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European and Mediterranean Workshop

"Climate change impact on water-related and marine risks"

Murcia, October, 26th-27th, 2009

Climate changes impacts on drought management in Mediterranean area: how to improve the approaches?

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The aim of the presentation:

1. To identify requirements for natural risk management in the context of increased threats related to climate change consequences.
2. To promote a network of actors to transform such requirements into a better protection of the population against such emerging natural hazards.

CIRCE started from…

What would we expect from climate change in water-stressed regions?

- *CIRCE wants to understand and to explain how climate will change in the Mediterranean area. The project will investigate how global and Mediterranean climates interact, how properties of the atmosphere, the radiactive fluxes vary, the interaction between cloudiness and aerosol, the modifications in the water cycle and implications on social and economic sectors.*

IPCC 4AR

- *Many semi-arid and arid areas (e.g., the Mediterranean basin, western USA, southern Africa and north-eastern Brazil) are particularly exposed to the impacts of climate change and are projected (with high confidence) to suffer a decrease of water resources due to climate change.*
- *There is an urgent need to understand and quantify the impact of projected climate change on hydrological processes including vegetation and crops (feedbacks).*
- *Linkages between models for climate change and hydrological processes is crude, with models' scales not relevant for decision making.*

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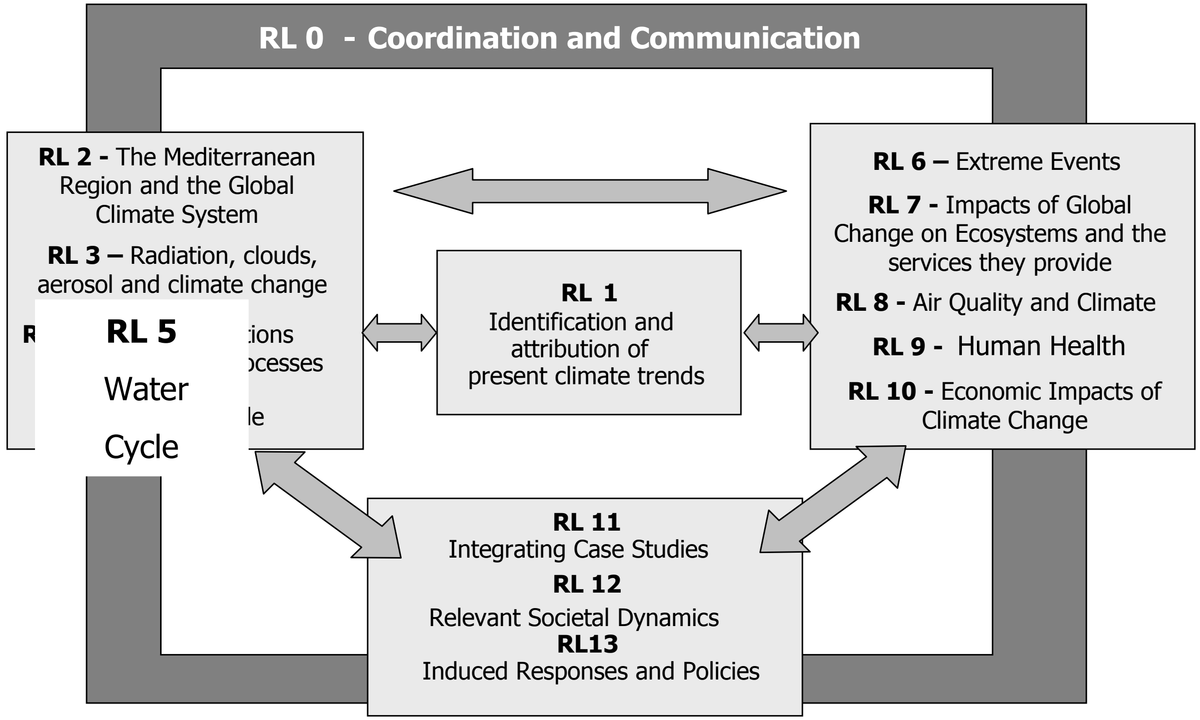
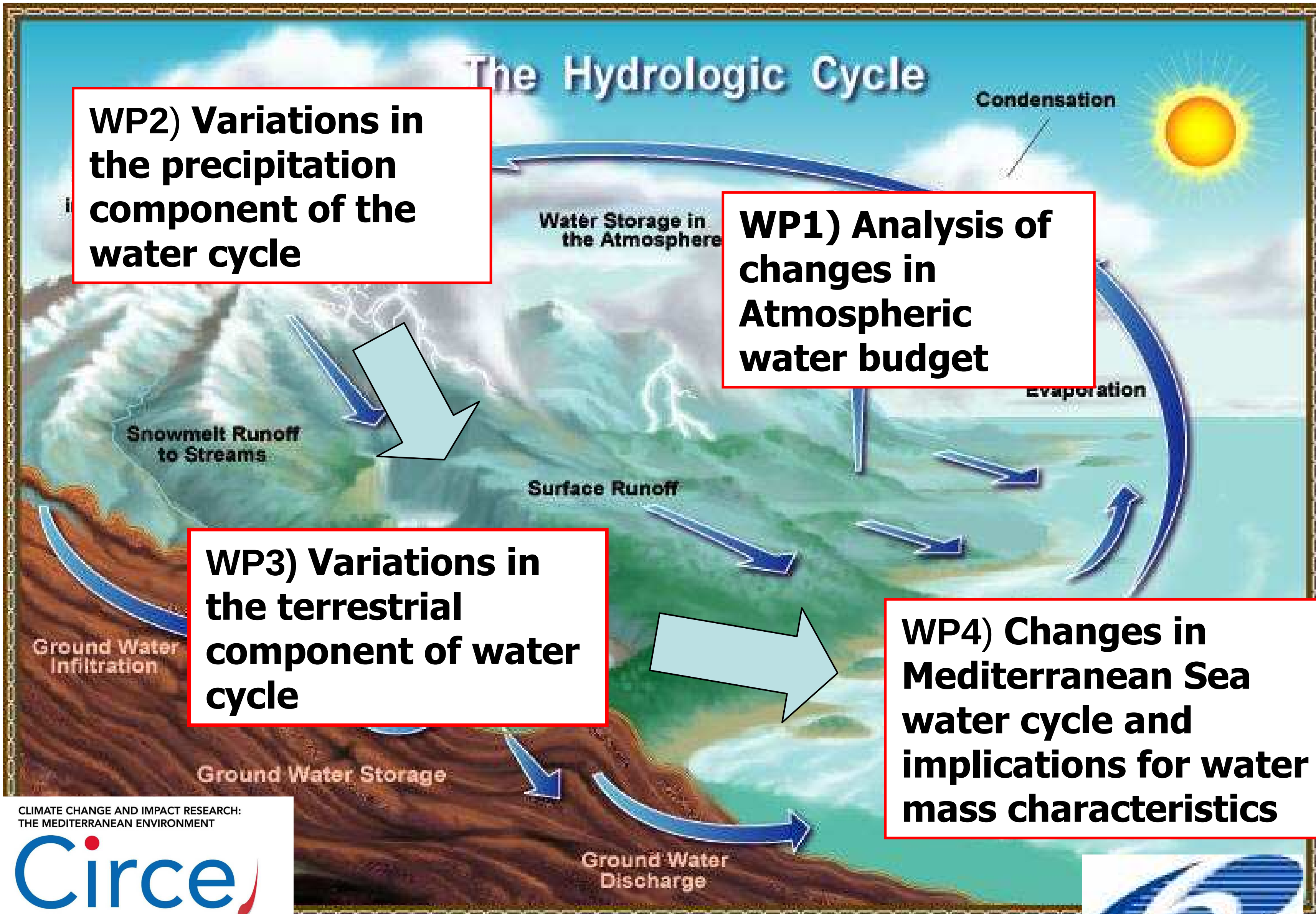


