



REGION OF  
CRETE  
DIRECTORATE  
OF WATER

Περιφέρεια Κρήτης



MINISTERIO  
DE MEDIO  
AMBIENTE

CONFEDERACIÓN  
HIDROGRÁFICA  
DEL SEGURA

**MENBO  
WATER COOPERATION SESSION  
IN MEDITERRANEAN RIVER BASINS  
TWINBASIN SEGURA-CRETE**



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*Region of Crete, Directorate of Water*

*Sunday 5, November 2006*

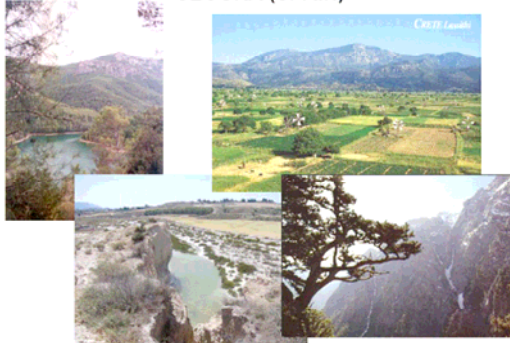


Eye alt 2851.40 km

## SEGURA-CRETE

TWINNING PROJECT BETWEEN THE RIVER BASIN ORGANISATIONS:

- CRETE (GRECE)
- SEGURA (SPAIN)



IN AGREEMENT WITH THE TWINBASIN<sup>XXN</sup> PROJECT LEADED BY OIEAU, GWPO AND TECHWARE.



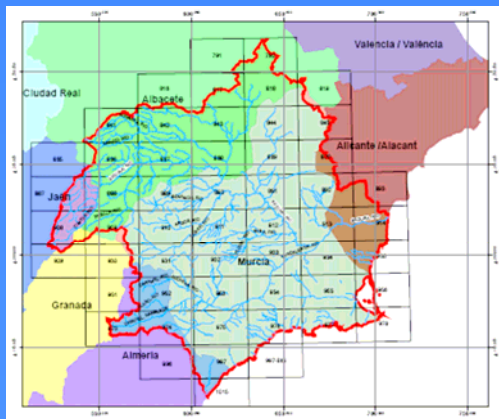
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DEL SEGURA



# Presentation contents

1. Water resources management in Crete
2. Objective of the mission
3. Basin Organization's Administrative duties/ Responsibilities
4. Activities have been developed
5. Results of the missions
6. Conclusions





# PRECIPITATION ON MEDITERRANEAN ISLAND

	<i>MAJORCA</i>	<i>CORSICA</i>	<i>SICILY</i>	<i>CRETE</i>	<i>CYPRUS</i>
AREA (Km2)	3.640	8.682	25.700	8.335	9.251
MEAN ANNUAL PRECIPITATION (mm)	625	900	625	927	513

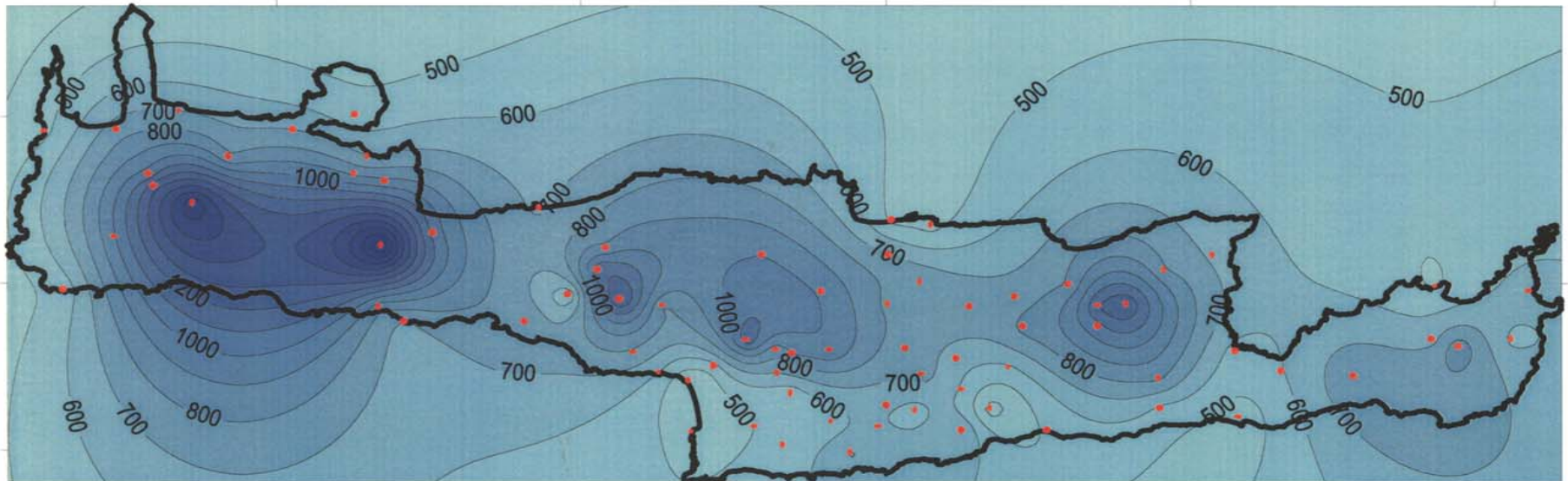


SOURCE: MEDIS PROJECT

## ANNUAL PRECIPITATION (mm)

<b>HYDROLOGIC CONDITIONS</b>	<b>CRETE</b>	<b>EASTERN CRETE</b>	<b>WESTERN CRETE</b>
<b><u>WET YEAR</u></b> (RETURN PERIOD 10%)	<b>1239</b>	<b>1108</b>	<b>1395</b>
<b><u>NORMAL YEAR</u></b> (RETURN PERIOD 50%)	<b>927</b>	<b>815</b>	<b>1052</b>
<b><u>DRY YER</u></b> (RETURN PERIOD 90%)	<b>608</b>	<b>526</b>	<b>708</b>

