

LIFE AgroClimaWater Networking Meeting

Irrigation water management in Crete: current status and perspectives



Dr. Marinos Kritsotakis
m.kritsotakis@apdkritis.gov.gr

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Crete Climate Conditions

The **climate** of Crete is a temperate Mediterranean climate
The **weather** in Crete is characterized by mild, rainy winters and hot, dry summers.



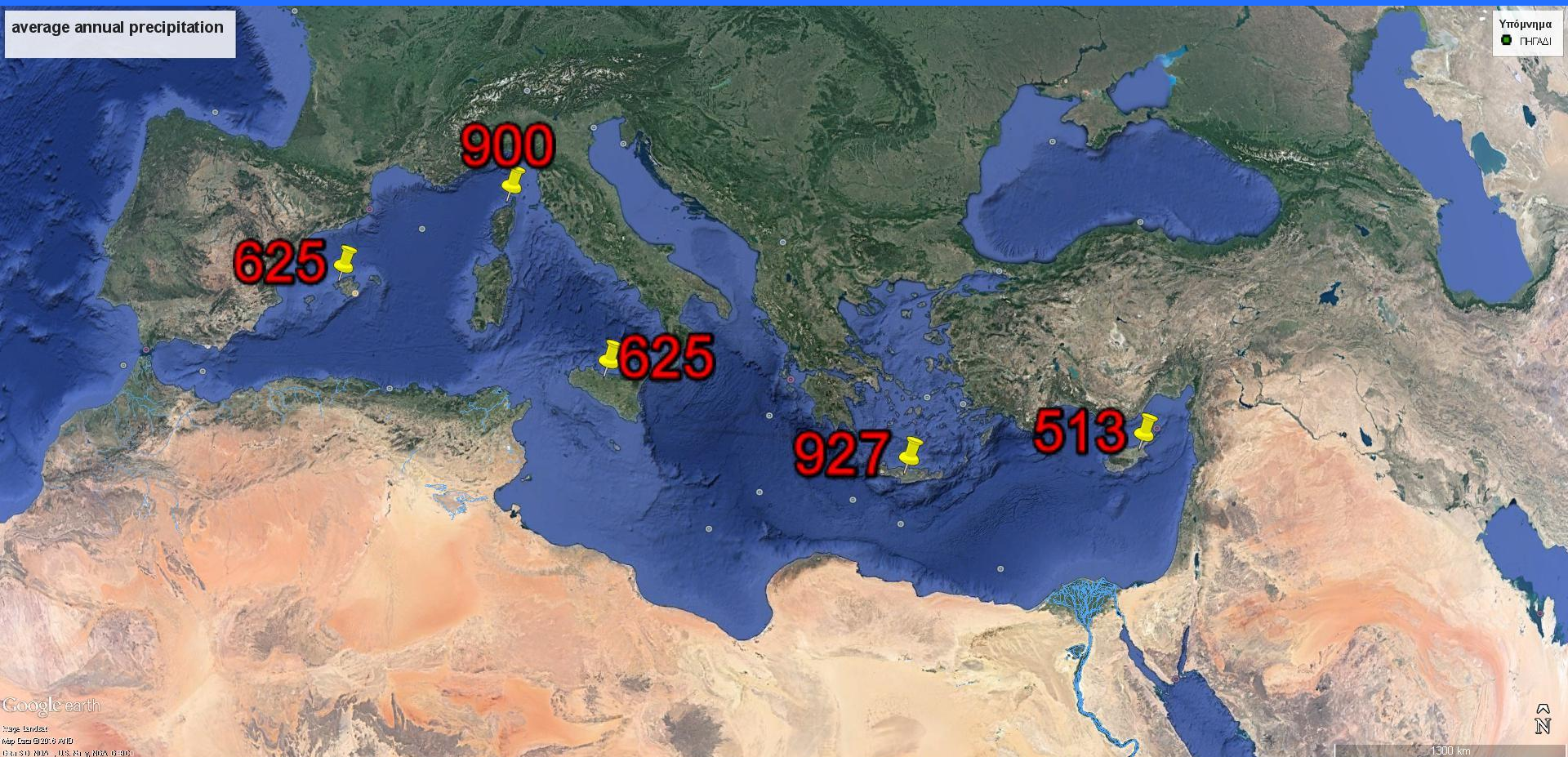
1500 Km
from the
Fertile
Crescent

500 Km to Sahara Desert

Google earth

PRECIPITATION ON MEDITERRANEAN ISLAND

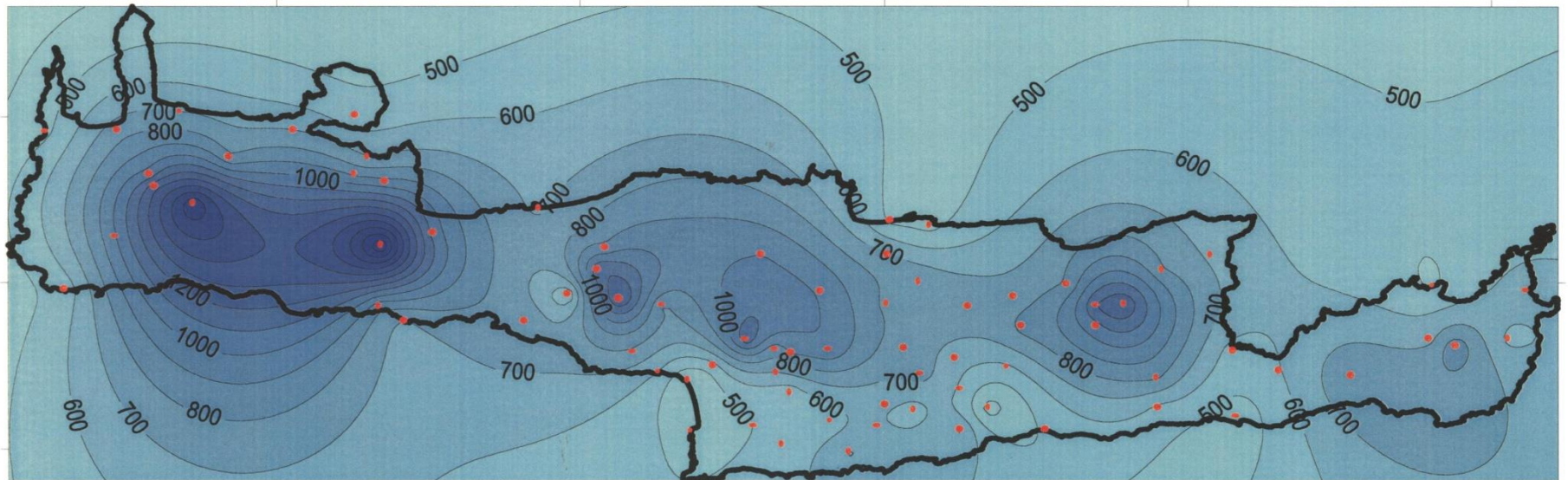
	<i>MAJORCA</i>	<i>CORSICA</i>	<i>SICILY</i>	<i>CRETE</i>	<i>CYPRUS</i>
AREA (Km2)	3.640	8.682	25.700	8.335	9.251
MEAN ANNUAL PRECIPITATION (mm)	625	900	625	927	513



SOURCE: MEDIS PROJECT

ANNUAL PRECIPITATION (mm)