CLIMATE CHANGE AND IMPACT RESEARCH: THE MEDITERRANEAN ENVIRONMENT
Circe

Objective:

"Quantify the past variations and future projections in the water cycle in the Mediterranean Environment under global climate changes system."

RL 5 Water Cycle



WP2) **Variations in the precipitation component of the water cycle**

WP1) Analysis of changes in Atmospheric water budget

WP3) **Variations in the terrestrial component of water cycle**

WP4) **Changes in Mediterranean Sea water cycle and implications for water mass characteristics**

CLIMATE CHANGE AND IMPACT RESEARCH: THE MEDITERRANEAN ENVIRONMENT

Circe

RACCM (Regional Assessment of Climate Change in Mediterranean Area)

- PART 1 : AIR, SEA AND PRECIPITATION: Past, Current and Future on Ocean, on Atmosphere, on Extremes and on Uncertainty; Mechanisms of climate variability in the Mediterranean Region
- PART 2 : WATER: The hydrologic cycle: different components and interactions; Impacts of climate change on surface water, on ground water and coastal aquifer and on water quality.
- PART 3 : AGRICULTURE, FORESTS AND ECOSYSTEM SERVICES: Climate change impacts on typical Mediterranean crops, forests and forest products, livestock population and productivity and evaluation of adaptation strategies to cope with. Vulnerability assessment of ecosystem services in the Mediterranean region,
- PART 4 : PEOPLE: Water for people, Health, The general equilibrium approach, Policy innovation, Future visions of society in the Mediterranean
- PART 5 : CASE STUDIES
  - Coastal Case Studies: Gulf of Valencia (Spain), Gulf of Oran (Algeria), Gulf of Gabes (Tunisia), Western Nile Delta (Egypt)
  - Rural Case Studies: Tuscany Region (Italy), Puglia Region (Italy), Judean Foothills (Israel), Tel Hadya (Syria).
  - Urban Case Studies: Alexandria (Egypt), Athens (Greece), Beirut (Lebanon),