Περίοδος 1977 - 1997, Παρεμβολή Ordinary Kriging



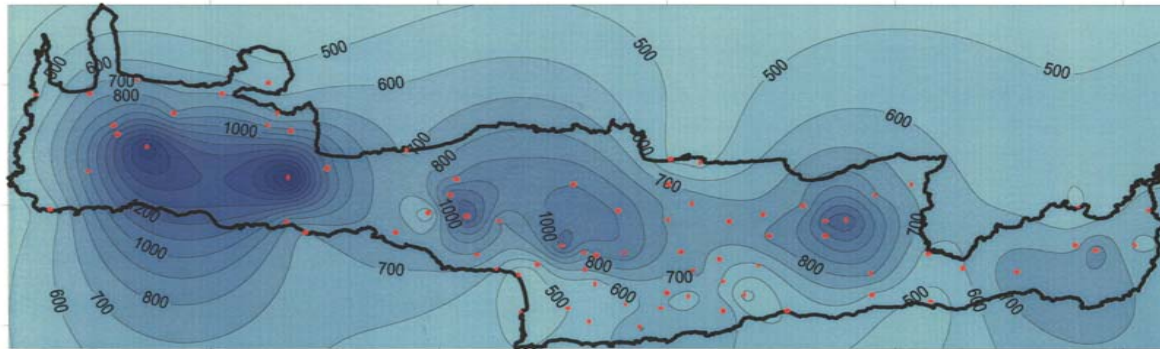
Αριθμός Βροχομετρικών Σταθμών: 80

**ΒΡΟΧΟΒΑΘΜΙΔΑ : 61 mm/100 m**



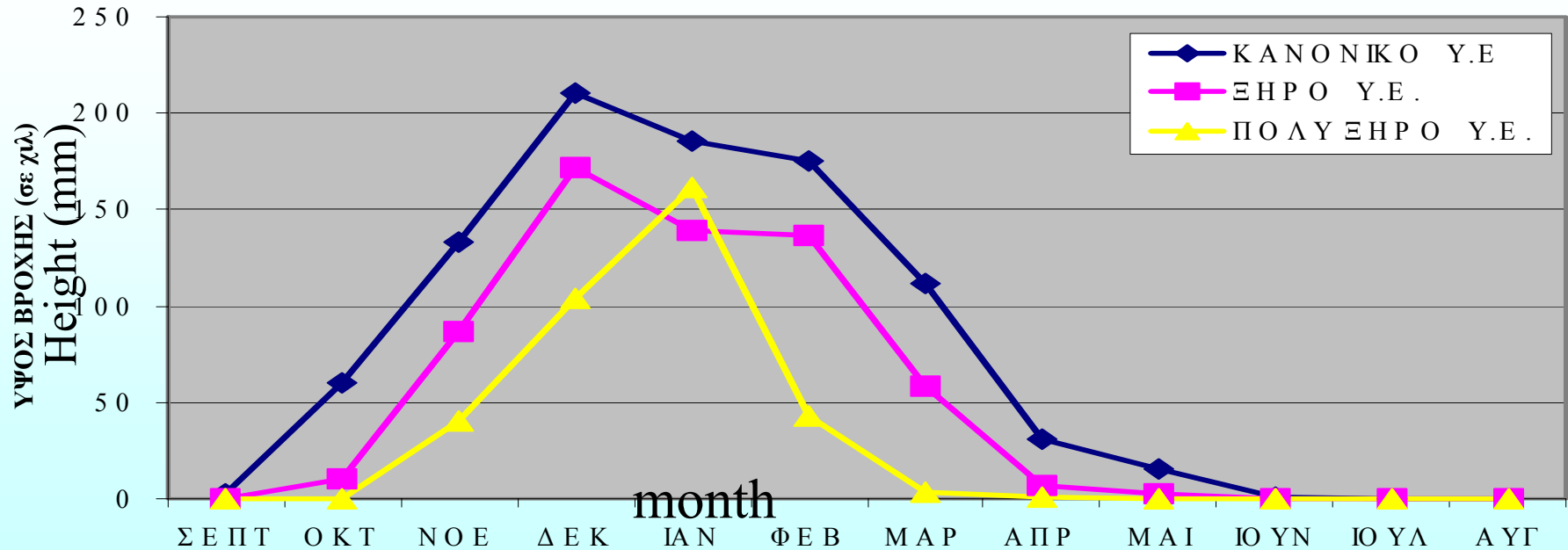
# ANNUAL DISTRIBUTION OF PRECIPITATION (mm)

Ισοϋέτιες Καμπύλες Μέσης Ετήσιας Βροχόπτωσης Νήσου Κρήτης  
Περίοδος 1977 - 1997, Παρεμβολή Ordinary Kriging



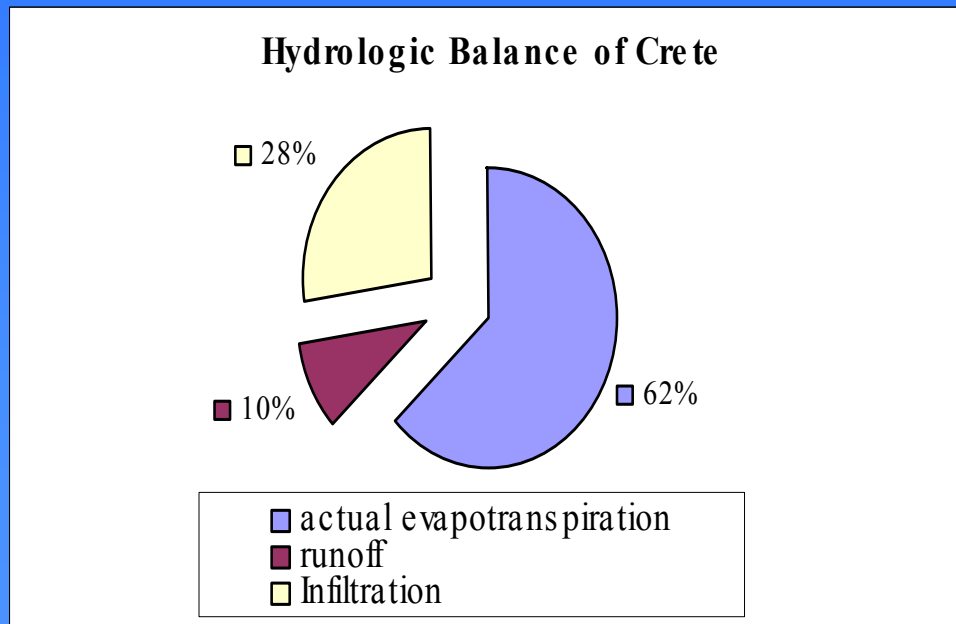
Αριθμός Βροχομετρικών Σταθμών: 80

## ΕΤΗΣΙΑ ΚΑΤΑΝΟΜΗ ΒΡΟΧΟΠΤΩΣΗΣ



# ANNUAL HYDROLOGIC BALANCE

	WET YEAR	NORMAL YEAR	DRY YEAR
<b>AREA (km<sup>2</sup>)</b>	<b>8,335</b>		
<b>PRECIPITATION (IN BILLIONS m<sup>3</sup>)</b>	<b>10.33</b>	<b>7.69</b>	<b>5.07</b>
<b>EVAPOTRANSPIRATION (IN BILLIONS m<sup>3</sup>)</b>	<b>6.48</b>	<b>4.83</b>	<b>3.18</b>
<b>INFILTRATION (IN BILLIONS m<sup>3</sup>)</b>	<b>2.85</b>	<b>2.12</b>	<b>1.40</b>
<b>RUNOFF (IN BILLIONS m<sup>3</sup>)</b>	<b>0.99</b>	<b>0.74</b>	<b>0.49</b>