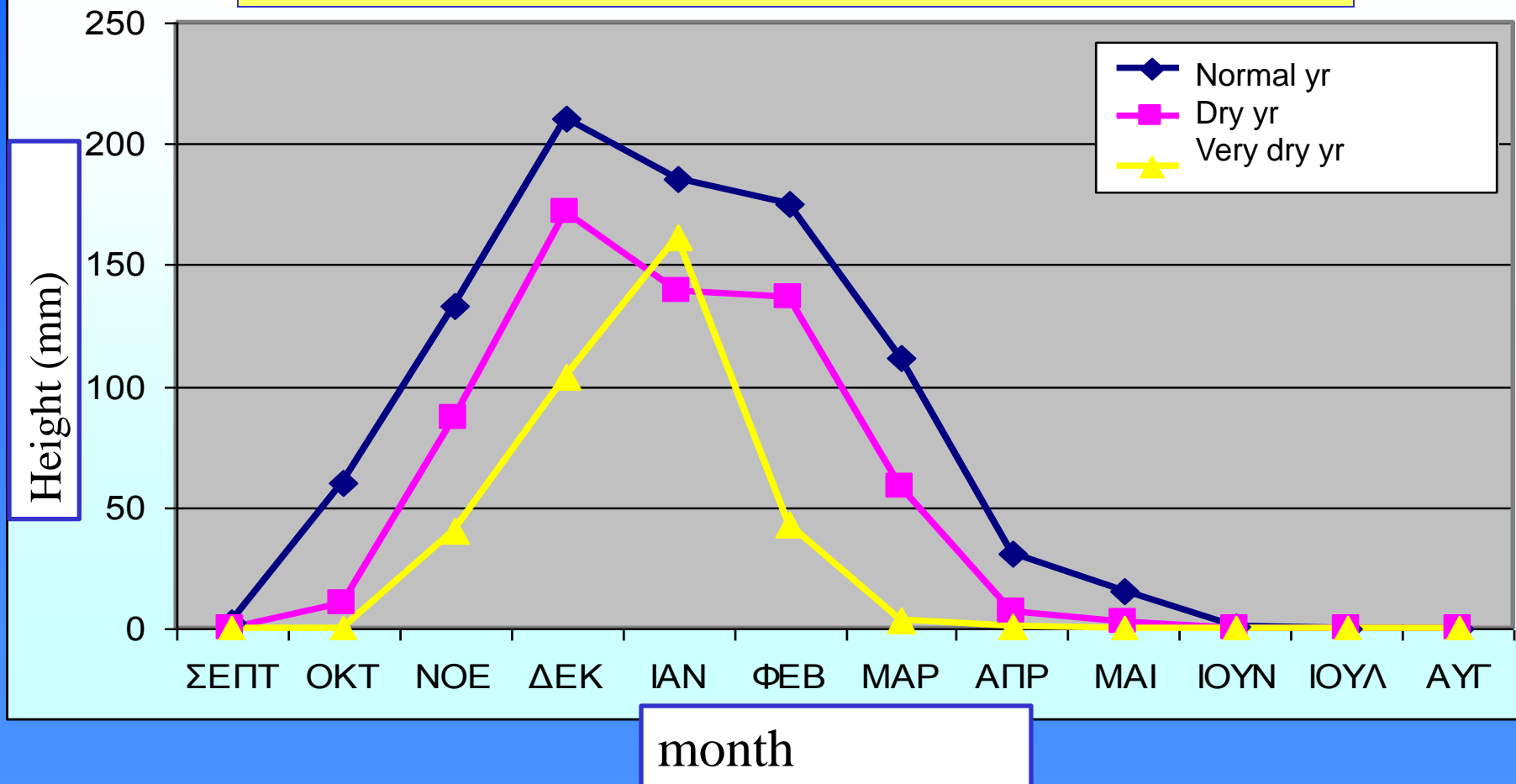
HYDROLOGIC CONDITIONS	CRETE	EASTERN CRETE	WESTERN CRETE
<u>WET YEAR</u> (RETURN PERIOD 10%)	1239	1108	1395
<u>NORMAL YEAR</u> (RETURN PERIOD 50%)	927	815	1052
<u>DRY YER</u> (RETURN PERIOD 90%)	608	526	708



Αριθμός Β

Spatial and temporal variation

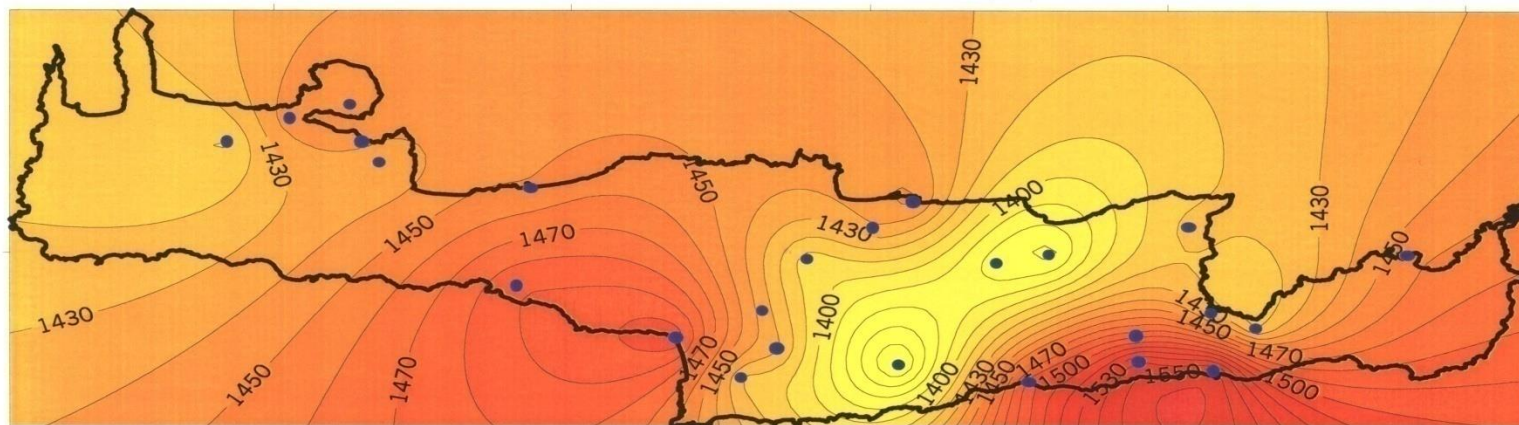
ANNUAL DISTRIBUTION OF PRECIPITATION (mm)



ACTUAL EVAPOTRANSPIRATION (in mm)

HYDROLOGIC CONDITIONS	CRETE	EASTERN CRETE	WESTERN CRETE
<u>WET YEAR</u> (RETURN PERIOD 10%)	777	695	876
<u>NORMAL YEAR</u> (RETURN PERIOD 50%)	579	512	659
<u>DRY YER</u> (RETURN PERIOD 90%)	382	330	444

Περίοδος 1977 - 1997, Εκτίμηση κατά Penman, Παρεμβολή Ordinary Kriging



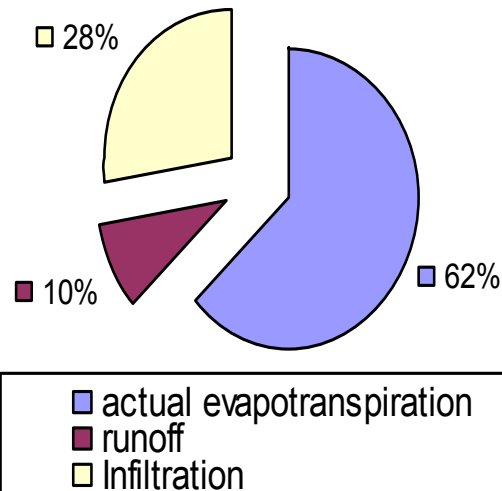
Η εκτίμηση ισχύει για περιοχές κάτω του υψομετρικού ορίου των 500 m

POTENTIAL EVAPOTRANSPIRATION (in mm)