Springs

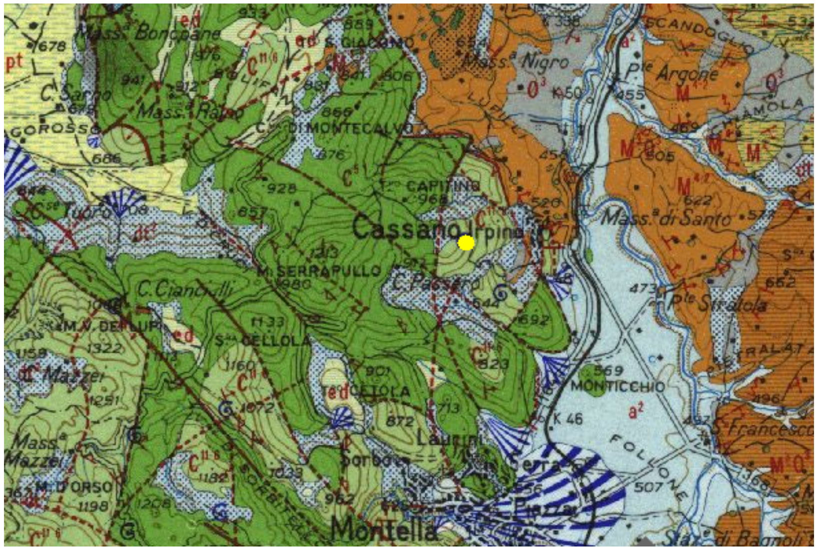
➢ **<u>Area of interest</u> :** it is located in **Campania,** a region of Southern Italy, in which there are not many studies about the relationship between climate change and water supply

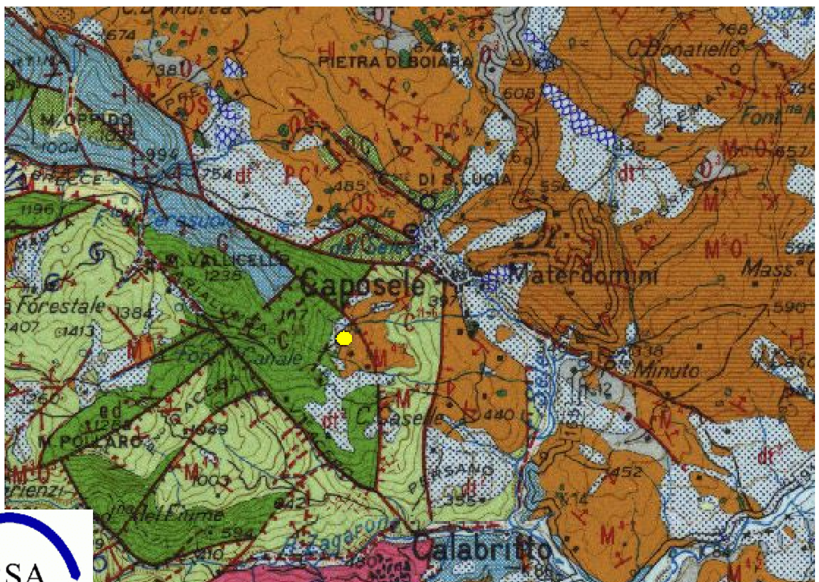
➢ **<u>Springs of interest</u> :** our studies are based on two main springs of the area,which are capped by Apulian aqueduct

✓ **Caposele Sanità**

✓ **Cassano Irpino**

Geological Characterization





Substantial preponderance of

➢Calcareous soil (Cretaceus)

with smaller areas especially of

➢Arenaceus soil (Oligocene – Miocene)

Hydrological Characterization

Hydrological basins of Cassano Irpino and Caposele Springs.