# INFILTRATION - GROUND WATER

## KARSTIC AQUIFERS

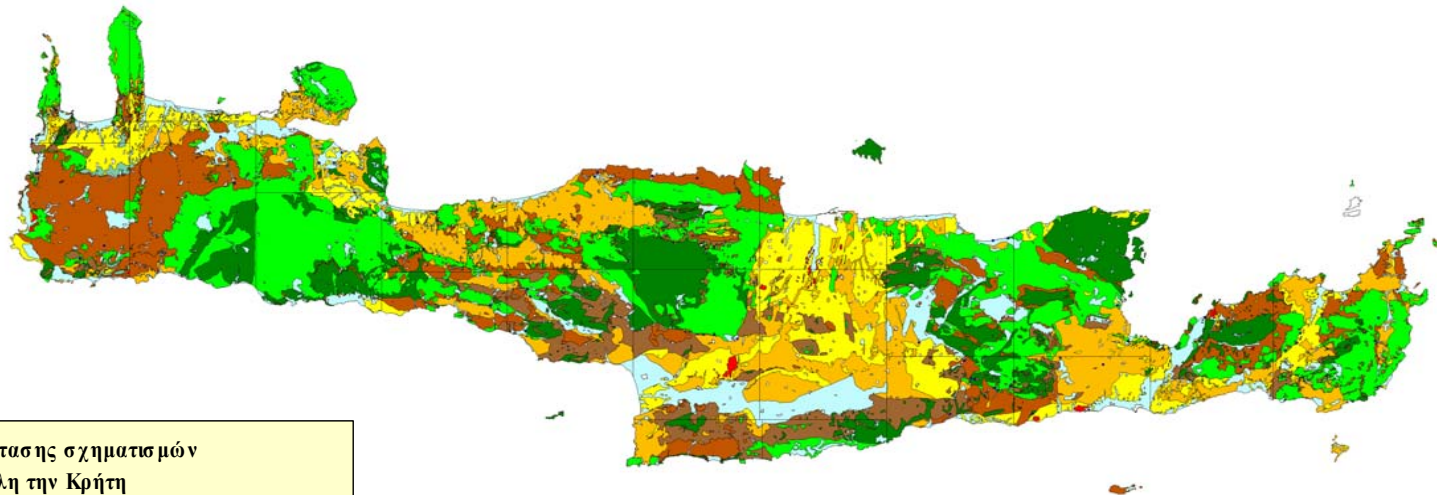
1.00 m rainfall →

- Half of which (50 cm) penetrates the surface and infiltrates the groundwater aquifers
- The other half (50 cm) evaporates

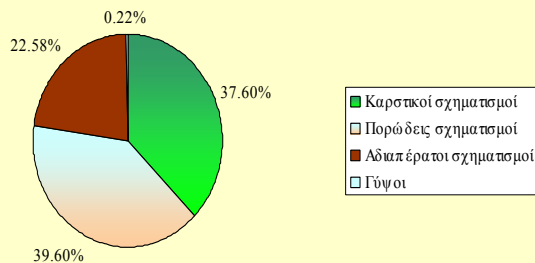
## ALLUVIAL AQUIFERS

0.7 m rainfall →

- 70% evaporates and transpires (lower altitudes)
- 10% penetrates the surface and infiltrates the groundwater aquifers
- 20% circulates as surface runoff

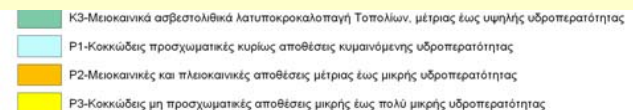


Ποσοστό έκτασης σχηματισμών σε όλη την Κρήτη



### Spatial distribution of

- Neogene – Quaternary sediment filled grabens hosting shallow mainly alluvial aquifers (yellow-brown, blue) and
- pre Neogene formations hosting deep Karstic aquifers (green).



75 100 Kilometers

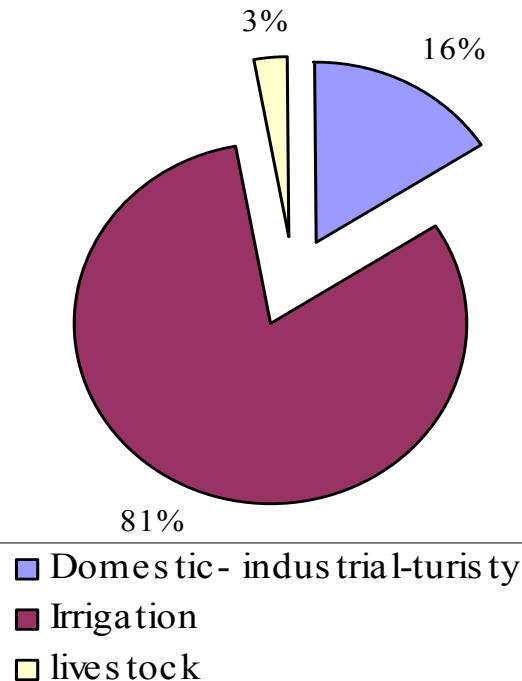
# USAGE OF WATER IN CRETE

In millions cubic meters

Domestic-Tourist	Irrigation	Livestock	Total
68	340	12	420

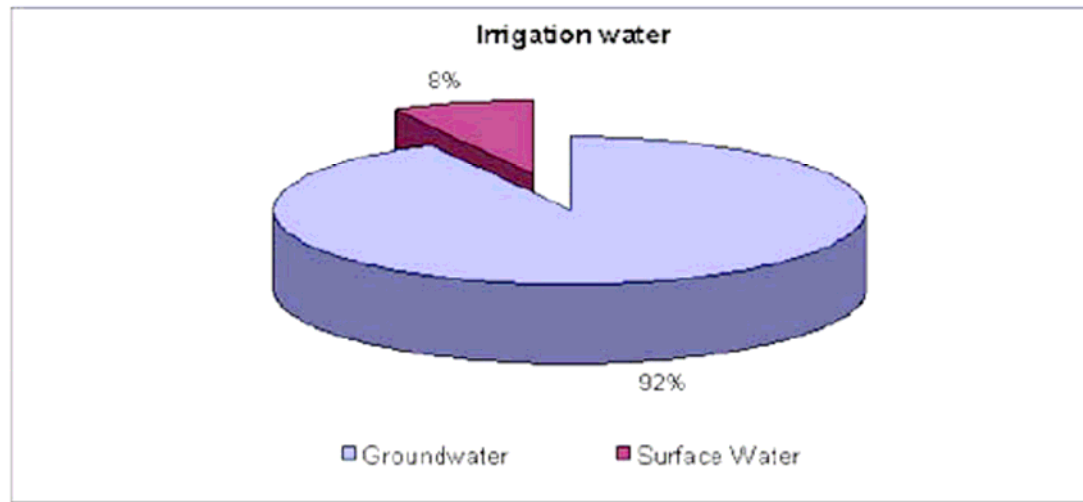
Only, 5% of total precipitation is currently being exploited