ANNUAL HYDROLOGIC BALANCE

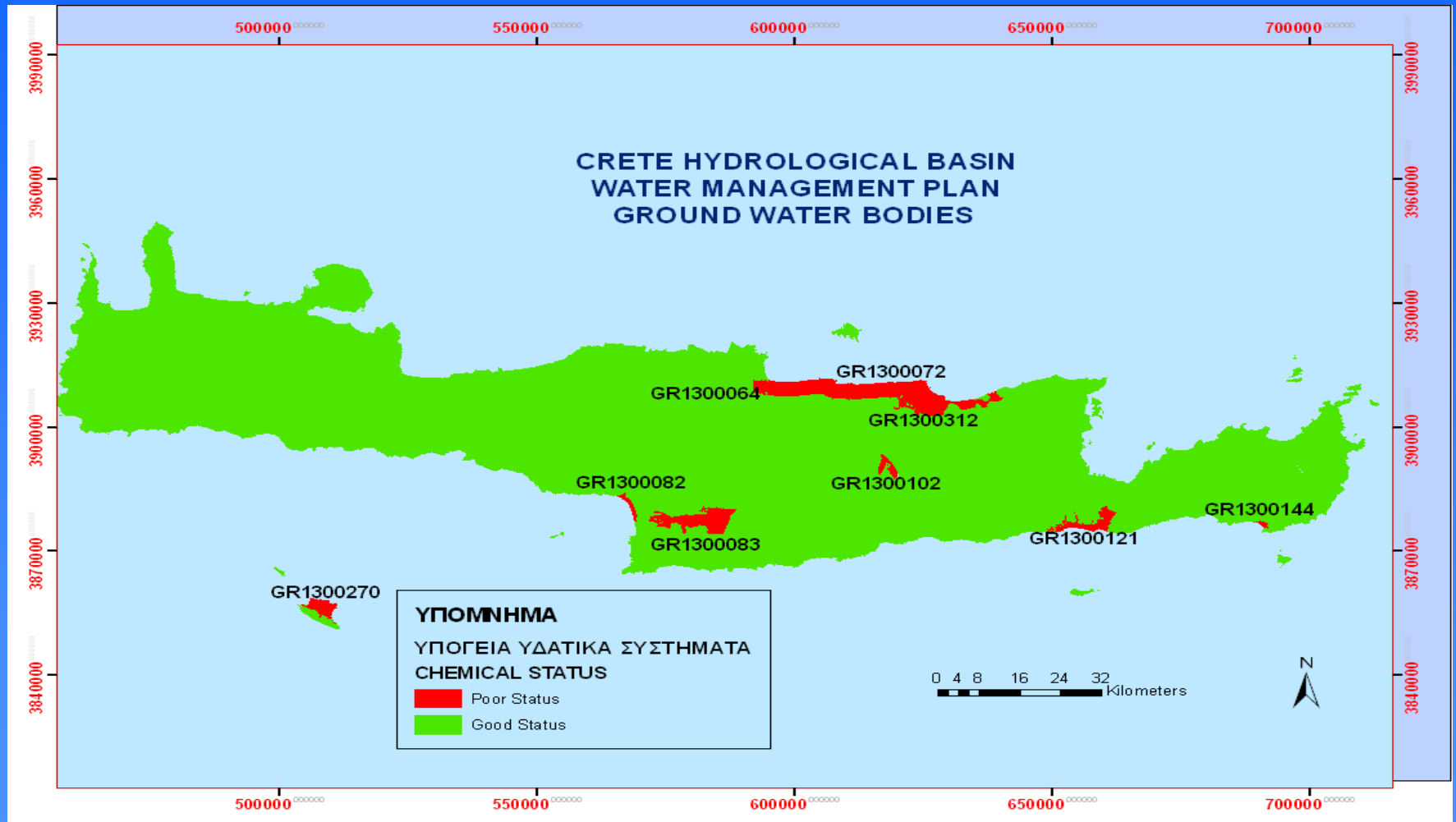
	WET YEAR	NORMAL YEAR	DRY YEAR
AREA (km²)	8,335		
PRECIPITATION (IN BILLIONS m³)	10.33	7.69	5.07
EVAPOTRANSPIRATION (IN BILLIONS m³)	6.48	4.83	3.18
INFILTRATION (IN BILLIONS m³)	2.85	2.12	1.40
RUNOFF (IN BILLIONS m³)	0.99	0.74	0.49

Hydrologic Balance of Crete



Recent Condition : Human impact on Groundwater Bodies

GROUNDWATER STATUS

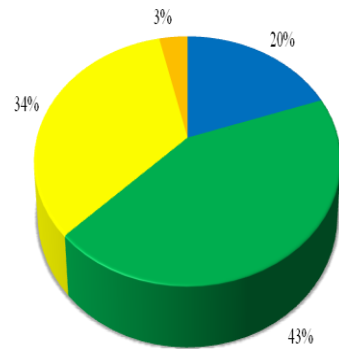


Red: Poor status

Green: Good status

Recent Condition : Human impact on surface water resources

ECOLOGICAL STATUS



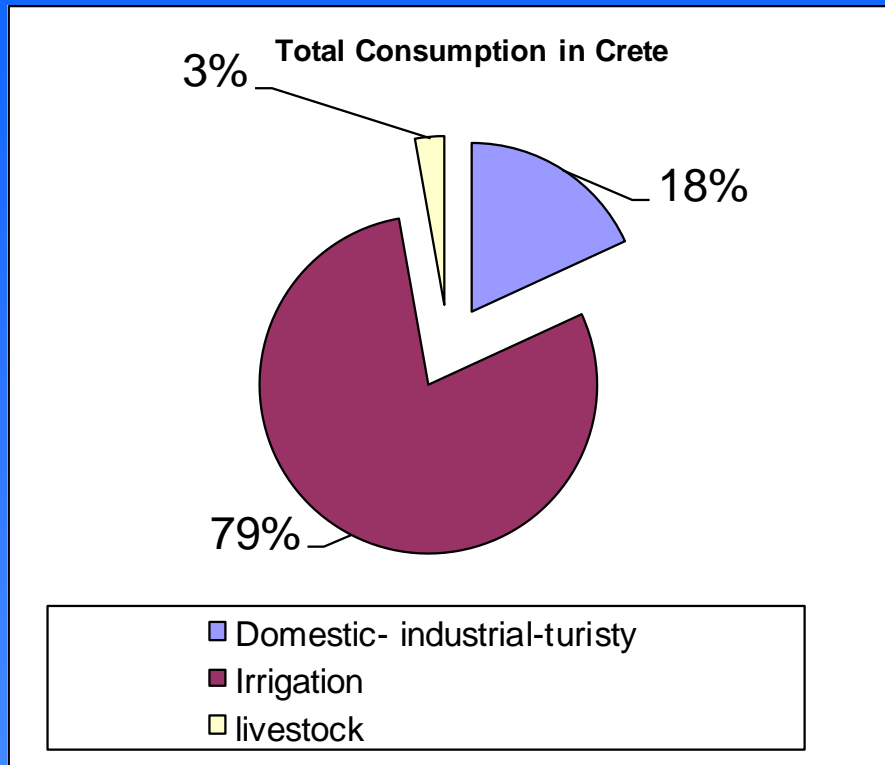
Χάρτης 36: Οικολογική κατάσταση και δυναμικό στα επιφανειακά συστήματα του ΥΔ Κρήτης

blue – Green line: very good and good status (63%)
Yellow Brown line: moderate and poor status (37%)

COSTAL WATER STATUS



Water Use – Crete (annual)



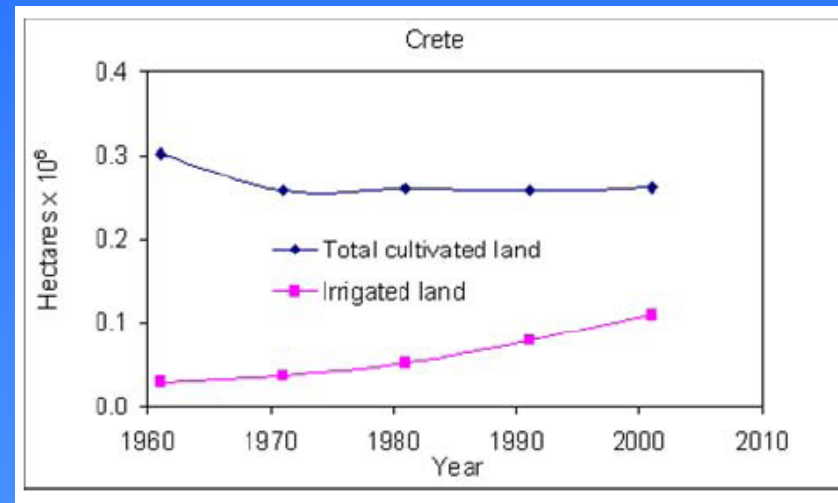
Greece does not present a balanced scheme of water uses, as the rural usage takes the “lion’s share” of about 80%.