Into these limits there are 5 meteo climatic stations:

- **M_1 = Caposele**
- **M_2 = Acerno**
- **M_3 = P.no Laceno**
- **M_4 = Serrapullo**
- **M_5 = Cassano Irpino**

and 6 hydrometric station:

- **I_1 = Acqua delle Brecce**
- **I_2 = Fiume Sele**
- **I_3 = V.ne dell'acero**
- **I_4 = V.ne Iannarulo**
- **I_5 = Sorgente Bagno**
- **I_6 = Vallone Pinzarino**

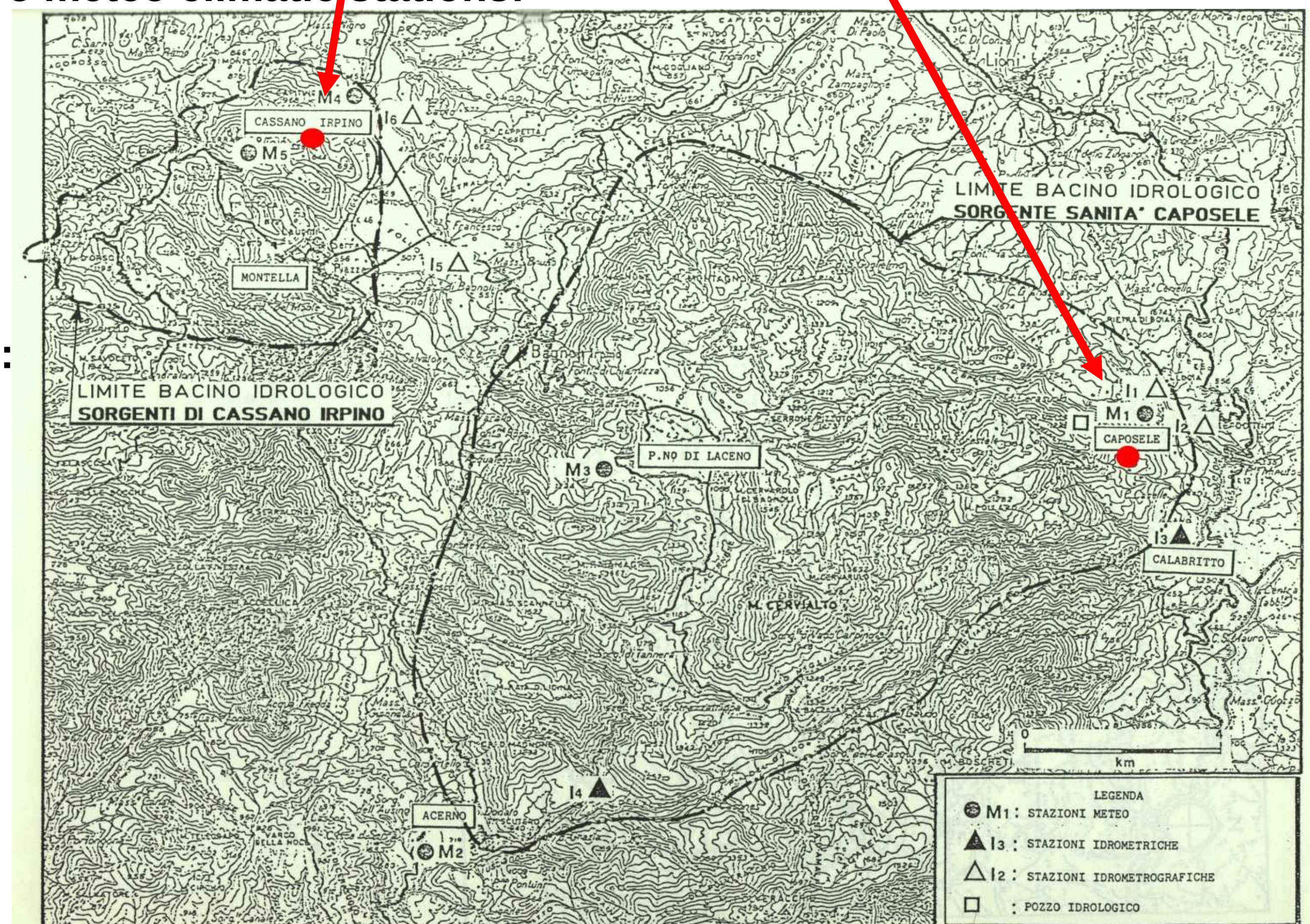


FIG. 32 - Planimetria con ubicazione delle stazioni idrometrografiche, idrometriche, meteo.