Total Consumption in Crete

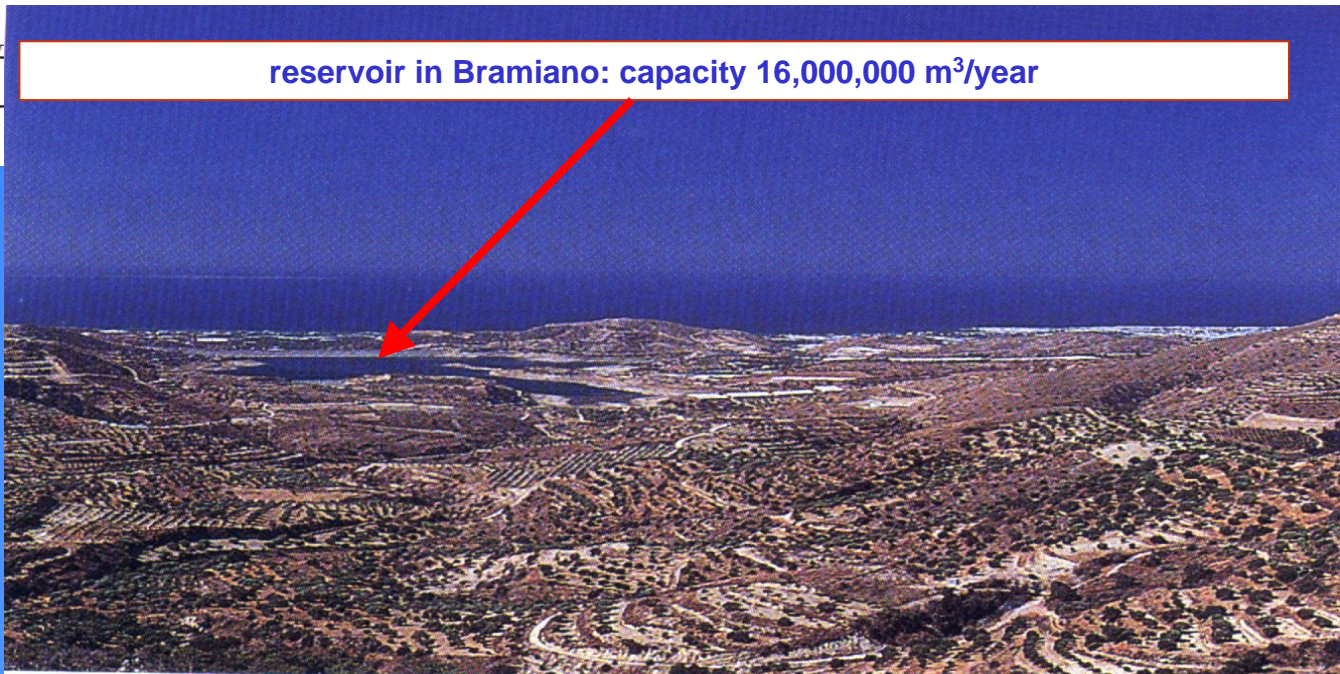




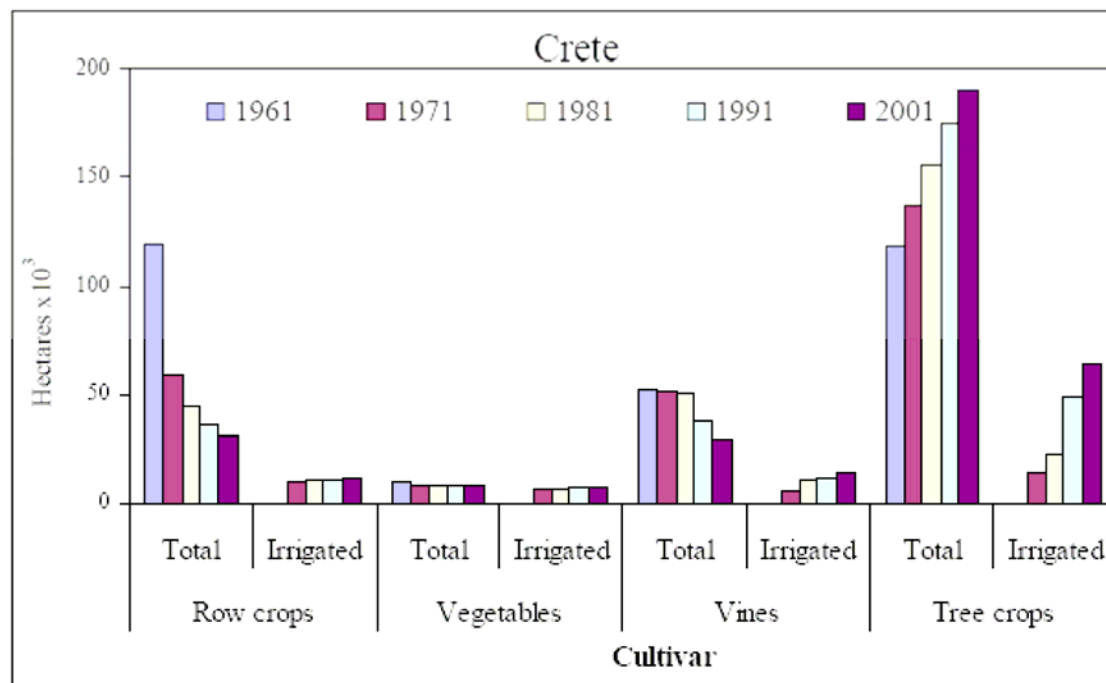
# Origin of irrigated water



reservoir in Bramiano: capacity 16,000,000 m<sup>3</sup>/year

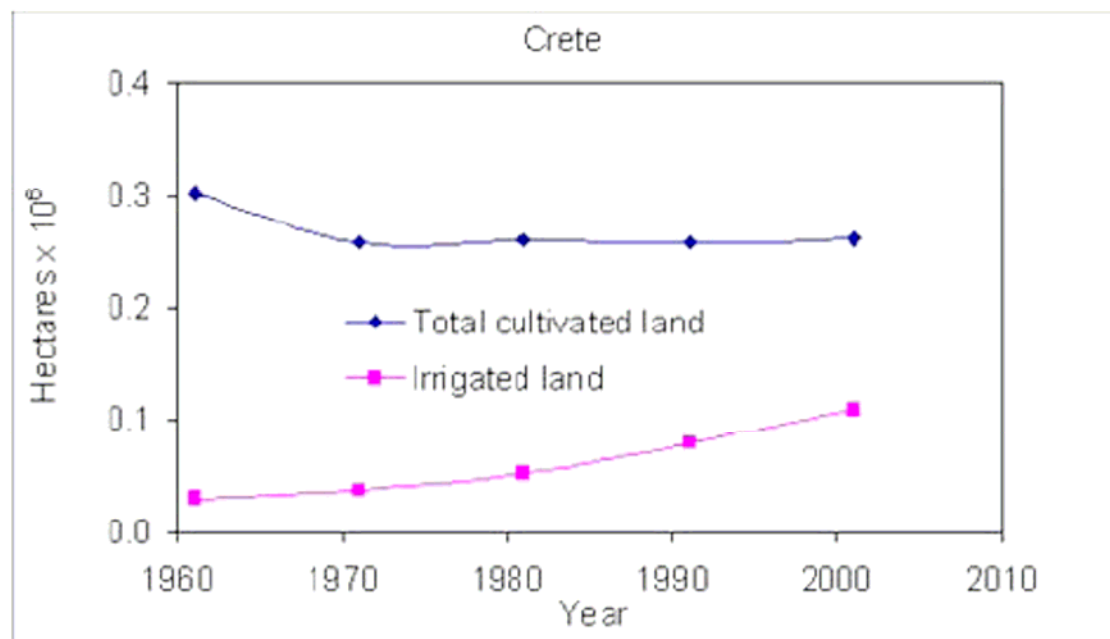



Agriculture represents an important sector of the local economy in Crete. It contributes 13% to the GDP of the island, while services