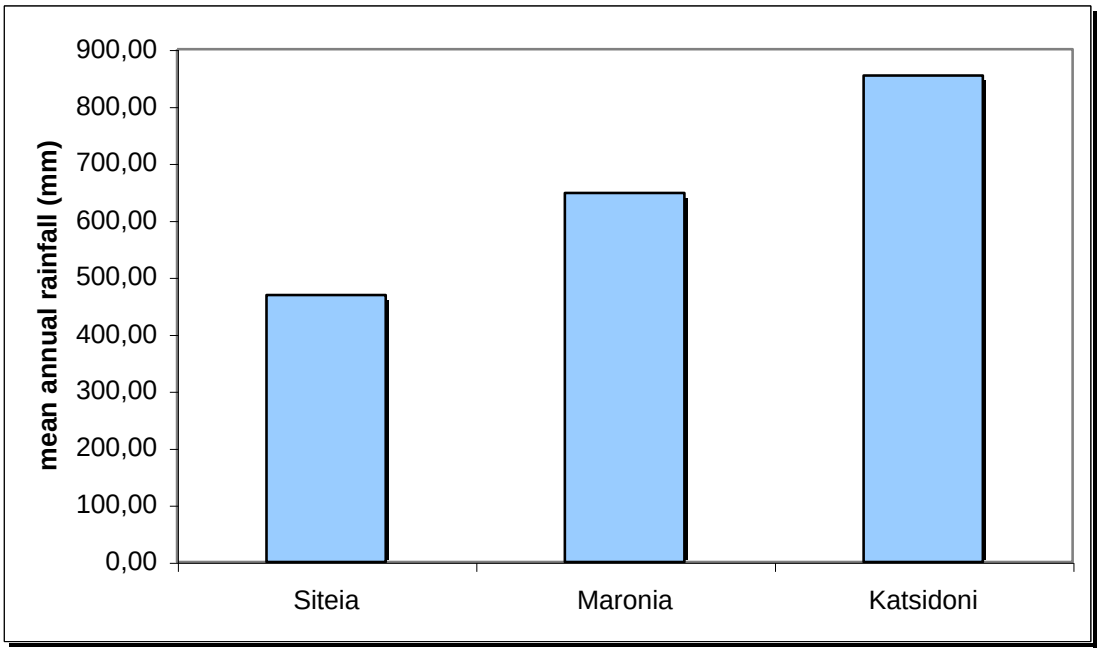

Figure 2.2.4: Mean annual rainfall for different station sin Patelis catchment

Rainfall ranges from 850 mm for Katsidoni station at an elevation of 480 m to 647 m for Maronia station at an elevation of 150 m and 470 m for Siteia station at an elevation of 115 m. Siteia station is a station that shows very low annual precipitation data compared to other stations in Crete, and Katsidoni station is at the upper end of stations that exhibit high annual precipitation.

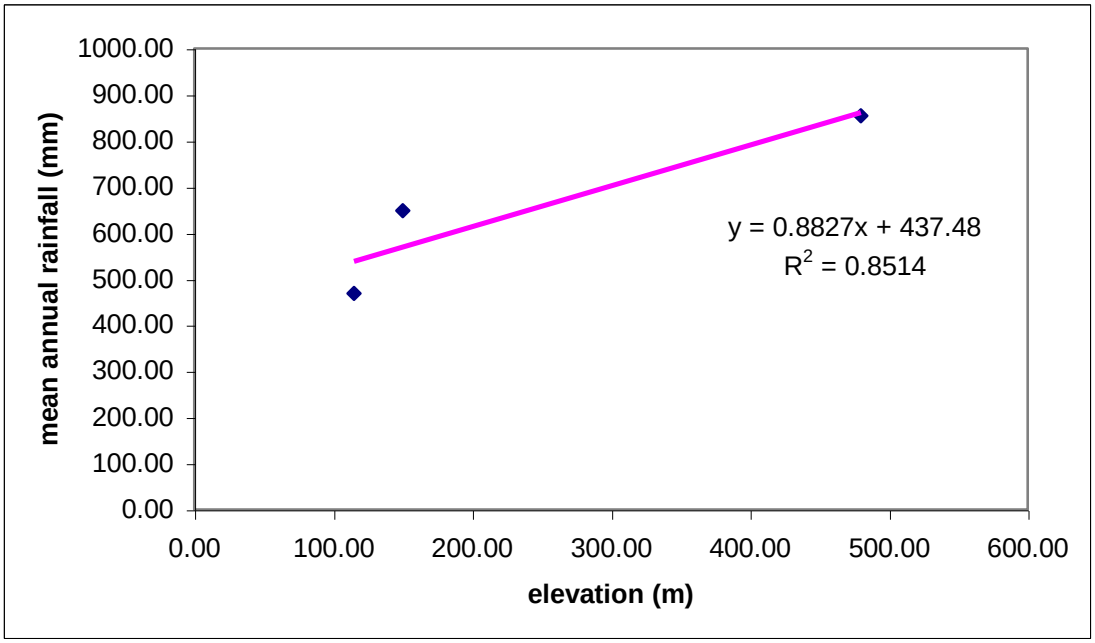

Figure 2.2.5: Rainfall for each of the three stations plotted against elevation. Also shown is the linear regression for the catchment

The mean annual and mean monthly rainfall for Pateli catchment is shown in figures 2.2.5 and 2.2.6 respectively.

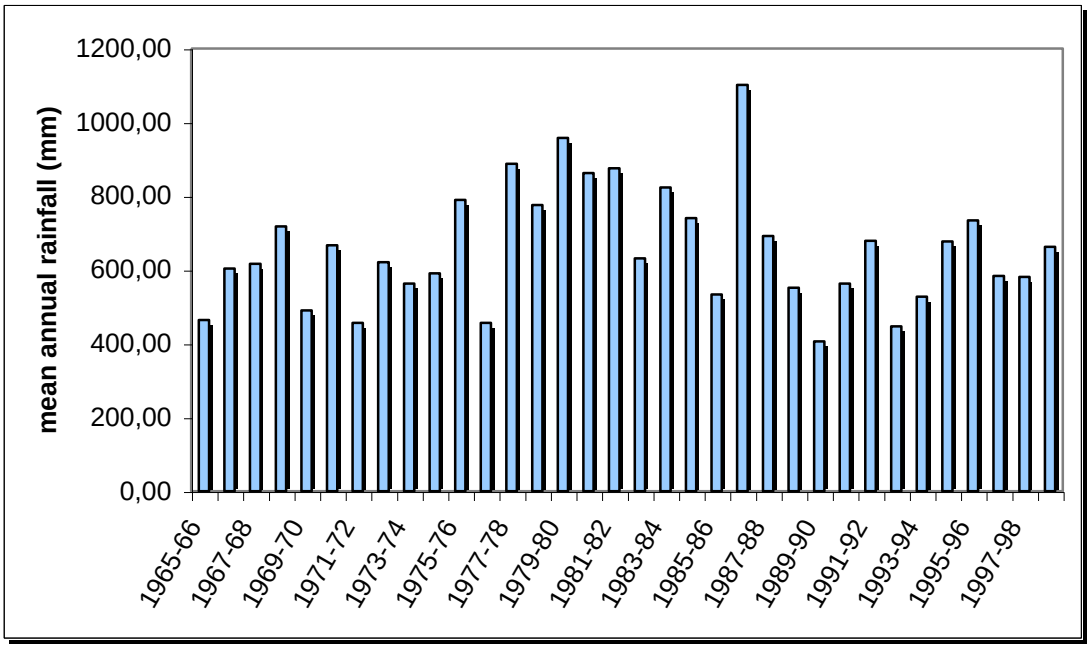

Figure 2.2.6: Mean annual rainfall for Patelis catchment

The hydrological year 1989-1990 was the driest year for the catchment while the wettest was the hydrological year 1986-1987.

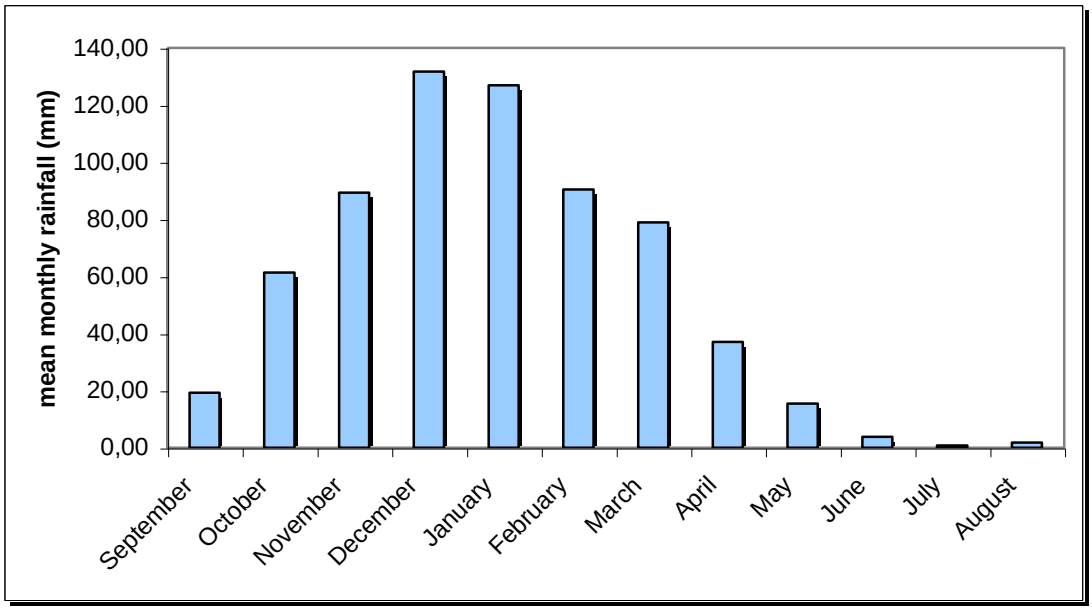

Figure 2.2.7: Mean monthly rainfall for Patelis catchment

Almost 40% of annual rainfall occur in December and January. The wet season lasts from November to March or April, while the dry season extends from June to September.