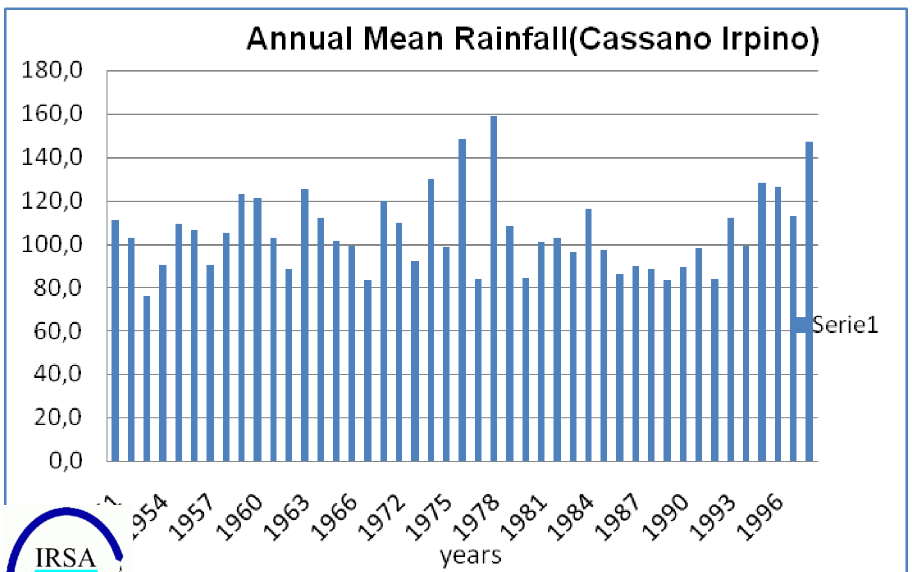
Datasets and references

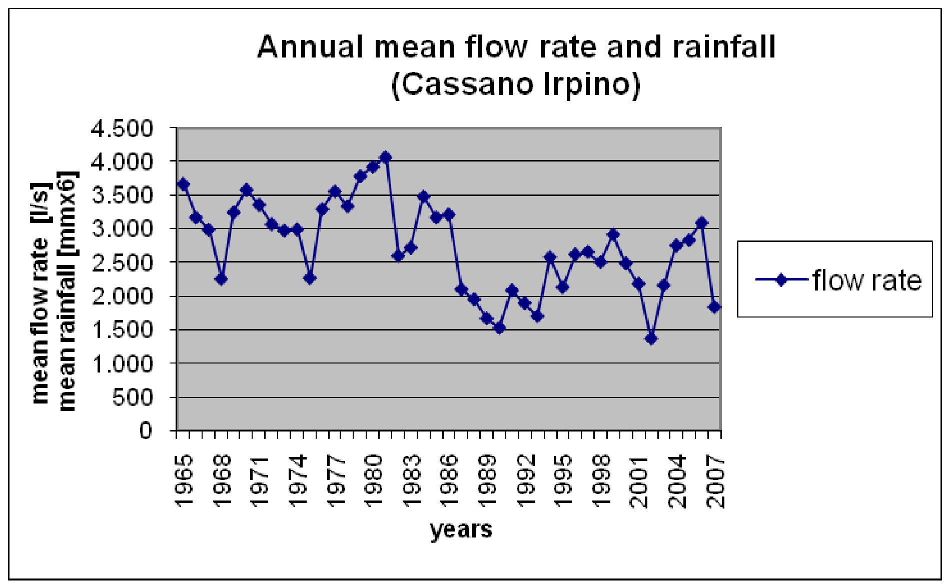
Previous studies of scientific literature,
Influence of **C.C. and water supply** in the area of our interest.

In addition, we will develop successive statistical analysis using the following datasets:

- historical daily series of rainfall from **1920 to 1999** (SIMN Naples);
- historical (ten day) series of flow rate from **1965 to 2006** for Cassano Irpino Springs and from **1920 to 2006** for Caposele Springs.

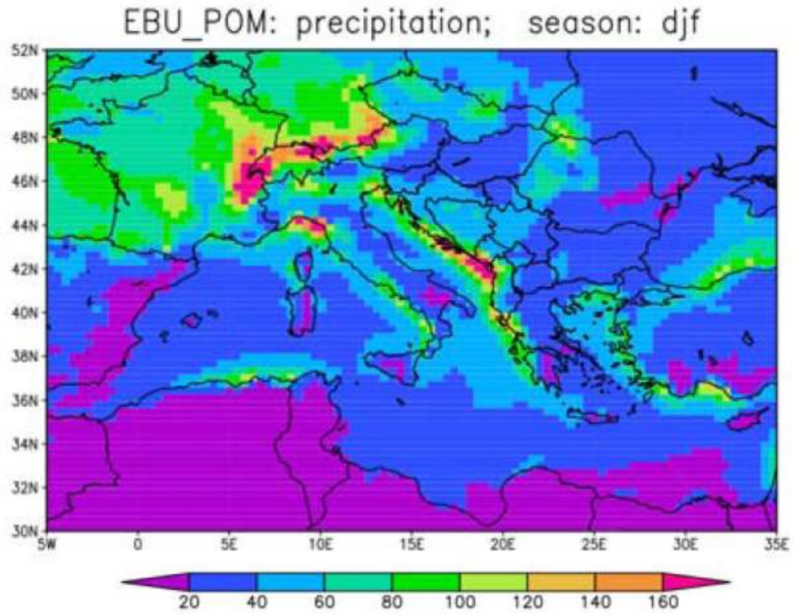
Annual Mean Rainfall, and Annual mean flow rate, for Cassano Irpino Springs