Only, 5.5% of total precipitation is currently being exploited

Irrigation = 340 Mm³

Domestic = 78 Mm³

Livestock = 12 Mm³

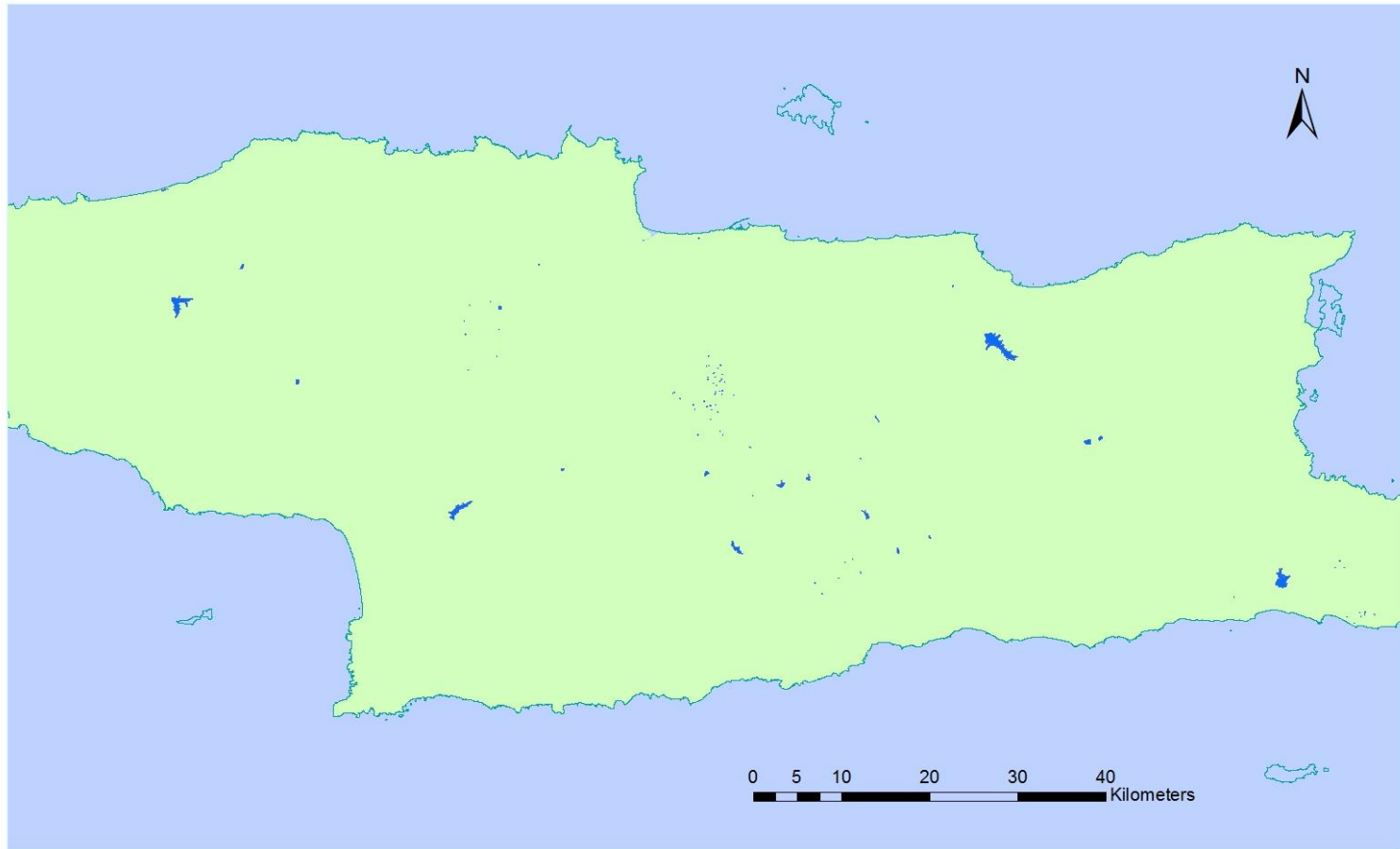


92 % of irrigation has groundwater origin

Water Use – Crete (annual)

Irrigation = 340 Mm³

Dams supply appr. 27 Mm³



Water Use – Crete (annual)

Irrigation = 340 Mm³

Wells supply : 313 Mm³

Wells in operation: 13,000 (approx.)



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
- Mean annual renewable groundwater 2.1 billions m³

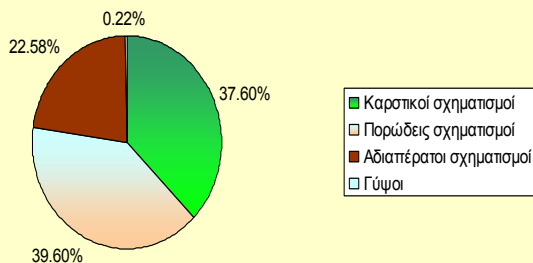
ALLUVIAL AQUIFERS

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



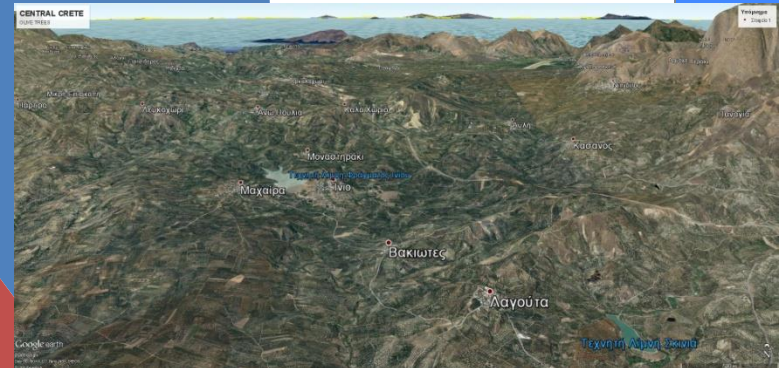
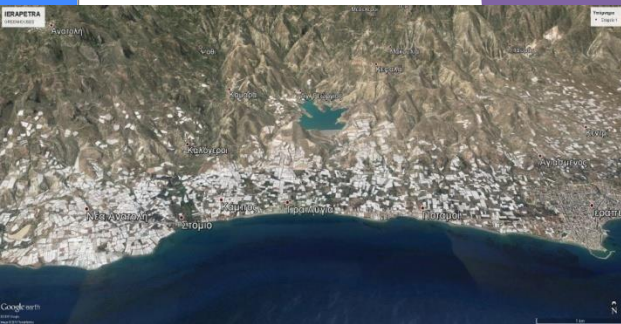
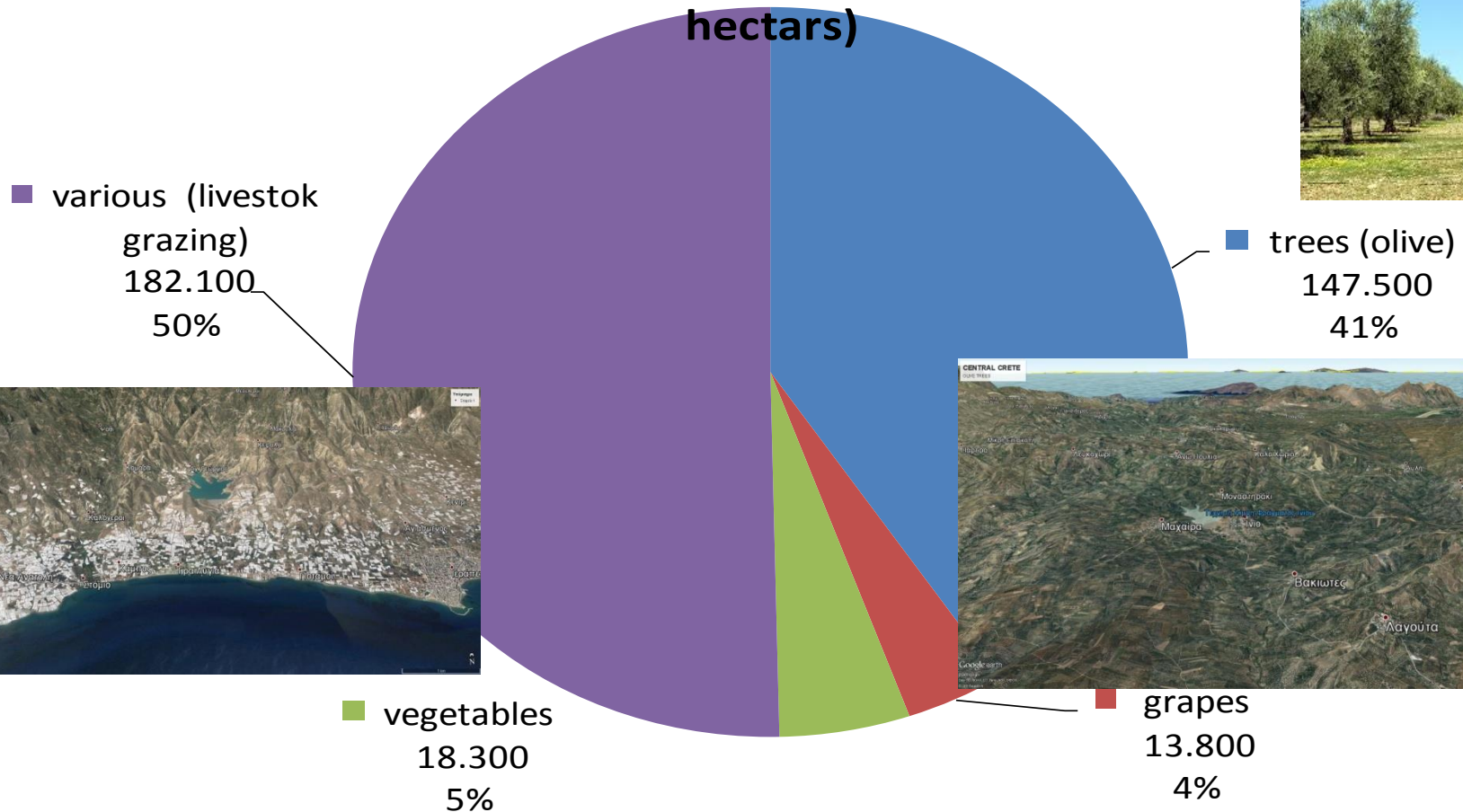
Spatial distribution of