There is one station measuring temperature in the catchment of Patelis, namely Siteia station. Mean annual temperature for Siteia station is 18.67°C. The highest temperatures occur in July and August (25.7°C) while the lowest temperatures occur in January and February (12.2 to 12.3°C). Siteia station exhibits a high mean annual temperature compared to other stations in Crete. The monthly pattern of temperature for Siteia station is depicted in figure 1.1.3.22. The hot period extends from May to October and the cold period lasts from November to March or April. The average winter temperature is 13°C, while for the summer it is 25°C. The temperature range between the coldest and the hottest month of the year is 12.8°C.

Surface waters

There are no big rivers in the area of the catchment but there are seasonal streams originated from the relatively low mountains in the central part of the catchment and their outlet is the coastal area of Siteia bay. The most important stream of the area is Patelis, which is the main outlet of the catchment at Siteia constriction. Important affluents of the Patelis River are the streams Xiropotamos, Petrolakkos and Platani. The mean elevation of the riverbed is 469 m with a minimum elevation of 64 m. The length of the river path is around 14 km.

The mean annual runoff for Patelis River for the years 1967 to 1994 is shown in figure 2.2.7. Data for the hydrological years 1981 to 1983 are missing due to misplacement of the gauge. No flow is observed from May to September 1990, July to November 1991, July to November 1992, August to October 1993, July to September 1994 and July and August 1995.

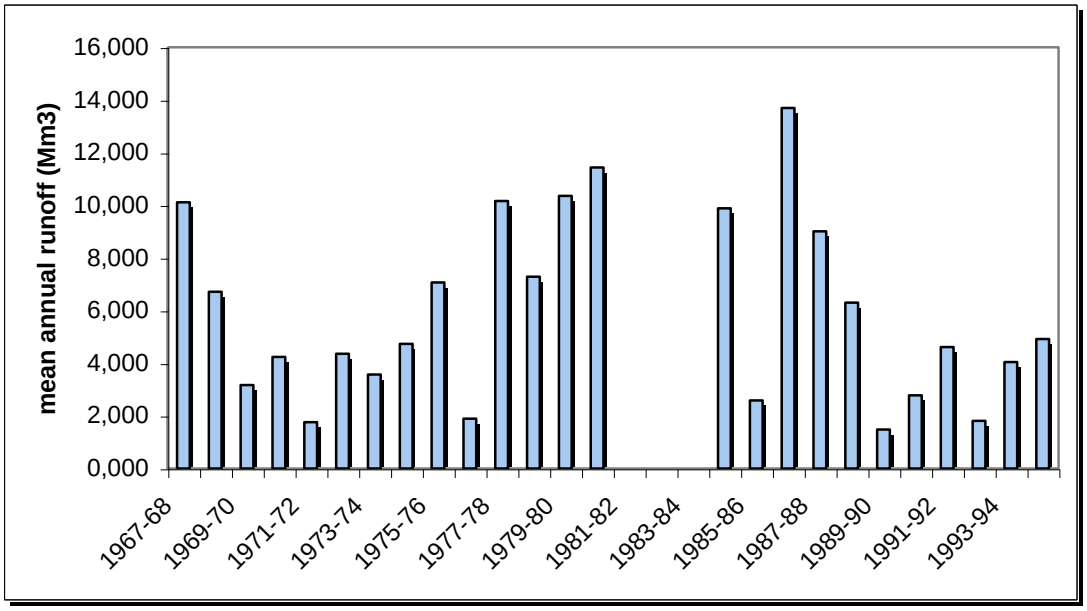

Figure 2.2.8: Mean annual runoff for Patelis

The hydrological year 1989-1990 was the year with the lowest rainfall and runoff, while the hydrological year 1986-1987 was the hydrological year with the highest rainfall and runoff.

The mean monthly runoff for Patelis River is shown in figure 2.2.8. High flows are observed in January and February, while low flows are experienced in July and August. The mean annual runoff for Patelis River is 6 Mm^3.

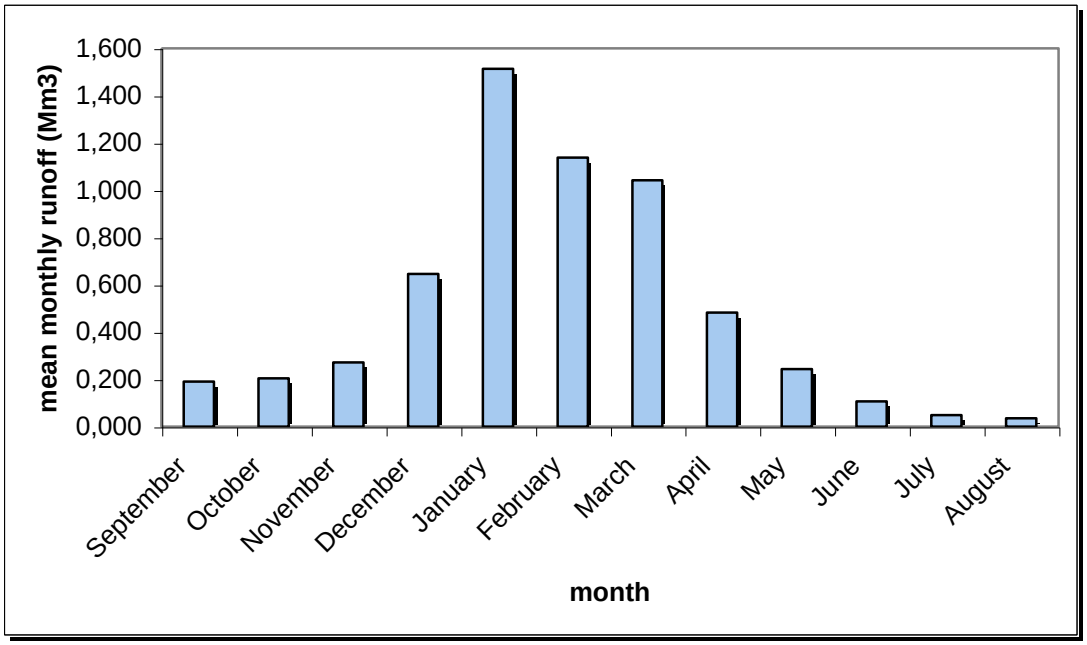

Figure 2.2.9: Mean monthly runoff of Patelis

The annual runoff coefficient for Patelis is shown in figure 2.2.9.

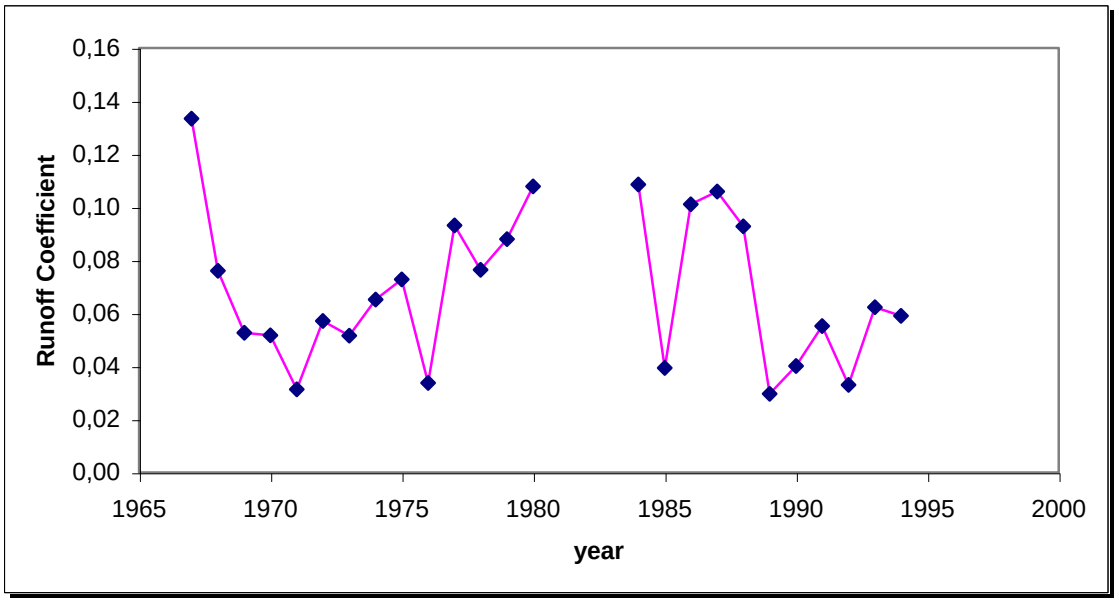

Figure 2.2.10: Annual runoff coefficient for Patelis

The mean annual runoff coefficient is 0.06 and the standard deviation 0.03. This value of runoff coefficient implies that pumping is taking place in the catchment. Figure 1.1.4.4 shows the mean annual runoff for the Patelis catchment compared with other stream in Lasithi prefecture. Water is abstracted from streams of the catchment for irrigation purposes.

Groundwater

The hydrogeological conditions of the catchment result from its geology. As mentioned above, the valley consists 50% of marly deposits, clays and conglomerates and 50% of Quaternary alluvial and silty deposits. Alluvial deposits consist of silty clay with conglomerates. Alluvial deposits exhibit high specific yield and are considered permeable formations, which form an unconfined aquifer. The east slope is less permeable due to the existence of silty clays and Neogene marly deposits. The valley is the receptor of discharge from the mountains. Groundwater levels are estimated at 50 m ASL. Surface and groundwater is used for irrigation purposes in the catchment area. Groundwater comes from pumping wells and springs.

In the area of the catchment the spring of Zou is located. This spring has a mean annual discharge of 51 L/s. The mean annual and monthly discharge of the spring is shown in figures 2.2.10 and 2.2.11 respectively.