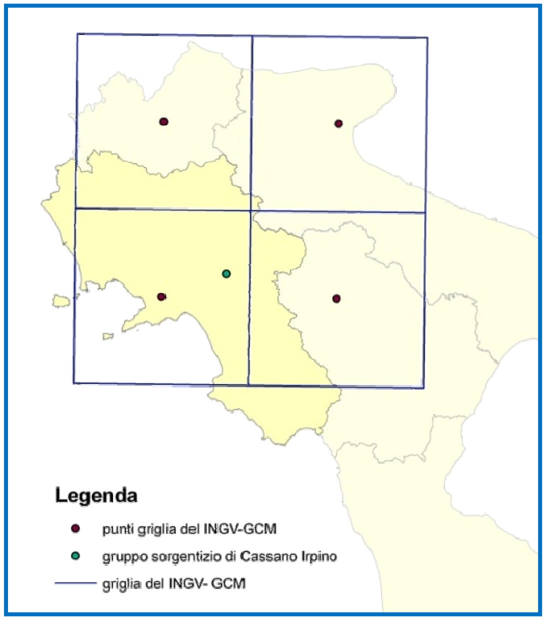




Case study application: Methods and dataset

- *Basin-scale testing of daily precipitation vs. 12 continuous precipitation records for 1961-1990*
- *Spatial averaging of point values over RCM grid-cells*





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Impacts on Ground Water Balance Regimes

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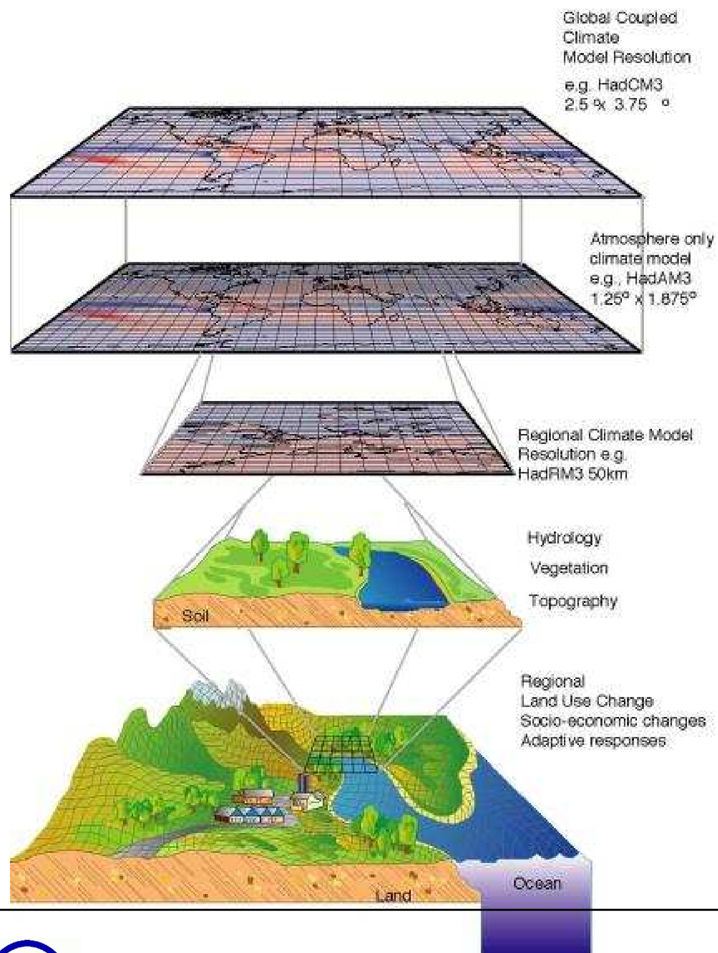
Development of a downscaling approach based on a Poissonian scheme of the rainfall process



SPACE-TIME DOWNSCALING METHODS

Physical D. (dynamic D.)

- RCM run with boundary c. from GCM.

Empirical D.