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

Crete: agriculture sector

Farming (number)	trees (olive)	grapes	vegetables	various (livestock grazing)	total	farming (excluded livestock grazing and wine grapes)	irrigated	non irrigated
	hectares							
89.926	147.500	13.800	18.300	182.100	361.700	166.500	101.400	65.100

area and crops cultivated in Crete in year 2013 (in hectares)

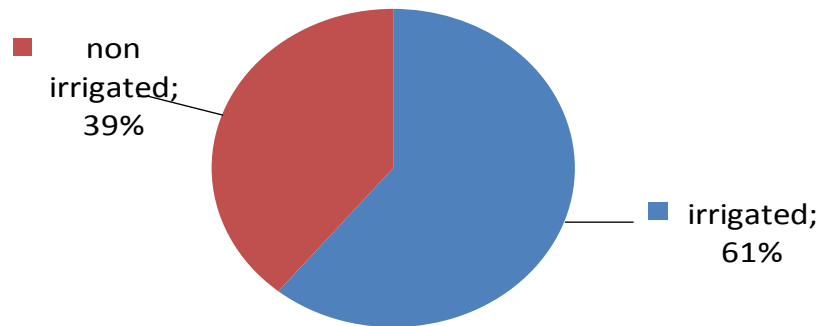


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(source : ELSTAT 2012)

farming (excluded livestock grazing and wine grapes)



Crete: Economic Sectors

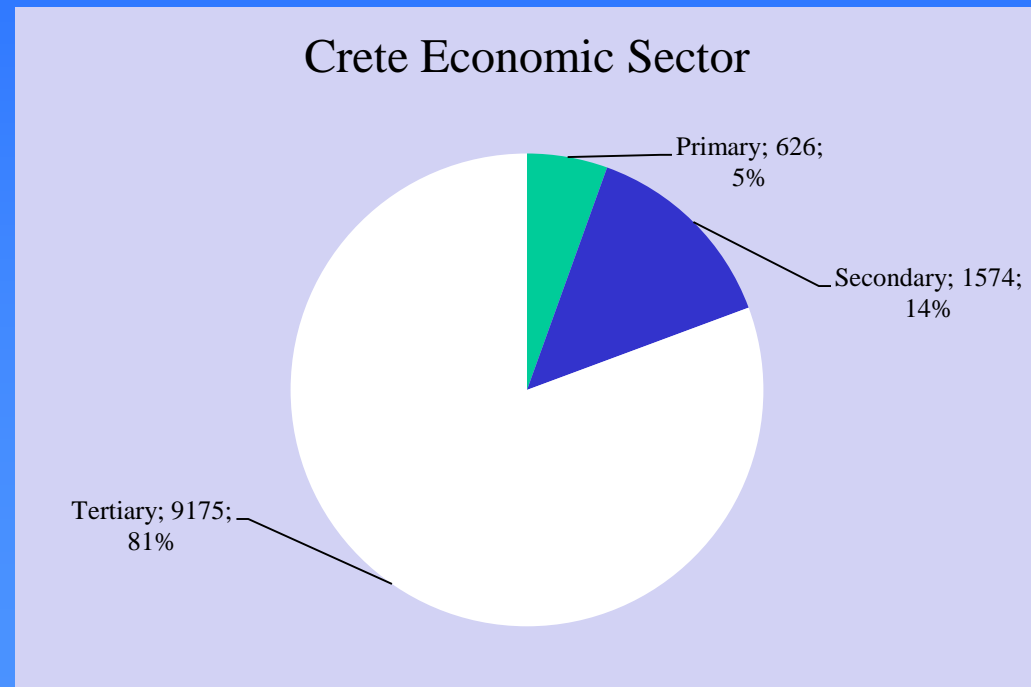
Crete 4.7% of the GDP of Greece (year 2012)

population	active population	Working population	unemployment	unemployment rate
623,065	286,000	214,800	71,200	24.89%

Agriculture represents an important sector of the local economy in Crete.

It contributes 5.58% to the Gross Production Value of the island

Approximately 6.7% of the active working population are in agriculture sector



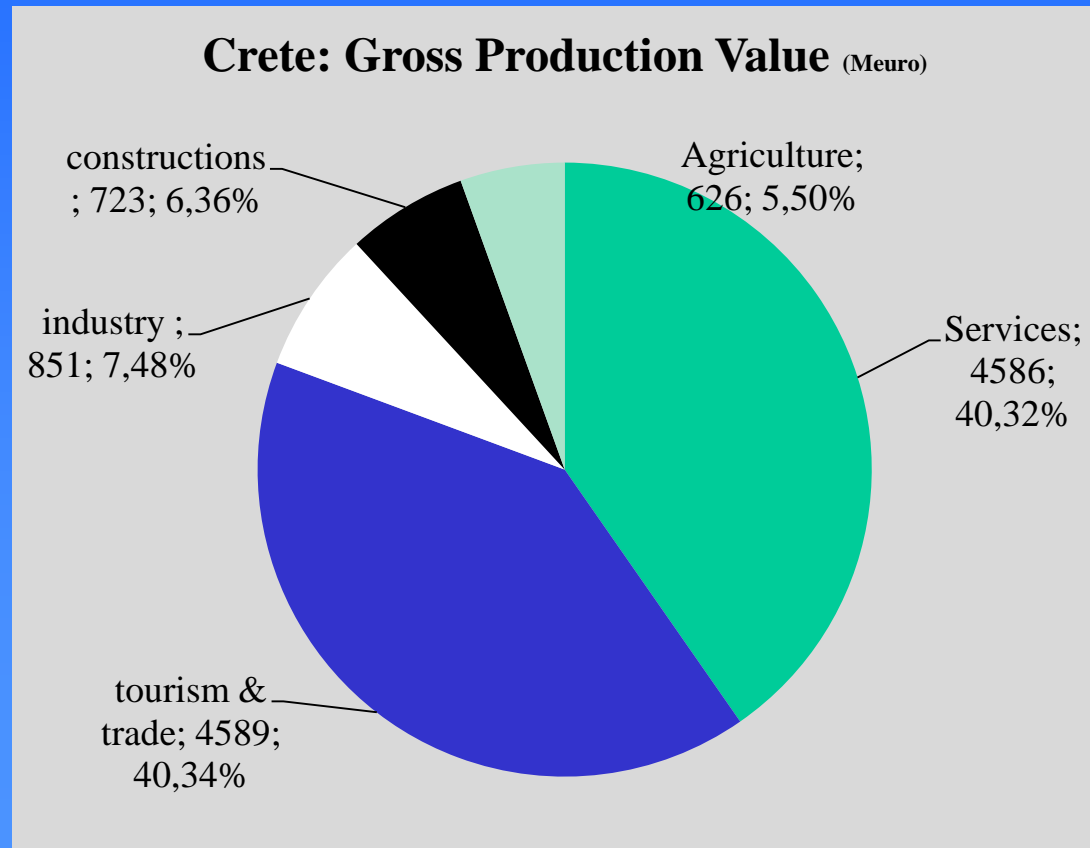
(source : ELSTAT 2012)

Crete: Economic Sectors

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Gross Production Value sector	Meuro	(%)
agriculture	626	5,50%
industry	851	7,48%
constructions	723	6,36%
tourism & trade	4.589	40,34%
Services	4.586	40,32%
total	11.375	



(source : ELSTAT 2012)

Strategic Key Actions

1. Protection of Groundwater Resources Against Over-Exploitation and Pollution
2. Demand Reduction: Agricultural, Industrial and Domestic.
3. Exploitation of Un(der)Exploited Aquifers such as Karstic Aquifers.
4. Improved Freshwater Storage and Transport. Groundwater Recharge.
5. Utilization of Untapped Surface Water Sources. Interbasin Transfer.
6. The determination of optimal measures / projects in conditions of extreme events (droughts of floods)
7. Reuse of treated wastewater of municipal waste treatment plant (eg Municipality of Heraklion)
8. The exploitation of brackish coastal karstic springs
9.