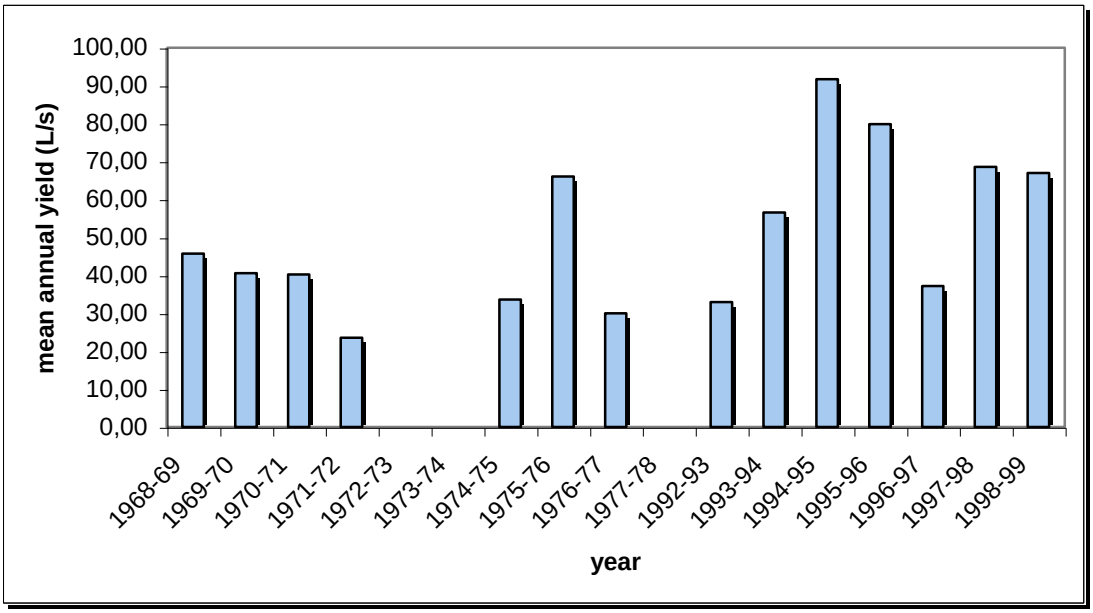

Figure 2.2.11: Mean annual discharge of Zou spring

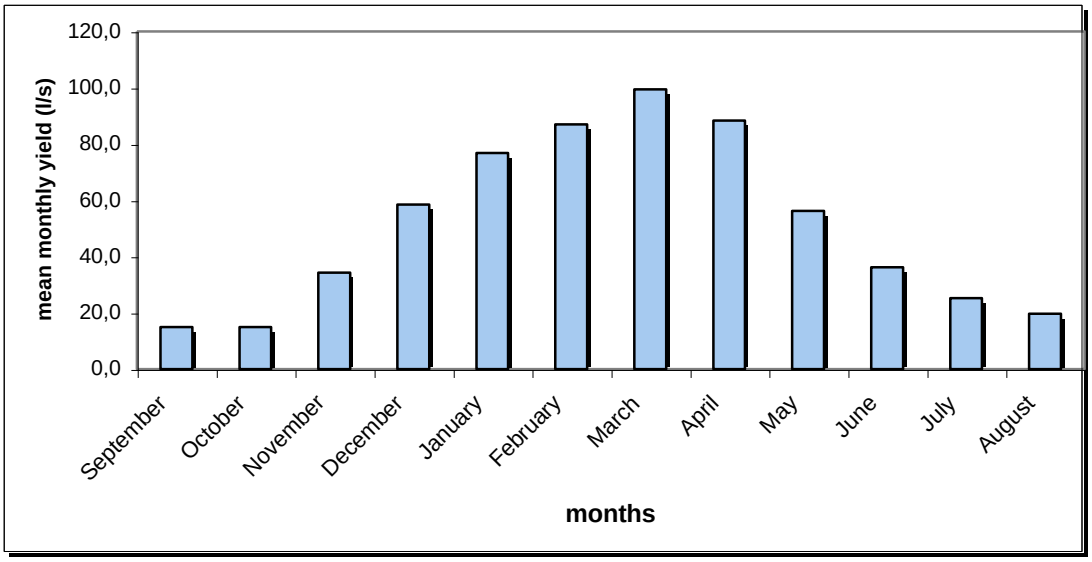

Figure 2.2.12: Mean monthly discharge of Zou spring

High yields are observed for February and March and low yields for August, September and November. A high percentage of the discharge of the spring ends up in the sea during winter time. From the spring of Zou 50m^3/h are abstracted for water supply of Siteia and Pistokefalo and another 33 m^3/h for irrigation.

There are about 35 registered pumping wells in the catchment. Around 25 of which are used for irrigation purposes, 10 are used for irrigation and water supply while some have not been exploited or have failed.

Agricultural situation

Around 90% of the catchment area is cultivated. Around 47% of the total tree crops are olives (cv Koroneiki), about 10% are vines (cv Sultanina), 6% are vegetables and 30% is fallow land and other crops.

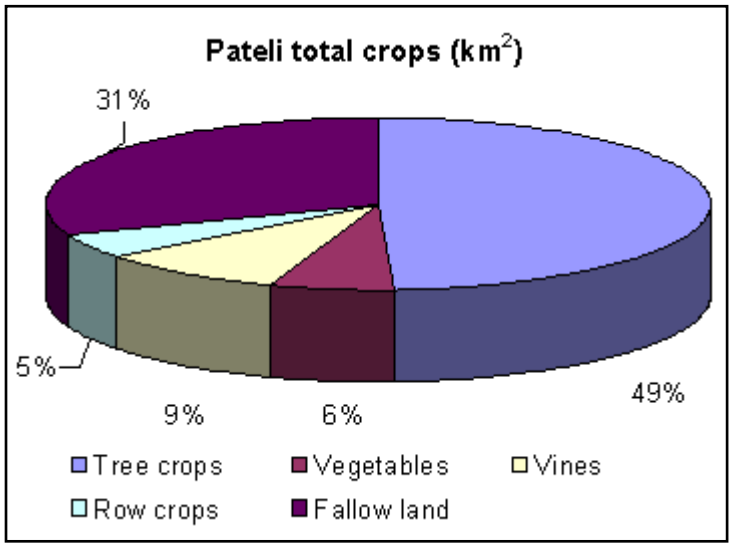

Figure 2.2.13: Crops cultivated in Platys catchment (HNSS, 1999)

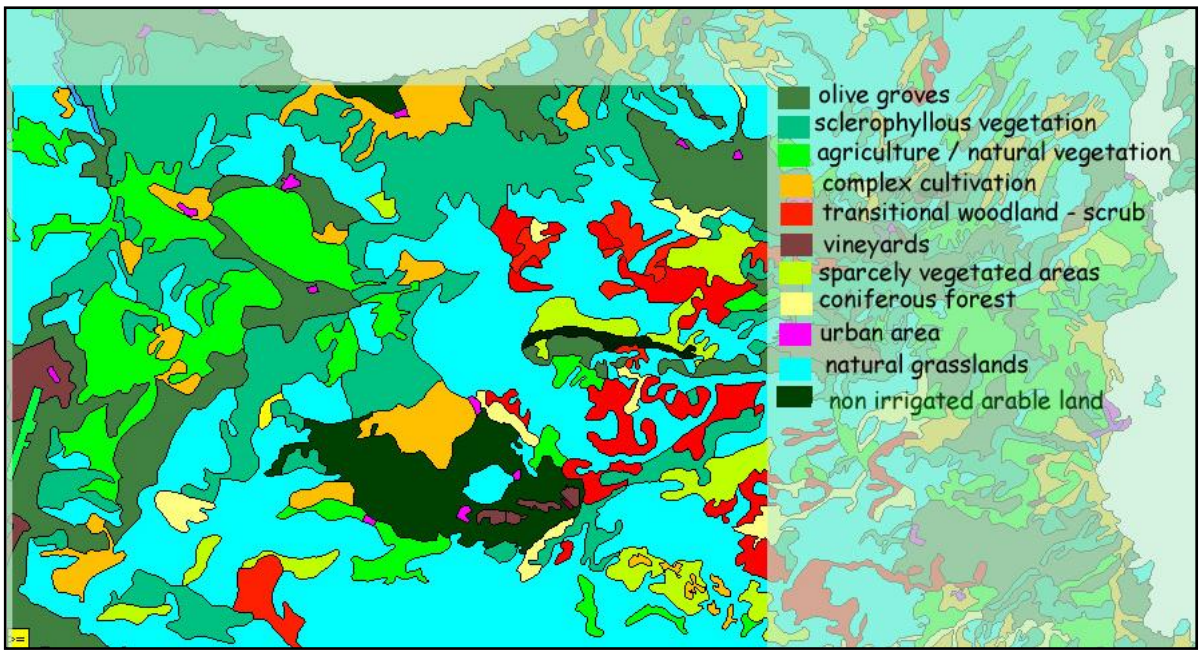

Figure 2.2.14: Land – use map of Patelis catchment (CORINE)

Irrigation systems and scheduling

Surface and groundwater is used for irrigation purposes from pumping wells, springs and stream runoff. Drip irrigation systems are used for olive orchards; micro-sprinklers for potatoes and furrow are used for the other vegetables. The time and amount of the water applied is empirically defined. The average water price is about 0.21 €/m^3. The price is increased compared to other catchments because the Local Board of Water Management (TOEB) has too many debts. When dept is paid the price of the water price will be reduced. The Local TOEB does not have water meters in all irrigated areas and thus it is not possible to know how much water the farmers in those areas use.

Crop water requirements

Reference evapotranspiration with Penman – Monteith method was estimated using data from Sitia weather station for the period 1971 – 1998.

Crop water requirements for the main crops in the catchment are presented on Table 2.2.1.

Fertilisers

Various forms of N-fertilizers (40%) and composite fertilizers (60%) applied empirically during winter without any analyses for the nutrient needs of the crops (about 5 Kg per tree). Fertigation is rarely used in the catchment.