- Transfer functions
- Weather-typing
- Stochastic Weather Generators

Models calibrated on observed properties from real observations

Model parameters can de derived from GCM's output

Suitable for cascade application of impact models for hydrology, ecology, agricultural projections

Often used in combination with transfer functions for the spatial downscaling

Case study application:

Quantile mapping and CDF anamorphosis for quantitative bias correction

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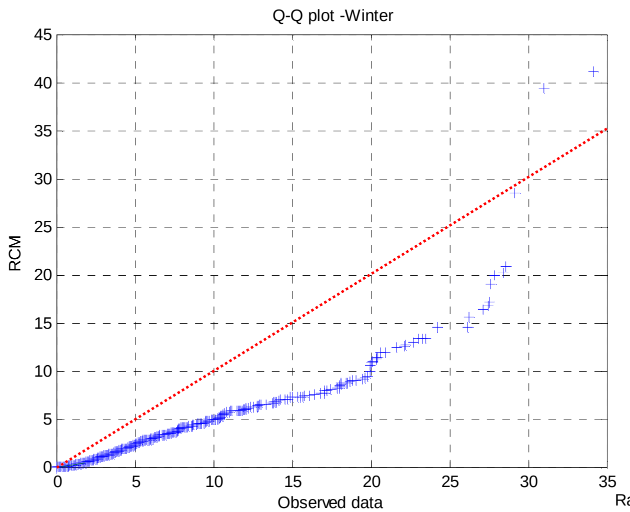
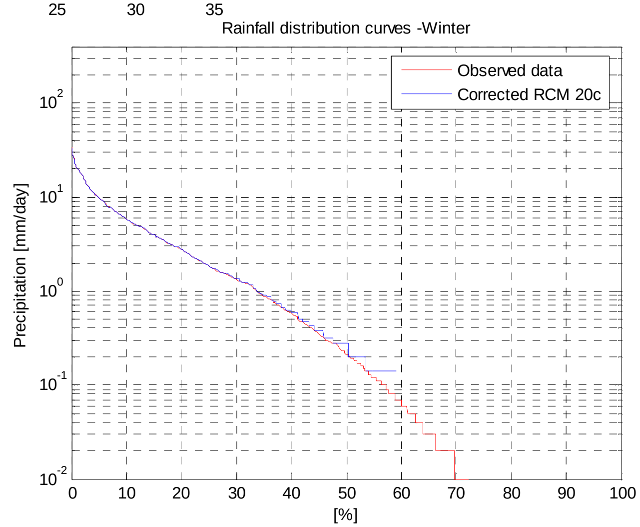


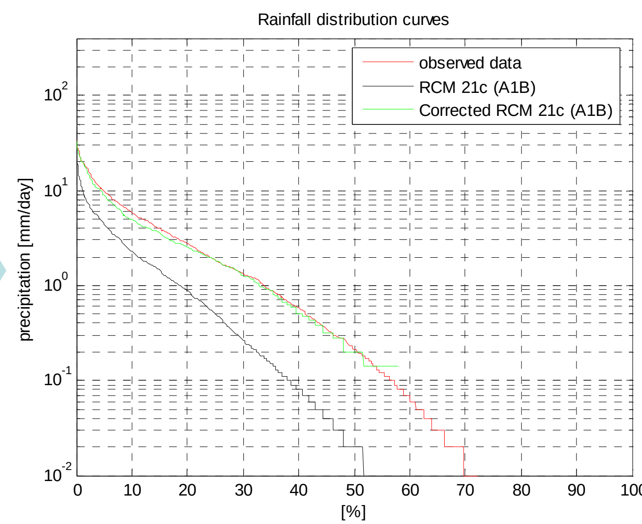
R*(d) = *f (R (d) |O)* ***S*(d)*** = *f (S (d) |O)*