and tourism represent 77% and industry 10%. Approximately 6.7% of its active working population are in the agricultural sector.



Area and crops cultivated in Crete in the last 40 years, (Hellenic National Statistical Service).

## Irrigated area

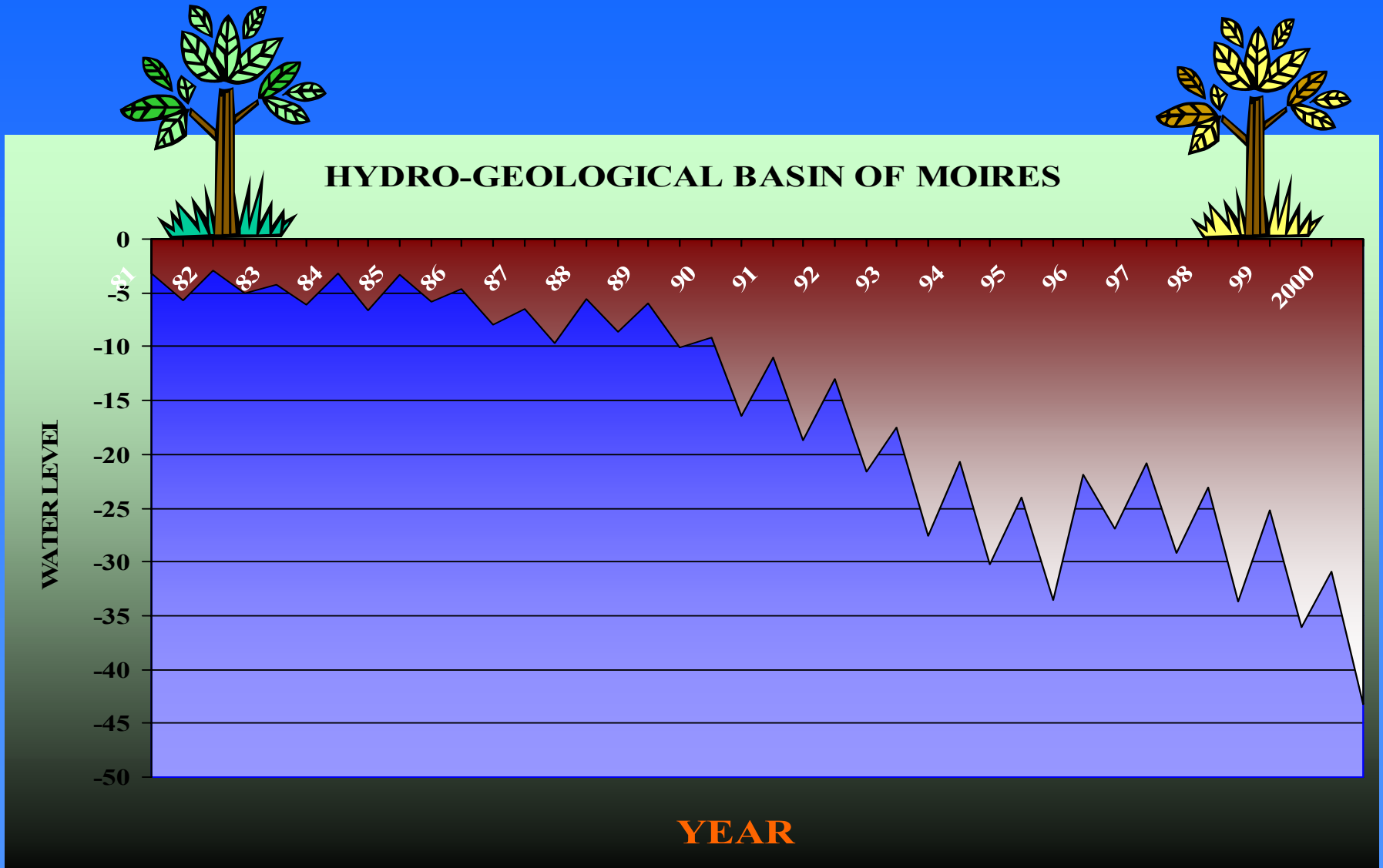


: Total cultivated and irrigated area in Crete, (Hellenic National Statistical Service).