Table 2.2.1: Crop water requirements in Patelis catchment

Crop	Crop water requirements (m^3x10^2/ha)												
	J	F	M	A	M	J	J	A	S	O	N	D	SUM
Olives	-	-	-	-	4.0	5.5	6.5	6.0	3.0	(1.0)*	-	-	**25.0 (26.0) ***
Citrus	-	-	-	-	8.0	10.0	11.5	10.5	6.5	1.5	-	-	**48.0**
Vines (cv Soultanina)	-	-	-	-	6.5	8.0	(9.0)*	-	-	-	-	-	**14.5 (23.5) ***
Watermelons, Melons	-	-	-	-	9.0	12.0	14.0	12.5	8.0	-	-	-	**55.5**
Potatoes (spring)	-	-	3.0	5.5	10.0	12.0	14.0	-	-				**44.5**
Potatoes (autumn)	-	-	-	-	-	-	13.0	11.5	7.0	2.0			**33.5**
Tomatoes (open)	-	-		2.5	7.5	12.0	14.0	12.5	-	-	-	-	**48.5**

* Additional irrigation due to low rainfall and/or high temperatures and/or extended crop

Taking into account the estimated crop water requirements, open field watermelons and melons are the most highly water demanding crops in Patelis catchment, followed by citrus and vegetables (open field tomatoes, spring potatoes).

Weed control, Irrigation systems and Fertilizer application

Weed control in olive orchards is done equally with herbicides, tillage and no tillage. In vines tillage (50%) and herbicides (50%) are used. Generally usage of chemicals is the most commonly used method in Patelis catchment.

In olive orchards weed control is done with herbicides (33%), tillage (33%) and no tillage (33%). In vines tillage (50%) and herbicides are used.

Surface and groundwater is used for irrigation purposes from pumping wells, springs and stream runoff. Drip irrigation systems are used for olive orchards; micro-sprinklers for potatoes and furrow are used for the other vegetables. The time and amount of the water applied is empirically defined. Sultanina is irrigated in winter and spring. Olives are irrigated after the irrigation period of Sultanina.

Various forms of N-fertilizers (40%0 and composite fertilizers (60%) are applied empirically during winter without any analyses for the nutrient needs of the crops (about 5 kg per tree).

2.3. Platys Catchment

Platys catchment lies in the southern part of Crete, in the prefecture of Rethymnon. The catchment covers an area of 203 km^2, comprising a north-south plain with mountains rising on the east and west side. The catchment receives around 850 mm of rainfall per year. Around 80% of the total Valley area is cultivated with olive groves. The main source of irrigation water is groundwater. Pumping stations that have been installed allow drip-irrigated cultivation of olive trees.

Relief and geology

Platys catchment comprises a north-south plain with mountains rising on the east and west side. Mountains on the west rise up to 1500 m while the plain stretches at an elevation of 250 to 50 m. The Platys River is the main stream of the catchment and its outlet at the south coast is located at Agia Galini constriction. An important affluent of the Platys River is Ligiotis.

Neogene and Preneogene formations comprise the basic geological setting of the area. In more detail: Formations that are classified in the Pindos Zone (a geostratigraphical classification regarding the evolution of the Preneogene rocks in Greece) crop out mostly on the area of interest. The basic formations of the Pindos Zone are upper Triassic limestones and radiolarites. They consist of pink finely bedded limestones underlying radiolarites and sandstones with sandstone limestones. Cretaceous thick bedded limestones consisting of pink limestones at the base, black-gray limestones in the middle of the stratigraphical sequence and a series of thin interchanging Palaeocene limestone and marl layers at the top of the sequence. Flysh of Eocene age comprises the most recent formation of the Pindos zone. It can be slightly metamorphic in places. Flysh is the most abundant formation in the area. Upper Miocene conglomerates, sandstones, sands with occasional lignites comprise the main Neogene outcrop in the Platys catchment. They crop out to the east, north east of the Platys River. The geological map of Platys catchment is depicted in figure 2.3.1.

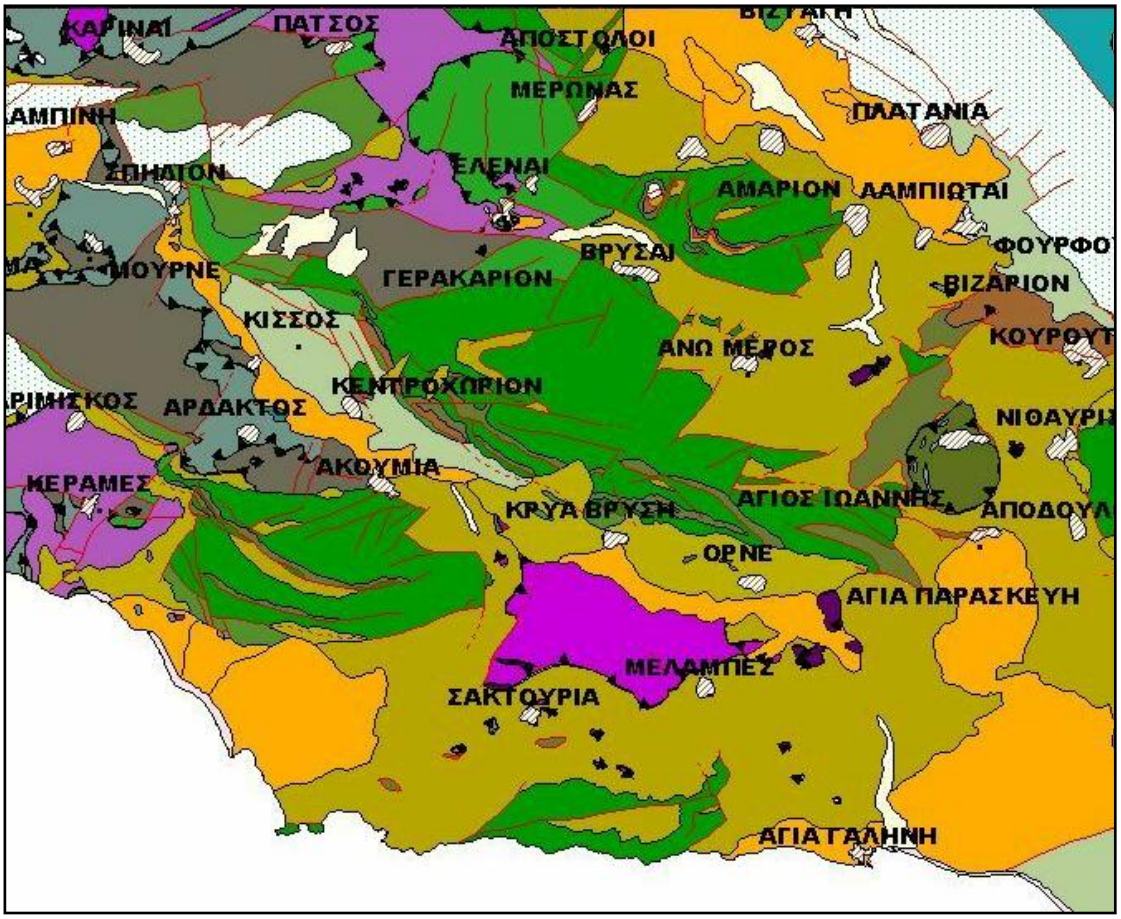

Figure 2.3.1: Geological map of Platys catchment

Climate and Water Resources

The climate is sub-humid Mediterranean with mild moist winters and hot and dry summers. The catchment shows a mean annual rainfall of 850 mm. Rainfall is measured by the Department of Ministry of Agriculture in Crete for around 30 years. There are four rainfall stations in the area. The location of these stations is shown in figure 2.3.2.

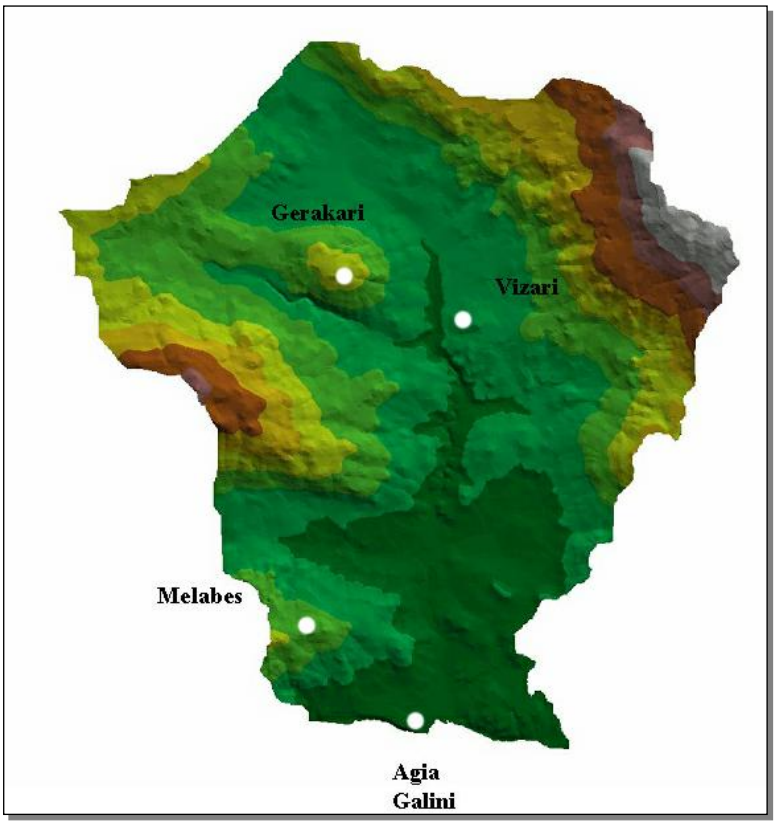

Figure 2.3.2: Geophysical map of Platys catchment with rainfall gauges

The mean annual rainfall for the four different stations in the catchment is depicted in figure 2.3.3. Gerakari station shows the highest mean annual rainfall, as it is located at high elevation. Rainfall ranges from 1300 mm at Gerakari station at an elevation of 580 m, to 754 mm at Vizari station at an elevation of 310 m, and 574 mm for Agia Galini station at an elevation of 20 m. Agia Galini station shows very low annual precipitation compared to other stations in Crete and the lowest in Rethymnon prefecture and Gerakari station is at the upper end of stations that exhibit high annual precipitation and the second highest in Rethymnon prefecture.