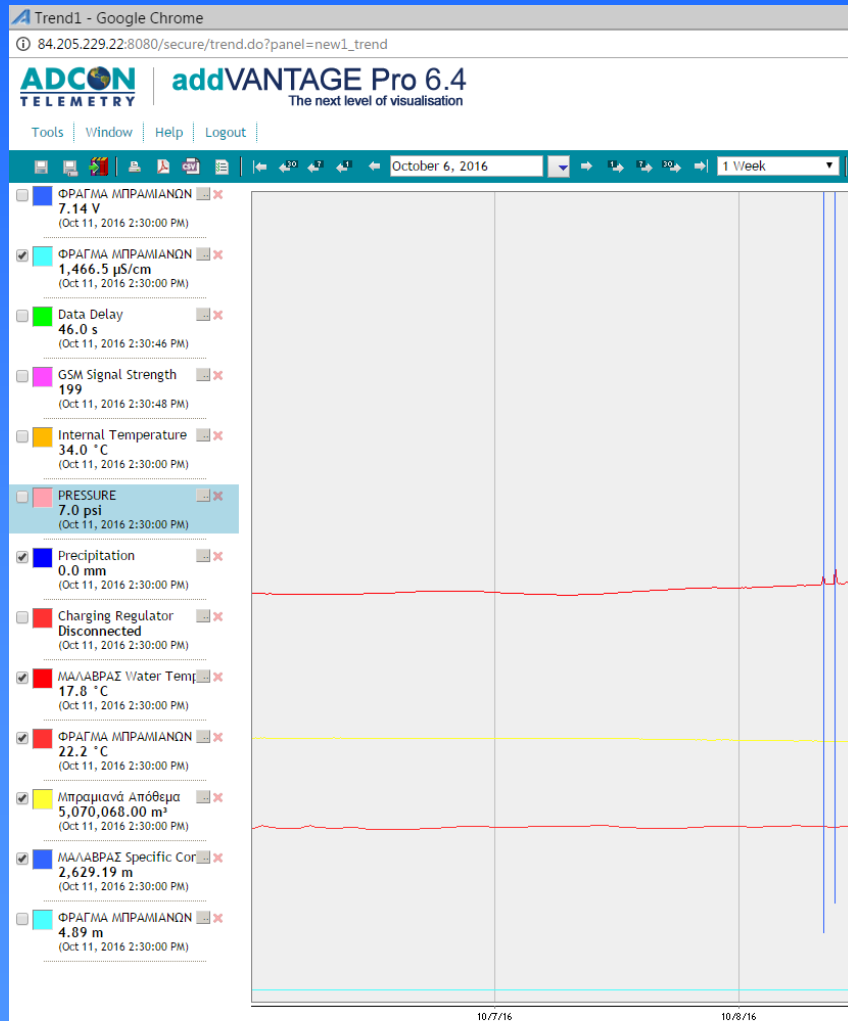
Until now, the Climate change impact not included into measures

The major problem are a) the low resolution of climatic models their accuracy and b) the big gap to communicate the different groups, eg scientists, decision bodies, consumers, administrative staff

USE OF BRACKISH WATER

Reservoir in Bramiano: capacity 16 Mm³/yr
Irrigation : 4,500 hacres
Malavra spring: 5.85 Mm³/yr

Local Agricultural Organization
TOEB Merabelou
Irrigated Area: 1,535 Hectares
Wells : 4.5 Mm³/yr



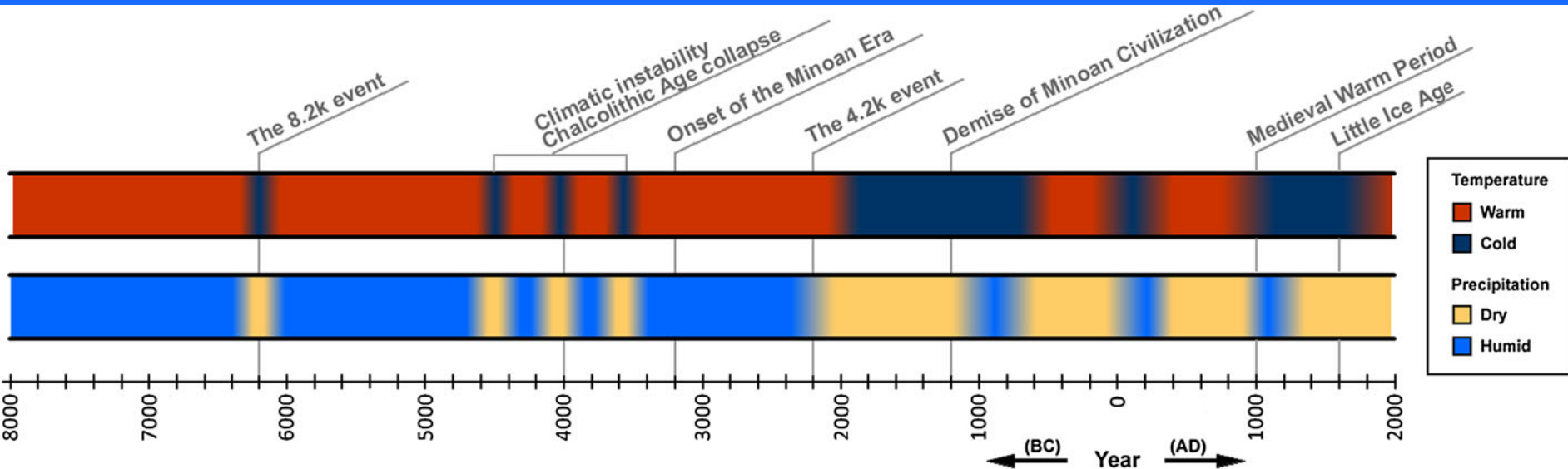
Impacts of climate change

- Sea water rise - potential effects
 - ✓ Sea water intrusion on costal aquifer, deterioration of costal aquifers
 - ✓ Problems on coastal infrastructures (2 power station, ports, tourist resorts, oil storage tank etc)
 - ✓ Erosion of sandy beaches

- Decrease of precipitation
 - ✓ Decrease of available water resources
 - ✓ Collapse of infrastructures

- Change of precipitation / evaporation patterns
 - ✓ Increase of agricultural demand
 - ✓ Change of the outflow of kartik springs - problems in domestic supply
 - ✓ Potentially creation of floods on coastal areas
 - ✓ Collapse of water wells

Climate reconstruction of Crete for the last 10,000 years based on proxy and historical data



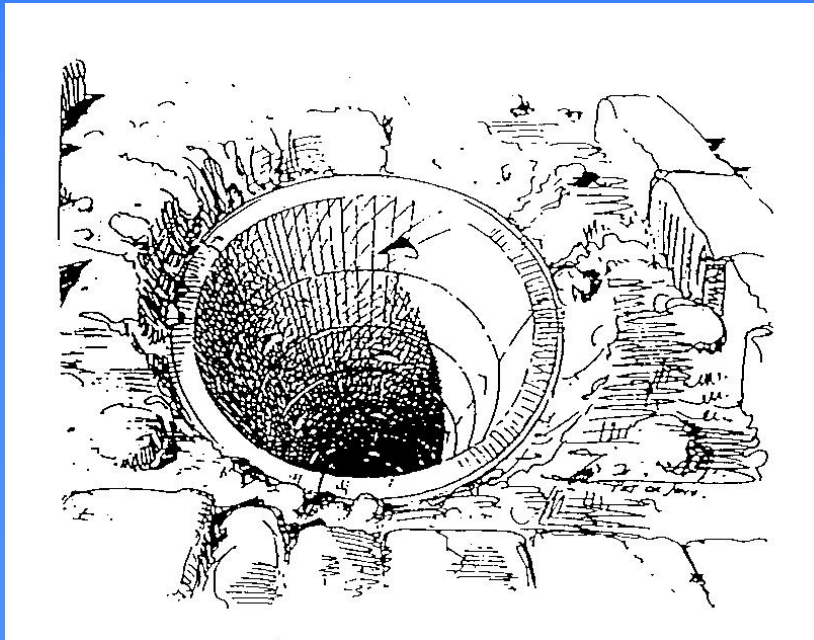
This reconstruction demonstrates the succession of warm/cold or moist/dry periods, which lasted from a few centuries to some millennia and imply that the climate of the whole region was far from stable

Greek Civilization

Plato (428–348 BC)

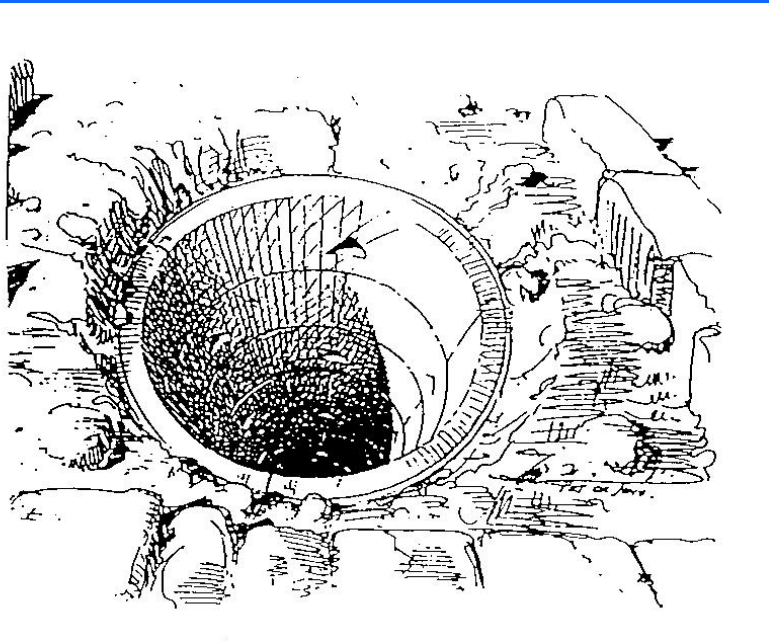
the need induces creativity.