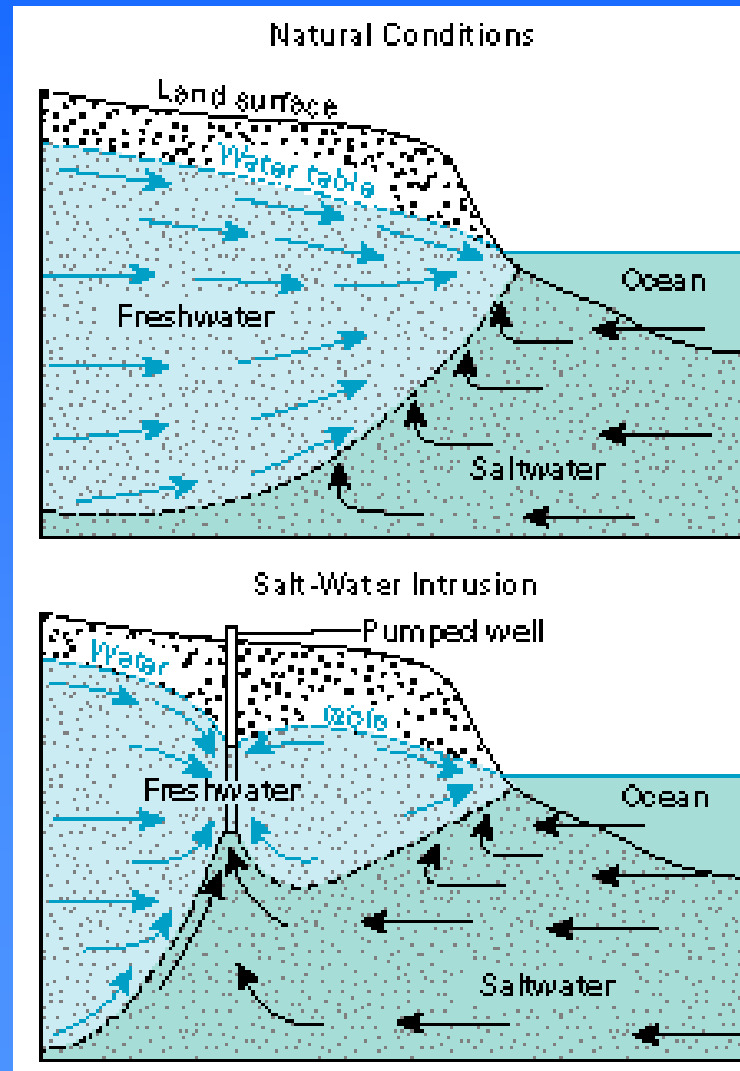
# AFFECTS OF OVER EXPLOITATION OF GROUND WATER

QUANTITATIVE PROBLEMS: lack of water for the various uses



# AFFECTS OF OVER EXPLOITATION OF GROUND WATER

QUALITY DETERIORATION: sea water intrusion, fertilizers in plain - cultivated areas



# PROTECTED AREAS - METERS ON REGIONAL LEVEL

ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ  
ΔΙΝΣΗ ΣΧΕΔΙΑΣΜΟΥ & ΑΝΑΠΤΥΞΗΣ  
ΤΜΗΜΑ ΔΙΑΧΕΙΡΙΣΗΣ ΥΔΑΤΙΚΩΝ ΠΟΡΩΝ

## PROTECTION OF WATER RESOURCES

ΜΕΤΡΑ ΠΡΟΣΤΑΣΙΑΣ ΥΔΑΤΙΚΟΥ ΔΥΝΑΜΙΚΟΥ ΚΡΗΤΗΣ  
(σύμφωνα με τις κανονιστικές αποφάσεις Νομαρχών)



**Ground water:** emission of restrictive measures related to the drilling of bores and wells, according to the quality and quantity status of the water resources in every one of the 4 prefectures of the island.

■ ΠΕΡΙΟΧΕΣ ΥΠΟ ΑΠΑΓΟΡΕΥΣΗ



# 31% of Crete is under the protection of the Natura 2000 Treaty



REGION OF CRETE  
DIRECTORATE OF PLANNING AND DESIGN  
SECTION OF WATER RESOURCES MANAGEMENT

## NATURA 2000



0 12.5 25 50 75 100 Kilometers

### Legend

-  Όρια περιοχών Natura2000
-  Όρια περιοχών Corine

# Objective of the mission

The *Segura-Crete TWINBASIN* project was focused on specific areas of interest based on Integrated Water Resources Management (IWRM), that have been identified as:

- Implementation of the Water Framework Directive (WFD)
- Draught and flood prevention (plans and programmes)
- Groundwater – Surface water (exploitation and protection)
- Telemetric Network monitoring (meteorological and groundwater parameters)
- Monitoring of water
- Administrative framework (structure of the River basin authority)

Two missions have been taken place one in Segura River Basin and one in Crete, each one was lasted one week. During the missions the personnel visited the departments of the Basin Organisation (BO), learned about their functioning, interacted with the host BO's personnel, and discussed about IWRM, projects, programmes etc. In situ visits in specific areas have also taken place.

# BO's Administrative duties/ Responsibilities

## ... water management (water protection) at the basin level (1)

### Crete River Basin

- The elaboration and implementation of River Basin **Management Plan** and Program of **Measures**
- Taking **actions** and developing specific measures to combat or minimize the effects of **pollution** and **maintaining and improving the quality** of the waters within its jurisdiction
- Planning and implementation of specific measures for the protection during “**emergency situations**”

### The Segura River Basin

- Elaborating the River Basin **Hydrologic Plan**, as well as its reviews and follow-ups

- The **implementation of the WFD** and other EU Directives in Regional Level



# BO's Administrative duties/ Responsibilities

## ... water management (water protection) at the basin level (2)

### Crete River Basin

- The **coordination of the function of other related authorities** (protection agencies– water users etc) in the region

- The controlling of the uses of the available water resources and the effluent discharges

- The Issue of the licenses (water uses, construction of infrastructure, effluents disposal )

### The Segura River Basin

- Developing functions derived from **agreements with Autonomous Communities, Local Corporations**, and other private or public entities

- Administering and controlling the hydraulic public domain

- Administering and controlling the uses of general interest or uses that affect more than one Spanish Autonomous Community

- Developing projects, constructing and exploiting water infrastructures charged to the Organisation own funds, and constructing other public works entrusted by the Government.

- To ensure the public participation on water resources management issues.

- The water monitoring (qualitative and quantitative status)

# Administrative framework (structure of the River basin authority)

## Crete River Basin

- New structure (2006), the Directorate of Water at Regional is now organised (in harmonization to WFD)
- The administration of the main infrastructure (dams, pipe system, system of wells etc) belong to several Organisations (Municipal, Local agricultural organization etc)
- The bigger water bodies play an important role in the management-distribution of water

## Segura River Basin

- Older and bigger structure with higher degree of freedom in different aspects
- The administration of the main infrastructure system (dams, pipe system, wells etc) belong to SRB
- The control of the water uses especially in scarcity conditions is more effective in practice.