As shown in figure 2.3.4, rainfall increases with elevation but there is no linear dependence between rainfall and elevation. Melabes station, which is located at an elevation of 560 m ASL, shows lower precipitation than Vizari station located at an elevation of 310 m. This is most probably due to the location of Melabes near the coast while Vizari lies in the mainland close to the mountains. For Agia Galini, Vizari and Gerakari stations show a linear dependence of rainfall with elevation is observed with the fit being:

$P_i = 491.57 + 1.2991z_i$

P_i and z_i = rainfall (mm) and elevation (m) of a particular location in the catchment

The correlation coefficient R is 0.927 as shown in figure 2.3.5.

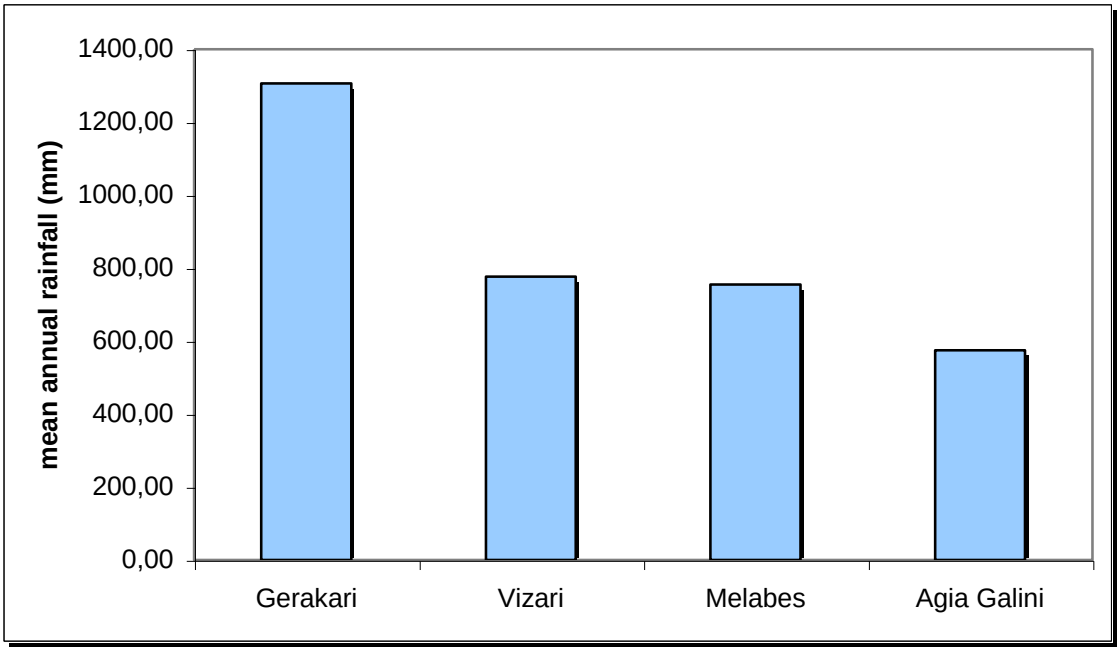

Figure 2.3.3: Mean annual rainfall for the different stations in Platys catchment

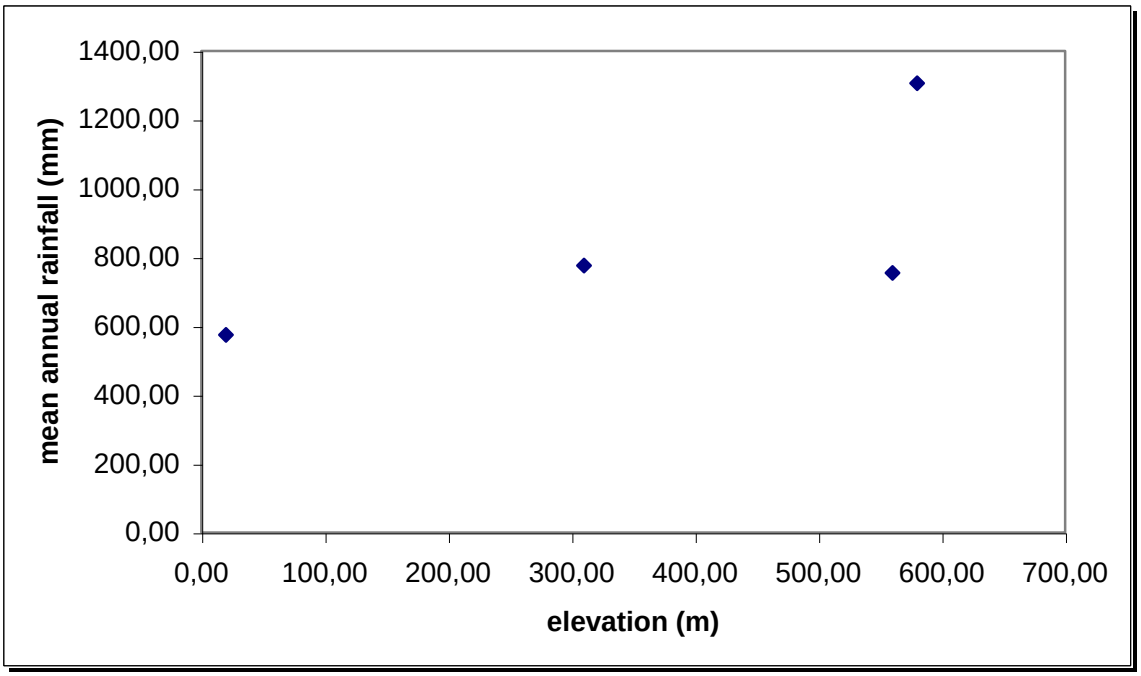

Figure 2.3.4: Rainfall distribution with elevation

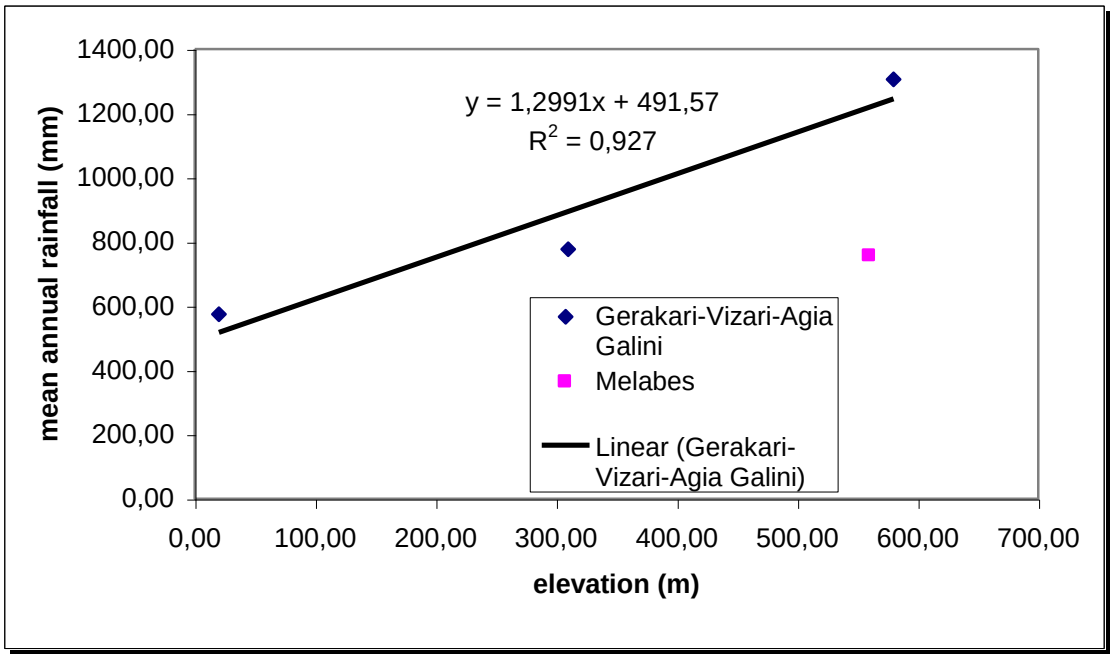

Figure 2.3.5: Linear dependence of rainfall with elevation

The mean annual rainfall for the catchment is shown in figure 2.3.6.

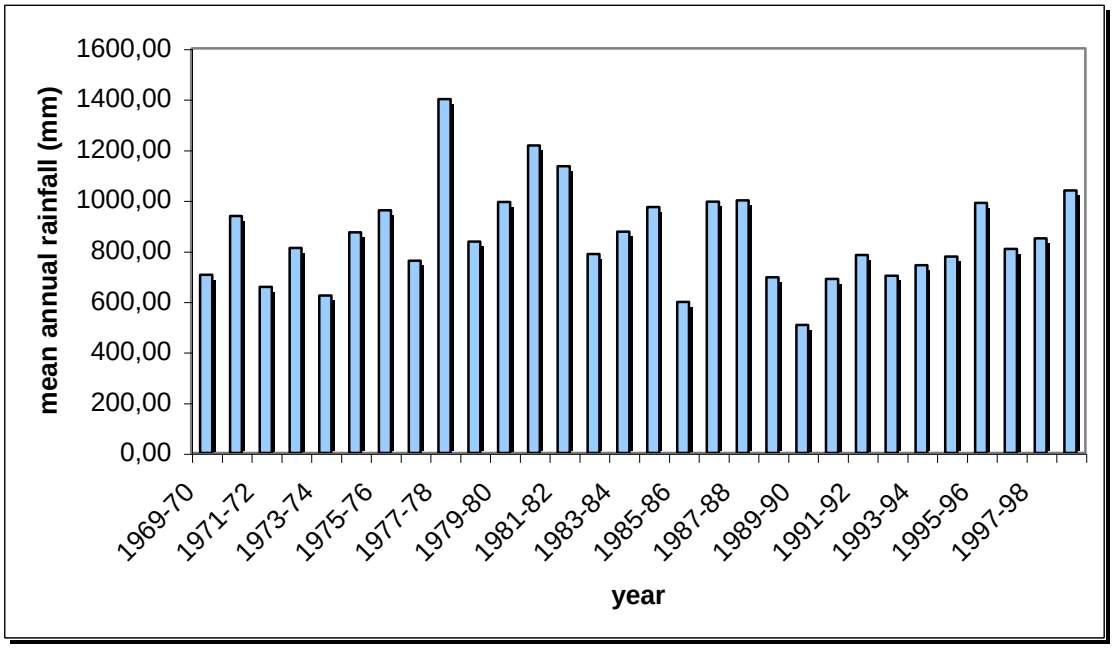

Figure 2.3.6: Mean annual rainfall for Platys catchment

As it is shown in figure 2.3.6, the driest year was the hydrological year 1989-1990 and the wettest year was the hydrological year 1977-1978. Figure 2.3.7 depicts the seasonal pattern of rainfall for the catchment. Around 40% of mean annual precipitation occurs in December and January. December seems to be the wettest month, while July and August are usually the driest months. The wet season lasts from October or November to March and the dry season extends from May to September.