The water demands of the first towns, built on hills, were met by springs. When the water needs increased due to agriculture, groundwater exploitation was expanded with the construction of wells. It was known that the cultural and technological achievements in ancient Greece were mainly due to the limited water resources

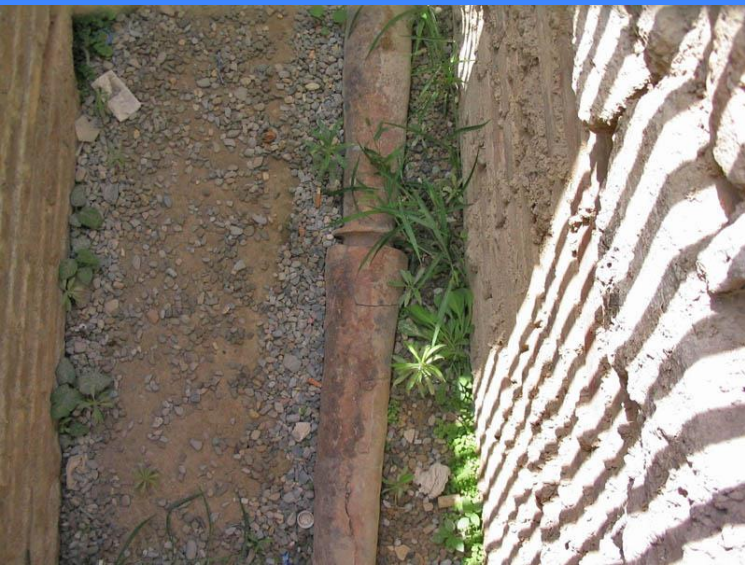
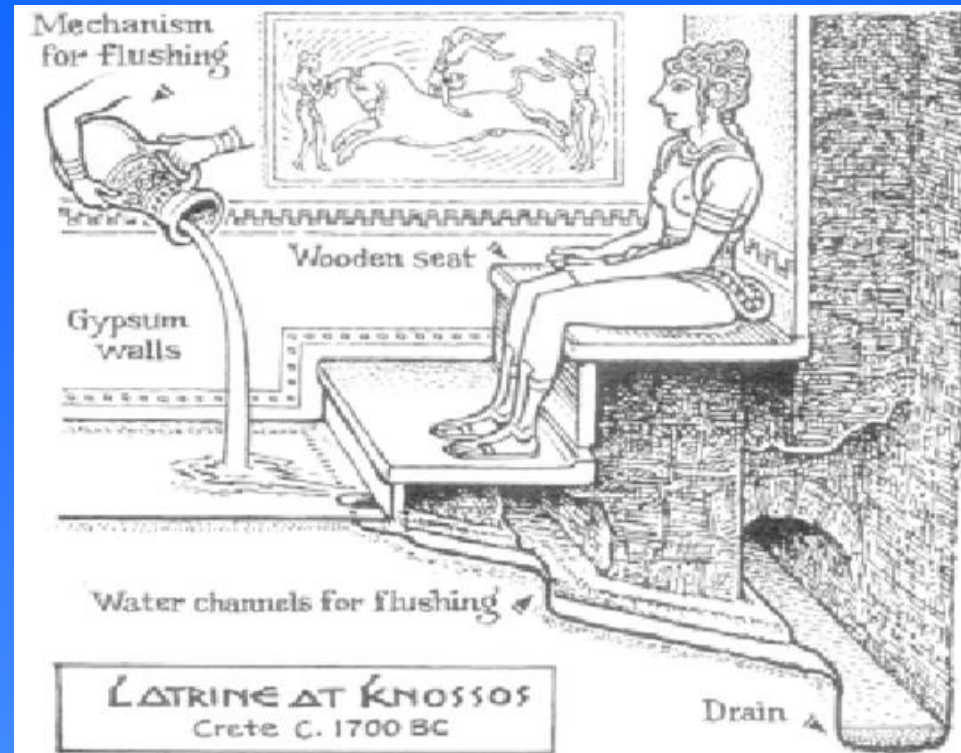


Minoan civilization

Knossos Palace



well



Ancient pipe system
(clay) at the Palace of
Knossos,
4,000 years old.

ROMAN PERIOD

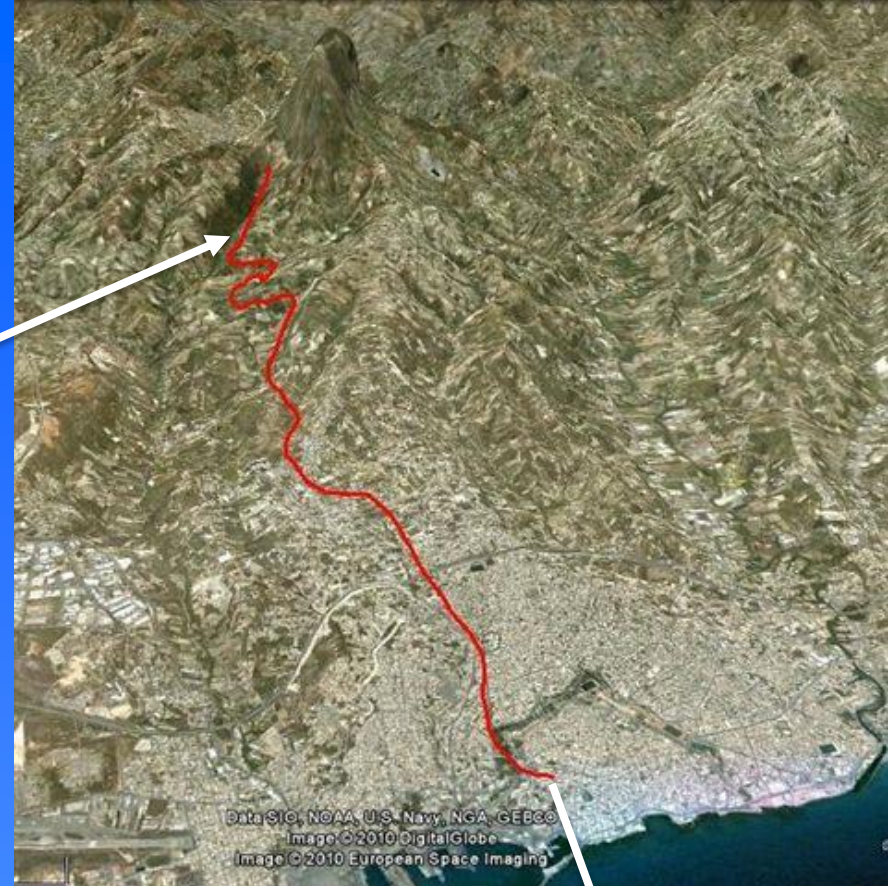
The Lyttos aqueduct - in total 22 km long - had its source at the W flank of the Lassithi mountain (limestone) - at a location called Pègè Kournias (altitude apr.600 m). The channel here was 0,35 - 0,40 m wide (blue line).