# Implementation of the Water Framework Directive (WFD)

## Crete River Basin

## Segura River Basin

- Both BOs are responsible for the **implementation of the WFD** and other EU Directives in regional level
- The developed **methodologies** in SRB for the adaptation of WFD could be applicable for the CRB or for other Mediterranean river basins and vice-versa due to similar climatic- environmental conditions, water scarcity, hydrologic conditions, ephemeral streams, water usages, agricultural patterns, tourist industry etc.
- Furthermore the **results** are comparable and have an added value for a common water police in the Mediterranean Region.



# Groundwater (exploitation and protection)

## Crete River Basin

- The 96% of the total water use is originated from ground water
- Approximate 5,000 wells are in operation, 80% are individual and the rest belong to municipalities or other organizations .
- An aquifer management system ( monitoring, models, GIS etc) has been applied to monitoring the main aquifers for a sustainable use.

## Segura River Basin

- Use both surface and ground water
- the droughtwells, on reserving ground water supplies in order to deal with emergency situation, are considered as a best practice.

- Both BO faces same Problems that are focused on water depletion of the shallow aquifers and seawater intrusion in costal both resulting from the overexploitation. Measures and restrictions have been imposed.
- A monitoring system of main aquifers has been established since 1980 (Crete).

# Water resources management plans and programmes

## Crete River Basin

**Decision Support System  
has been developed since 2002**

## Segura River Basin

- The River Basin **Hydrologic Plan**
- **DSS** based mainly on G.I.S
- Now, a nodal model for River Basin Simulation is developed by Valenthia university including economical and environmental modules

# Crete River Basin Decision Support System

A systematic inventory of :  
1) the available water resources and their spatial distribution ;  
2) all water uses;  
3) environment  
(GIS, HYMOS DATABASE)

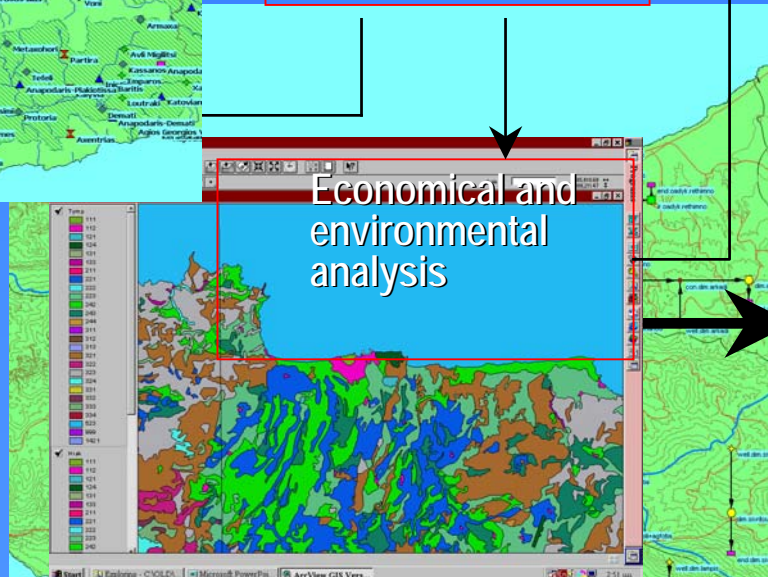
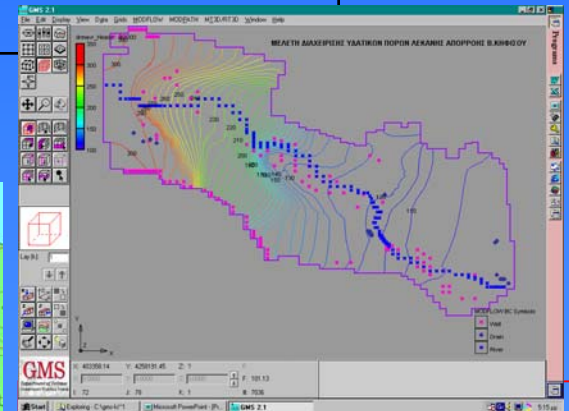
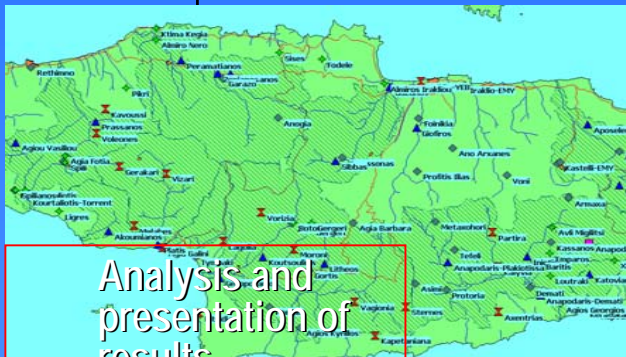
Hydrological and  
Hydrogeological  
simulation  
(SACRAMENTO,  
GMS/Modflow)

The evaluation  
of different  
development  
scenarios  
(RIBASIM)

Analysis and  
presentation of  
results  
(GIS, ARCGIS)

Economical and  
environmental  
analysis

- Choosing Best Scenario  
- Optimal planning and  
infrastructure development



# Monitoring networks

## Crete River Basin

- the water monitoring system comprises:
  - Meteorological stations and
  - Hydro- stations (Stream flow, Spring flow), in operation since 1960
  - Groundwater stations, in operation since 1980 (parameters: water level, conductivity, Cl<sup>-</sup>)
- Telemetric system both meteorological and ground water station, in operation since 2000.

## Segura River Basin

- **ICA netstations**
- **COASstations**
- **COCAautomatic alert stations**

- Both telemetric systems applies relevant technologies for communicating with the basic station and measure the same parameters. Partially, could be operated as alarm system.
- In Crete the data of the telemetric system direct introduced to Hydrological database of DSS for further analysis

# Activities developed SEGURA RIVER BASIN (1)

## *Institutional Framework*

Visit at all department of the CONFIGERACION  
HIDROGRAFICA LA SEGURA –  
SEGURA RIVER BASIN CONFEDERATION.  
The exchange of expertise and the acquaintance



## *Water Resources Management of Segura River Basin*

Presentation of water Demand- Supply balance of SRB.

- Water resources: Physical characteristics, climatology, meteorological conditions, hydrology, hydrogeology.
- Infrastructure: Main Hydraulic systems, conveyance system of Tago river- Segura river, dams, wells, desalination plants, water treatment plants.
- Conjunctive use of surface water and ground water.
- Water uses: land use, consumption per use (domestic, agriculture, industrial, tourist), reuse of treated water, modernization of agricultural practice
- Water Balance: presentation and analysis of related problems

**Hydrological National Plan** (problems to be addressing)



# Activities developed SEGURA RIVER BASIN (2)

## *Infrastructure of Segura River Basin*

- Visit the Ojos' reservoir and dam, the inter basin transfer channels and pumping station
- Visit at the San Pedro del Penatar **Desalination Plant**. (Presentation of the operation of the plant and discussion with the experts about the cost analysis of desalinated water, and the impacts to the environment)
- Visit at the Mar Menor-Sur a **Waste – water treatment plant** ( Presentation of the plant's operation and discussion with the experts about the cost analysis and the reuse of water)



## *Ground Water in Segura River Basin*

- Visit the area of Synclinal of Calasparra aquifer (The geology, hydrogeology, as well as the water balance of the aquifer were discussed with the Geologist. We also visited an “drought well” installation system and a karstik spring in the Segura river basin)
- Presentation and characterization, according to WFD, of the main aquifers of the Segura River Basin.