Surface waters

Platys River is the main stream of the catchment and its outlet is at the south coast at Agia Galini constriction. An important affluent of the Platys River is Ligiotis. The mean annual runoff for Platys River is depicted in figure 2.3.7. The river shows mean annual runoff of 50.7 Mm^3.

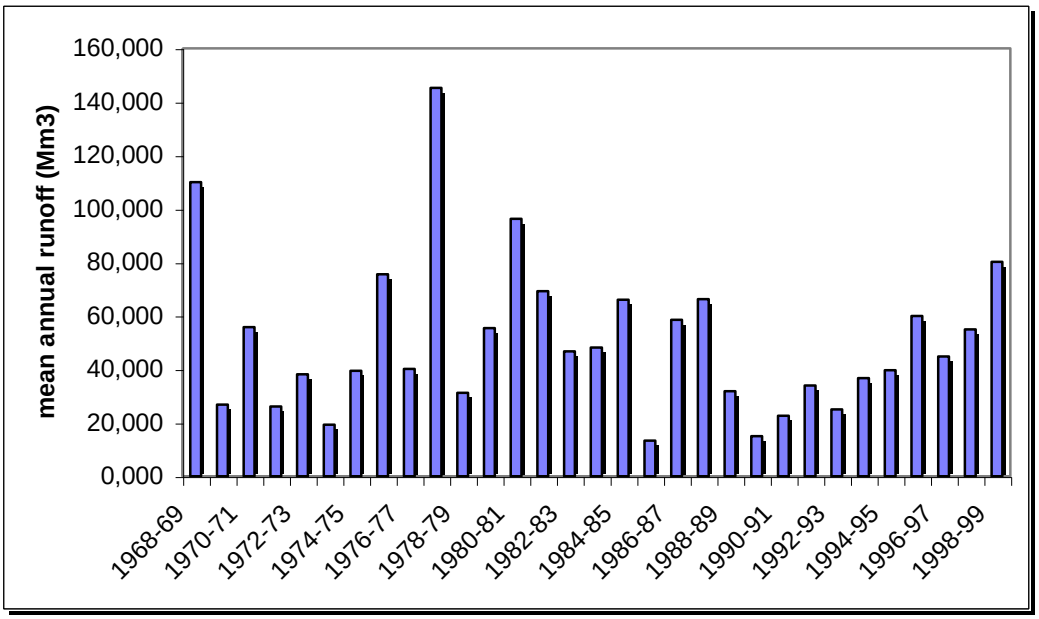

Figure 2.3.7: Mean annual runoff of Platys

The highest mean annual runoff is observed at the hydrological year 1977-1978 and the lowest at 1985-1986.

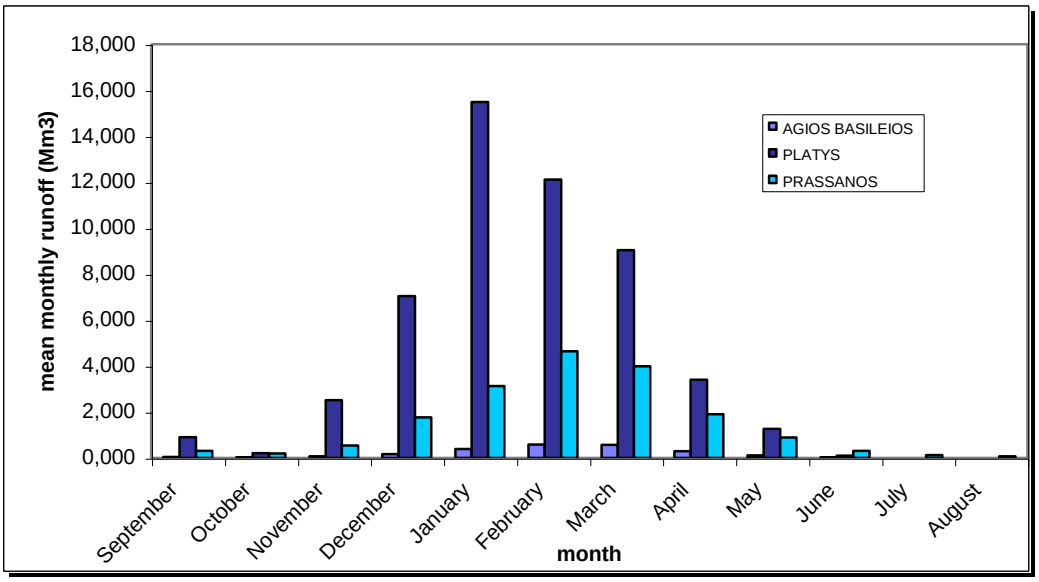

Figure 2.3.8: Mean monthly runoff for different streams in Rethymnon

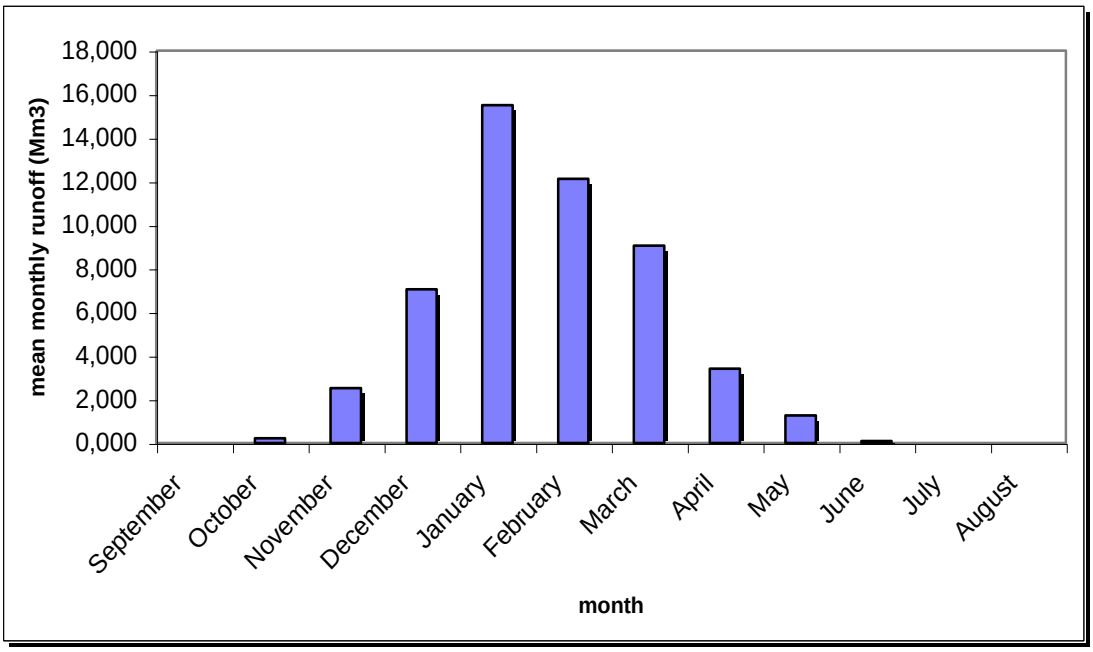

Figure 2.3.9: Mean monthly runoff of Platys

As shown in figure 2.3.9, the highest flow is observed in January and February while low flows or no flow are observed from June to October. The river was dry for all hydrological years in July, August and September and in October of 1969, 1971 and 1973 to 1998. For many hydrological years no flow was observed in June and even in November. The mean annual and mean monthly runoff coefficients are shown in figure 2.3.10 and 2.3.11 respectively. The mean runoff coefficient is 0.26, a relatively high value, which shows that not much pumping is taking place.

Groundwater

The main source of irrigation water in the valley is groundwater. ~~Drip irrigation systems are used for olive orchards of cv Koroneiki. The cv Throumbolia is non-irrigated. Vines are also non-irrigated.~~ Around 20 pumping wells have been registered in the area. Most of them are used for water supply and irrigation purposes, while some are used for research and some are either not in use any more, or have failed. It is estimated that not much groundwater is pumped form the aquifer. This is also suggested by the relatively high value of runoff coefficient.