Pègè Kournias,
elevation 600 m asl



the Venetian aqueduct (Morozini)(1628)



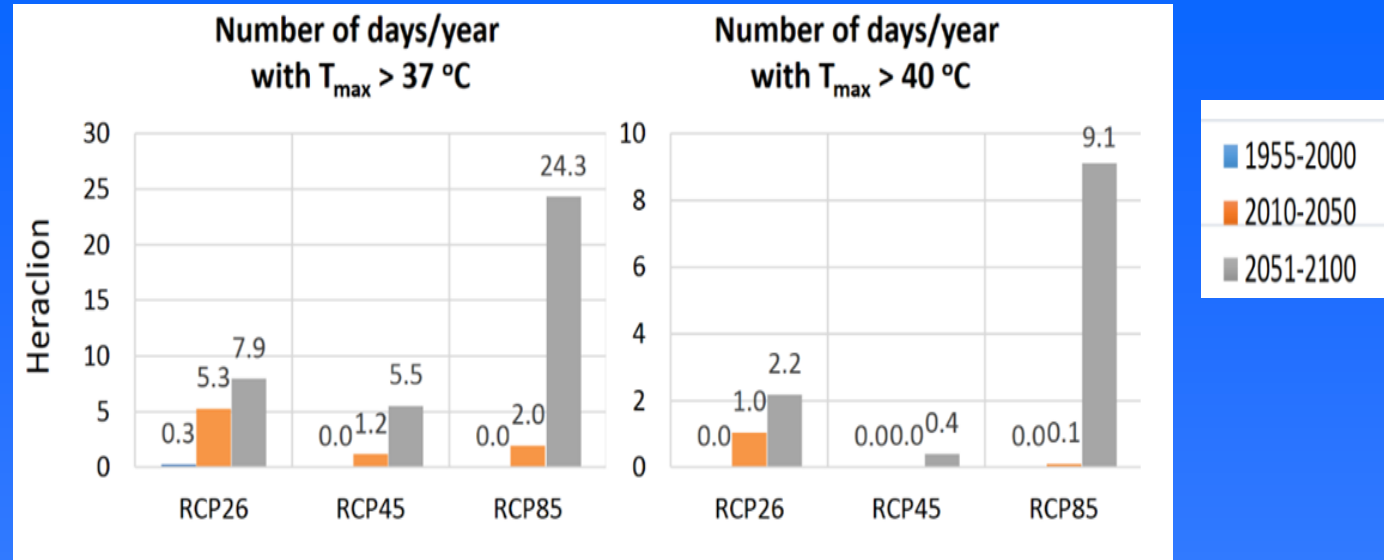
length : 15,5 Km
Constructed: 15 months

ΠΗΓΗ ΣΤ. ΣΠΑΝΑΚΗΣ

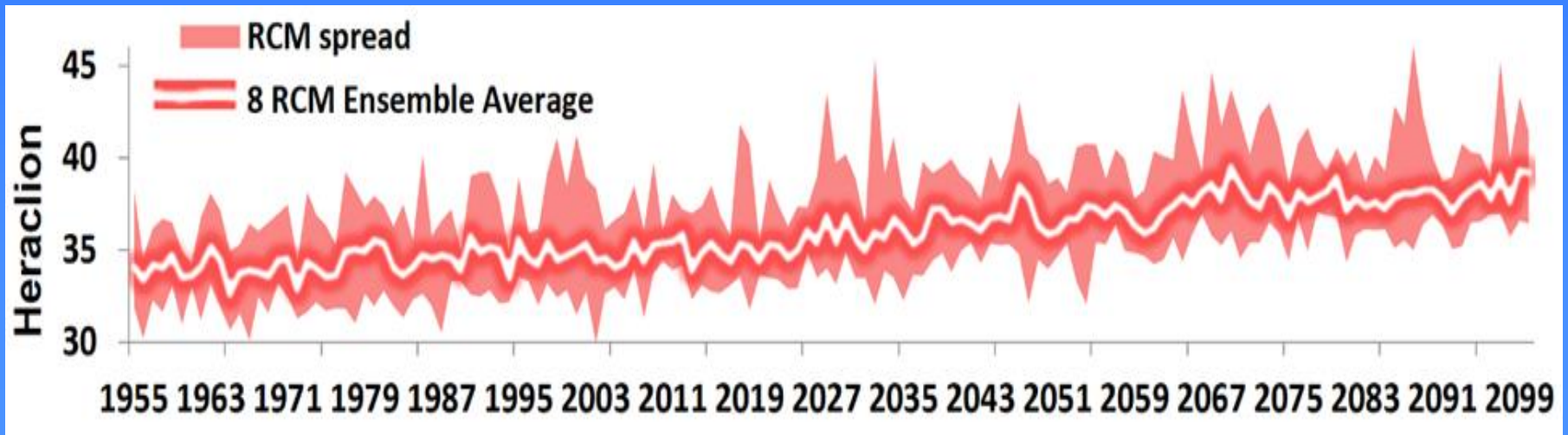


HEAT WAVES

Changes in number of days annually exceeding 37°C and 40°C.



Maximum Temperatures

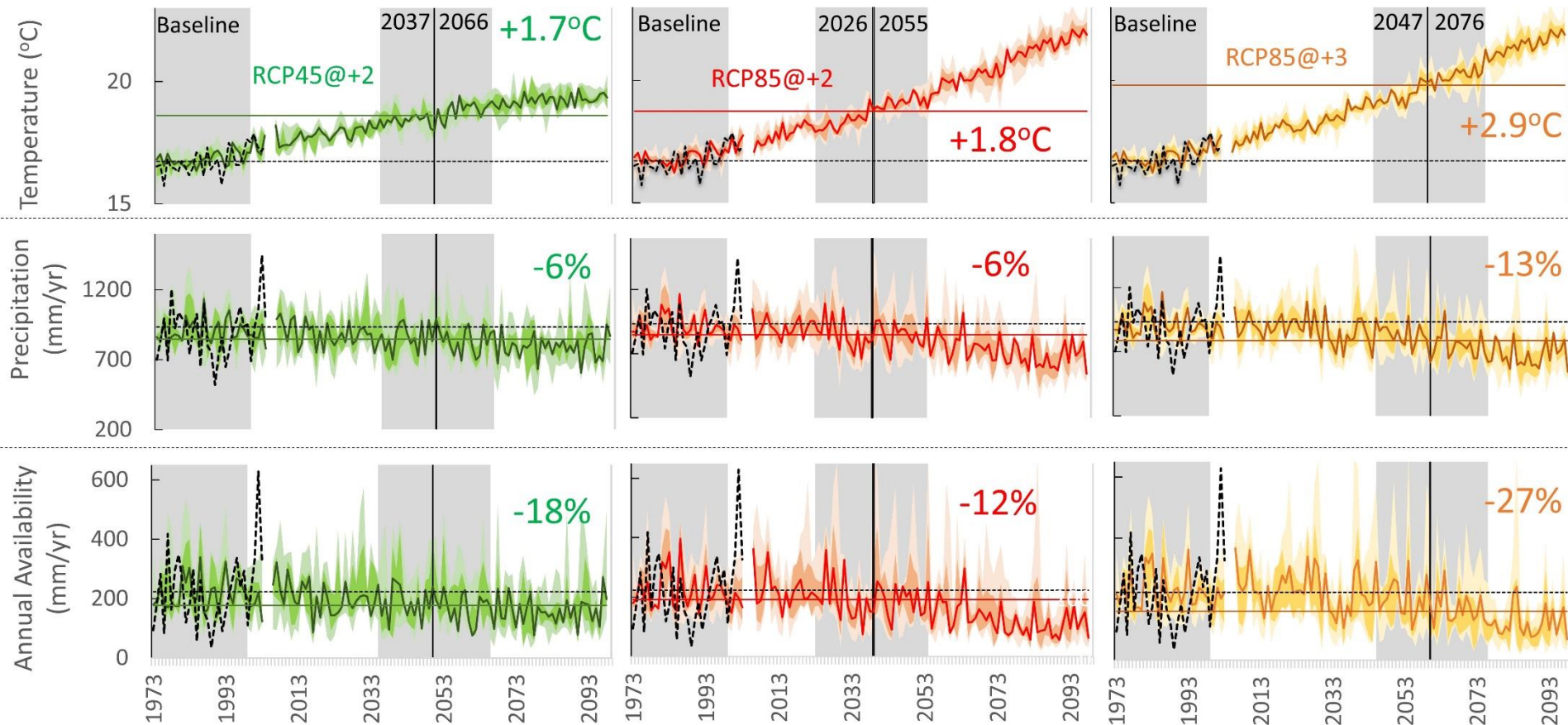


Source: Ioannis K. Tsanis, Aristeidis G. Koutroulis, Manolis G. Grillakis. Cross sectoral impacts on water availability at +2°C and +3°C for east Mediterranean island states: the case of Crete. Deliverable D11.1: Synthesis report on cross-sectoral analysis and case studies, including European vulnerability maps. August 2015

Impacts of climate change

DEMAND-SUPPLY RATIO (DEFICIENCY)

Changes in average temperature, precipitation and annual availability for two scenarios (RCP4.5 and RCP8.5) and for two warming levels +2 and +3 degrees from preindustrial.



Source: Ioannis K. Tsanis, Aristeidis G. Koutroulis, Manolis G. Grillakis. Cross sectoral impacts on water availability at +2°C and +3°C for east Mediterranean island states: the case of Crete. Deliverable D11.1: Synthesis report on cross-sectoral analysis and case studies, including European vulnerability maps. August 2015

Thanks for your
time