# Activities developed SEGURA RIVER BASIN (3)

## ***Agriculture practice***

Visit a green house in the Campo de Cartagena- (cultivating hydroponic crops. Discussion with the owner about the applied agricultural patterns, and the consumption of water to irrigate hydroponic crops).



## ***System Tools for Water Resources***

DSS – AQUATOOL Demonstration of SSD – AQUATOO,L which is a nodal supporting decision system (software), concerning the planning and management of water resources. Discussion on the capabilities of the tool and the new developments for adapting the WFD. - GIS Demonstration of the Geographic Information System applied by the Segura River Basin Confederation.

## ***Implementation of Water Framework Directive***

Presentation of the progress done by the Segura River Basin Confederation in incorporating the requirements of the 5th , 6th and 7th articles in SRB:  
-Basin characterization Pressures and impacts ; Protected areas ;Economical analysis; GIS

## ***Water Quality Management of Segura River Basin***

-Presentation of the qualitative and quantitative monitoring networks, applied in surface and ground water.  
--ICA netstations ; COASstations ;COCAautomatic alert stations

# Activities developed CRETE RIVER BASIN (1)

## *Institutional Framework*

Visit at all sections of the REGION OF CRETE/  
DIRECTORATE OF WATER.  
(exchange of expertise and the acquaintance)



## *Water Resources Management of Crete River Basin*

Presentation of water Demand- Supply balance of CRETE.

- Water resources: Physical characteristics, climatology, meteorological conditions, hydrology, hydrogeology.
- Infrastructure: Main Hydraulic systems, conveyance systems, wells, reservoirs, water treatment plants.
- Conjunctive use of surface water and ground water.
- Water uses: land use, consumption per use (domestic, agriculture, industrial, tourist), modernization of agricultural practice,

Water Balance: presentation and analysis of related problems

## **Decision Support System (DSS)**

# Activities developed CRETE BASIN (2)

## *Infrastructure of Crete River Basin*

- Visit the Bramiana reservoir – Malavra costal
- brackish spring and the conveyance system
- (eastern Crete)
  
- Visit the Karstik spring system of Agia- reservoir
- (Management of a NATURA 2000 area)
  
- Visit the Organization for Development of Western Crete (responsible for distribution and supply of water for 200,000 inhabitants and 200.000 ha )
  
- Visit Waste – water treatment plant in Chania (Presentation of the plant's operation and discussion with the experts about the cost analysis and the environmental impacts)



## *Ground Water in Crete River Basin*

- Visit the Karstik springs of Almyros, Agia, Stylos and the shallow aquifers ( The geology, hydrogeology, as well as the water balance of the aquifer were discussed with the geologists and water managers.)

# Activities developed CRETE RIVER BASIN (3)

## ***Agriculture practice***

Visit a green house in “Ierapetra” cultivating hydroponic crops.(Discussion with the owner about the applied agricultural patterns, and the consumption of water to irrigate hydroponic crops, recycling of ground water for cooling system.

Visit the Peza Cooperative (discussion of market prices, the cost of water and the irrigation methods)

## ***System Tools for Water Resources***

DSS – RIBASIM Demonstration– HYMOS GMS- GIS which is a nodal supporting decision system (software), concerning the planning and management of water resources)

## ***Implementation of Water Framework Directive***

Presentation of the progress done by the Crete River Basin :

- Administrative Framework
- Changes in the National Legislative system
- Pilot studies for ecological status of water.
- GIS

## ***Water Quality Management of Crete River Basin***

- Presentation of the qualitative and quantitative monitoring networks, applied in surface and ground water.





# Results of the missions (1)

- The missions were very interesting and well organized. It should be mentioned that over 60 people were involved in the different activities developed. The people involved are experts in a specific field concerning the management of water resources.
- Visitations to historical – archaeological interesting sites (Cartagena, Salzillo museum, Minoan palace, Roman settlements in Crete), focused on ancient hydraulics systems have contributed to a better understanding of the development of the area thought time.
- The common, Mediterranean characteristics between the TWINBASIN Segura and Crete basins, regarding climate, hydrology, hydrogeology, water deficiency, water uses, even agricultural patterns and the related water issues, strengthens the need for the development of a common methodology for Integrate Water Resources Management in Mediterranean areas.
- We find it very useful and support the idea of organizing a final conference of all involved TWINBASIN missions.

# Results of the missions (2)

## About Methodology:

- As the river basin analysis in Region of Crete is still in progress, the developed methodologies in SRB, according to WFD requirements (economical analysis of water; the characterization of river basin; the impact of human activities; the identification of pressures - establishment of reference condition for surface water bodies; the registration of protected areas and the application of GIS), can be used as a pattern for Region of Crete.
- The result of pilot study for the ecological status of water in Crete river basin (Indices) could be used on the SRB.

# Results of the missions (3)

## About Practice:

### Crete River Basin

- The Directorate of Water in Region of Crete is now being organized; the detailed organic structure of the Segura River Basin Confederation has much to offer on that field.
- The technical visit at the desalination plant, moreover the economical analysis and the related environmental issues, present a useful information for a future application in Crete.
- The reuse of treated water for agriculture

### Segura River Basin

- The DSS tool for the IWRM in Crete could be useful for Segura.
- The integration of data in a DSS- GIS in Crete is an important challenge for Segura database- GIS
- The decentralize system for ground water management, in which water management controlled by Crete River basin and the operation and maintenance of infrastructures by local organization, could be possibly solved problems in Segura that they derive of the Farmers.

# Conclusions

from the twinning between the Segura- Crete basin organisations and the collaboration between water management entities, much have been gained regarding:

- the operation of the River Basin Organization
- the exchange of practices and knowledge on IWRM that helps to improve the work and institutional capacity.
- the Improvement of the effectiveness of integrated water management within organisations.
- a friendly cooperation between water managers and strengthen ties among basin organisations.
- The improvement of the contacts between the basin management organizations and other institutes.
- The encourage of the exchange of expertise, knowledge and technical personnel beyond the project.
- The improvement of the overall functional operation of these institutions.
- To bring and to promote the contacts of other organizations, institutes etc

Thanks for your time !!