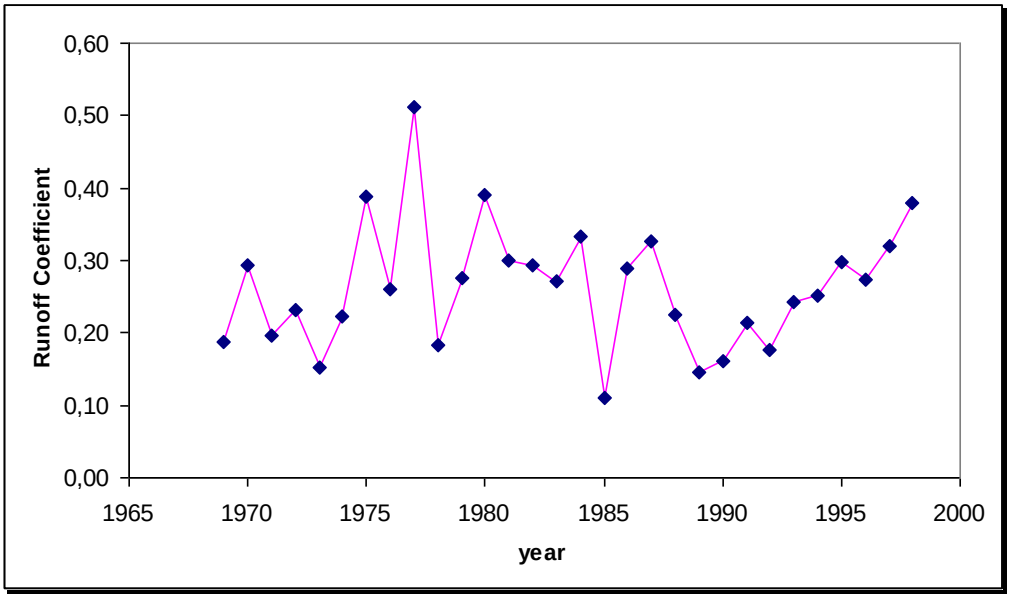

Figure 2.3.10: Runoff coefficient for Platys

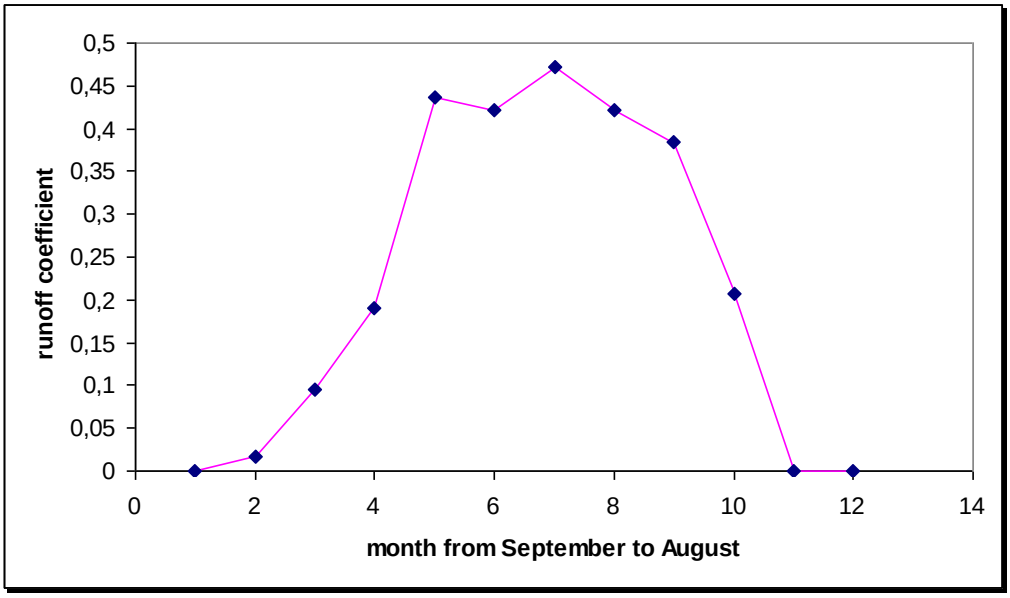

Figure 2.3.11: Mean monthly runoff coefficient for Platys

Agricultural situation

Around 80% of the total catchment area is cultivated but fallow land covers the biggest part of the cultivated area due to animal breeding and to difficult (or even impossible) access to irrigation water. 95% of the total tree crops are olives (80% cv Throumbolia, 15% cv Koroneiki, 3-4% cv Mastoidis).

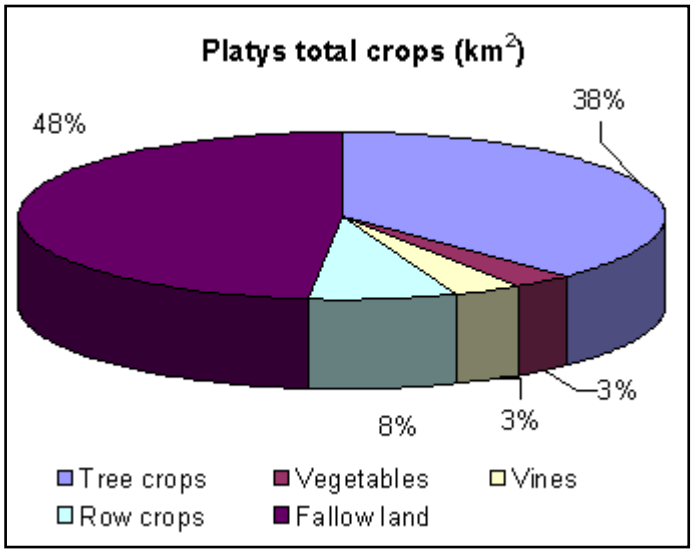

Figure 2.3.12: Crops cultivated in Platys catchment (HNSS 1999)

Irrigation systems and scheduling

The main source of irrigation water is groundwater. Drip irrigation systems are used for olive orchards of cv Koroneiki. The cv Throumbolia is non-irrigated. Vines are also non-irrigated. The amount of water applied is empirically defined. The average water price is approximately 0.06 €/m3.

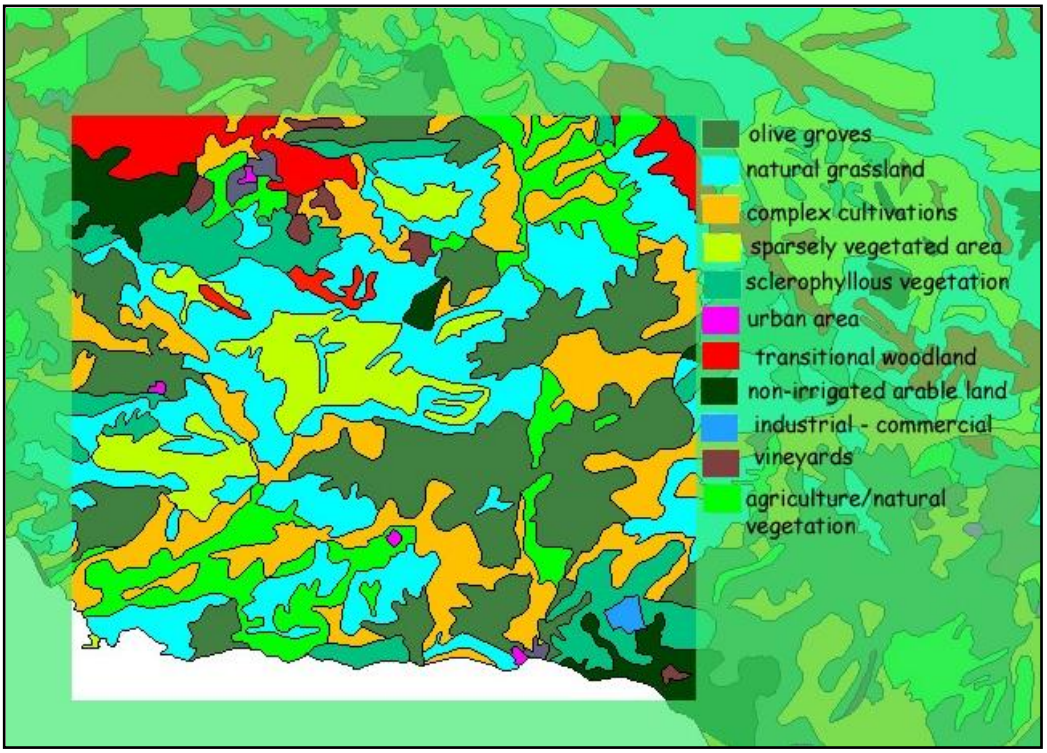

Figure 2.3.13: Land use map of Platys catchment (CORINE)

Crop water requirements

Data from Vizari station were used to estimate reference evapotranspiration with Penman – Monteith method, for the period 1971 – 2001. Missing data were filled from Gerakari and Leukogia stations. Crop water requirements for the main crops in the catchment are presented on Table 2.3.1.

Table 2.3.1: Crop water requirements in Platys catchment

Crop	Crop water requirements (m^3x10^2/ha)												
	J	F	M	A	M	J	J	A	S	O	N	D	**SUM**
Olives	-	-	-	-	3.0	6.0	7.5	6.5	3.5	(1.0)*	-	-	**26.5 (27.5)***
Vines for wine	-	-	-	-	-	8.5	11.0	-	-	-	-	-	**19.5**
Cherries	-	-	-	4.5	8.5	13.0	16.0	-	-	-	-	-	**42.0**
Potatoes (summer)	-	-	-	-	-	13.0	16.0	14.5	9.0	2.0	-	-	**54.5**
Artichokes	-	-	-	-	-	-	-	3.0	3.5	1.5	-	-	**8.0**
Tomatoes (open)	-	-	-	1.5	6.5	13.0	16.0	14.5	-	-	-	-	**51.5**

* Additional irrigation due to low rainfall and/or high temperatures

Taking into account the estimated crop water requirements, open field vegetables (summer potatoes and tomatoes) are the most highly water demanding crops in Platys catchment, followed by cherry trees.

Fertilisers

Various forms of N-fertilizers are applied empirically without any analyses for the nutrient needs of the crops (about 4 kg per tree for olive trees). Fertigation is rarely used in the catchment.

Weed control

Weed control is performed mostly with herbicides (40%) and tillage is used only in olives cv Koroneiki or supplementary to chemicals. 15% of the farmers use weed cutting.

~~The main source of irrigation water is groundwater. Drip irrigation systems are used for olive orchards of cv Koroneiki. The cv Throumbolia is non-irrigated. Vines are also non-irrigated. The amount of water applied is empirically defined.~~

~~Various forms of N-fertilizers are applied empirically without any analyses for the nutrient needs of the crops (about 4 kg per tree for olive trees).~~

~~Weed control is performed mostly with herbicides (80%) and tillage is used only in cv Koroneiki.~~

2.4 Kissamos catchment

The Kissamos catchment lies in the northwestern part of Crete in Chania prefecture. It constitutes one of the most important agricultural regions on the island. Of the total crops cultivated, 65% are olives (cv Koroneiki), 20% are vegetables, 5% are vines and 10% are other cultivars. Irrigation systems are mostly used for olive orchards. The amount of water applied is empirically defined. Various forms of N-fertilizers are applied empirically without any soil or leaf analyses for the nutrient needs of the crops. Weed control is performed mostly by tillage (70%), while herbicides are used by 20% only.

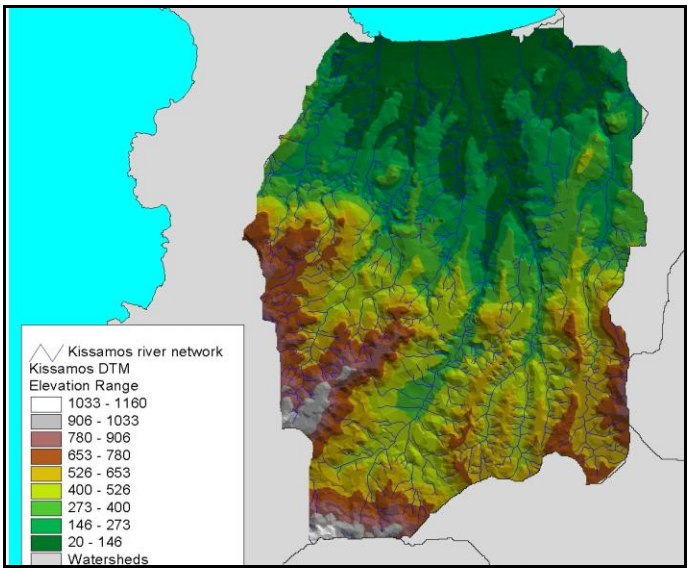

Figure 2.4.1: Kissamos catchment

The basic geological setting of the area is formed by Neogene formations overlying Palaeozoic formations, mainly phyllites and quartzites**.** The Neogene formations of Miocene up to Pleistocene age consist of conglomerates, white-gray marls and marly limestones on the top of the stratigraphical sequence. The upper Palaeozoic phyllites and quartzites crop out to the south of the area where the terrain becomes more mountainous.

The total permanent population of the area is about 5,000 inhabitants. The climate is sub-humid Mediterranean with mild winters and dry summers (aridity index=0.58). The mean annual temperature is estimated at 18+/-2 ^{0}C. The mean winter temperature is 13^{0}C and the mean summer temperature 24^{0}C. The mean annual precipitation is 745 mm, while the average monthly precipitation from April to September is 12.7 mm and from October to March 111.5 mm. The lowest annual rainfall observed was 350 mm and the maximum was 1100 mm in 30 years of record. Evapotranspiration varies from 1190 to 1420 mm/a.

Cultivated crops and cultivated land

Of the total crops cultivated, about 80% are olives (cv Koroneiki)(98% of the tree crops), 8% are vegetables, 3% are vines and 10% are fallow land and other cultivars.

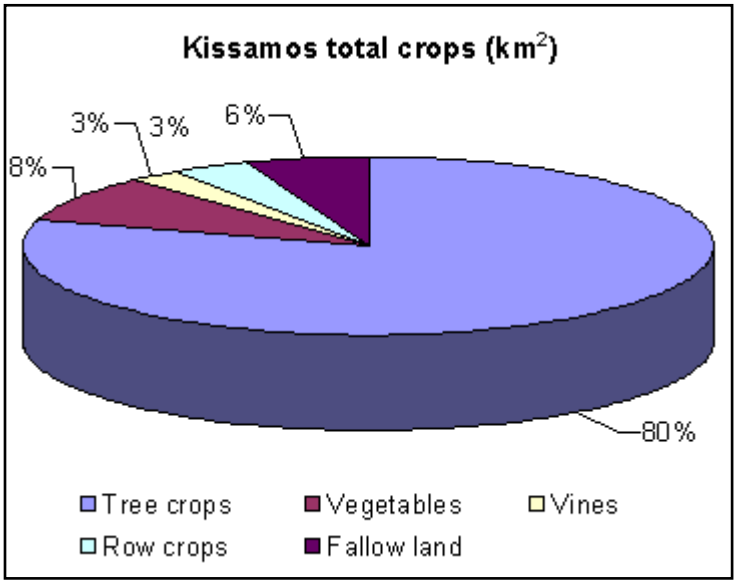

Figure 2.4.2: Crops cultivated in Kissamos catchment (HNSS 1999)

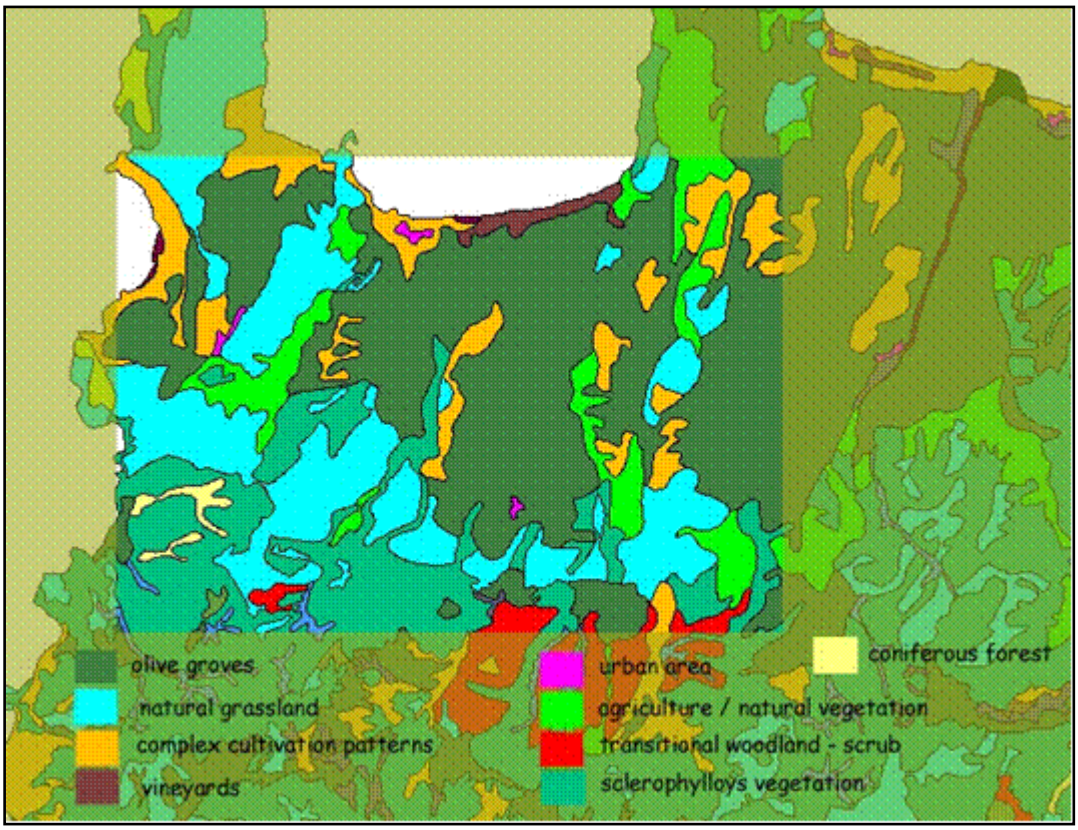

Figure 2.4.3: Land use map of Kissamos catchment (Corine)

Irrigation systems and scheduling

The amount of water applied is empirically defined. Approximately 2 Mm^3 of water is used for irrigation in Kissamos area. The average water price is approximately 0.08 €/m^3. The main irrigation system is drip irrigation.

Crop water requirements

Data from Drapanias station were used to estimate reference evapotranspiration for the period 1965 – 1992 with Penman – Monteith method. Missing data were filled from a station nearby (Zimbragou). Crop water requirements for the main crops in the catchment are presented on Table 2.4.1.

Table 2.4.1 Crop water requirements in Kissamos catchment

Crop	Crop water requirements (m^3x10^2/ha)												
	J	F	M	A	M	J	J	A	S	O	N	D	SUM
Olives	-	-	-	-	3.0	5.5	6.5	5.5	3.0	(1.0)*	-	-	**23.5 (24.5)***
Citrus	-	-	-	-	6.5	9.0	10.0	9.0	5.5	1.0	-	-	**41.0**
Table vines	-	-	-	-	-	7.5	8.0	7.5	4.5	-	-	-	**27.5**
Vines for wine	-	-	-	-	-	7.5	8.0	-	-	-	-	-	**15.5**
Greenhouse tomato (Oct – May)	2.0	2.0	3.0	5.0	9.0	-	-	-	-	2.5	2.5	2.0	**28.0**
Greenhouse cucumber (Aug – Dec)	-	-	-	-	-	-	-	3.5	7.5	7.5	5.5	4.5	**28.5**
Greenhouse cucumber (March – Jun)	-	-	3.0	6.0	8.0	8.5	-	-	-	-	-	-	**25.5**
Watermelons	-	-	-	-	8.0	10.5	12.0	10.5	-	-	-	-	**41.0**
Potatoes (spring)	-	-	2.5	3.5	8.0	5.0**		-	-	-	-	-	**19.0**
Onions	-	-	1.5	3.0	7.0	5.0**	-	-	-	-	-	-	**16.5**
Tomatoes (open field)	-	-	-	2.0	6.0	10.5	12.0	10.5	-	-	-	-	**41.0**

* Additional irrigation due to low rainfall and/or high temperatures

** Irrigation lasts until mid June

Taking into account the estimated crop water requirements, open field vegetables (tomatoes and watermelons) are the most highly water demanding crops in Kissamos catchment along with citrus, followed by table vines which though, do not account for a large area in the catchment.

Fertilisers

Various forms of N-fertilizers applied empirically without any soil or leaf analyses for the nutrient needs of the crops.

Weed control

Tillage and chemicals are equally used in weed control in Kissamos catchment.

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