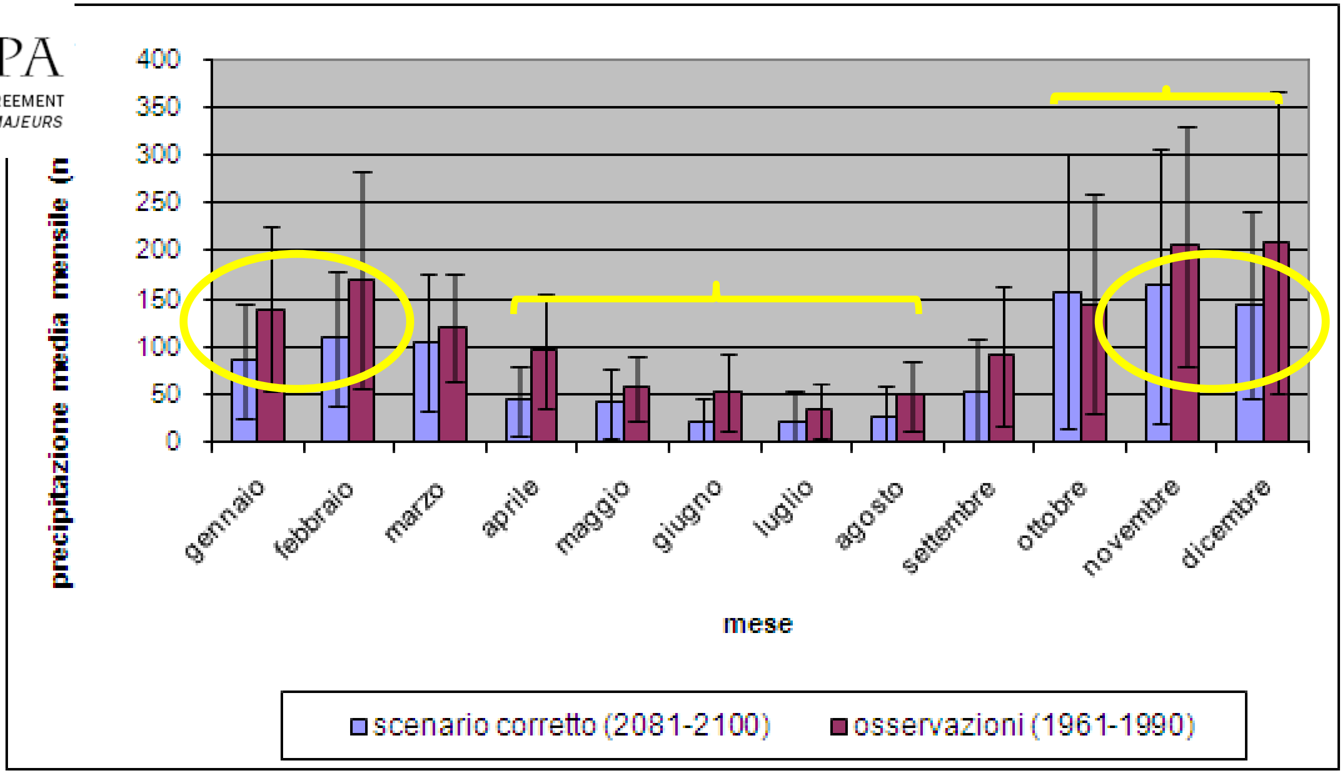
f(x(d) |*O*) correction function to be adopted in the SD of the scenario variable (Déqué, 2007)

Q-Q fit



f (x)





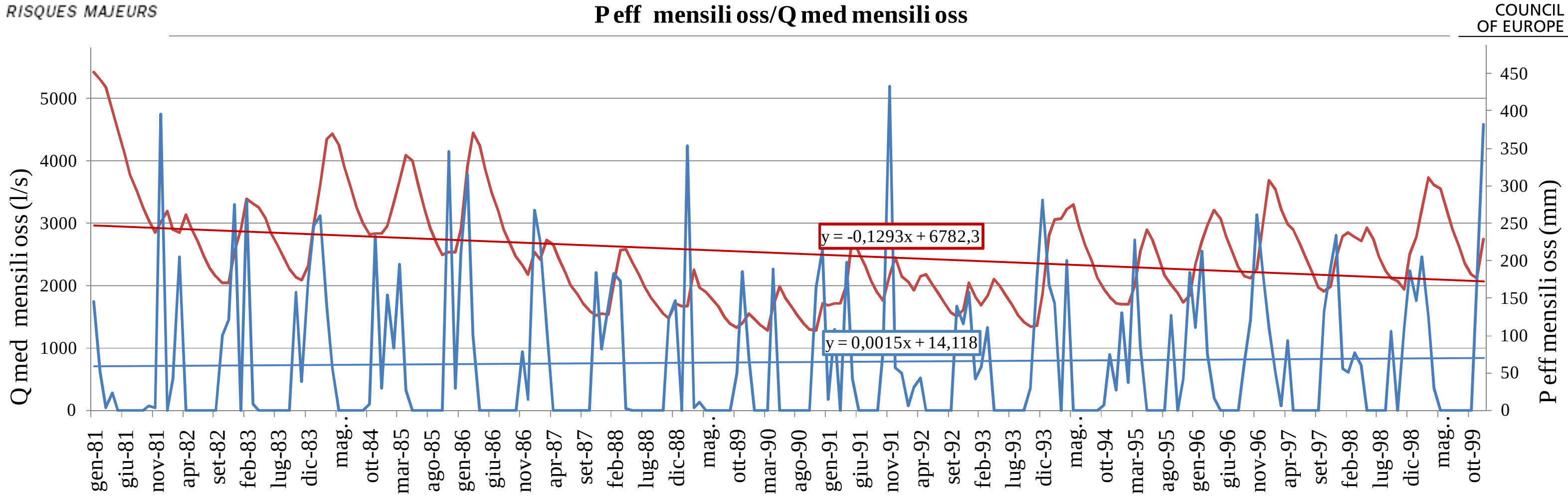
•Rainfall reductions will be during **fall and winter months.**

•During spring and summer period, rainfall reductions produce a prolonged water deficit period for soil, and consequently reduction of tha amount of groundwater recharge.

•The variability (standard deviation computed using observations and scenario data) of monthly rainfall shows high increase during late fall months.

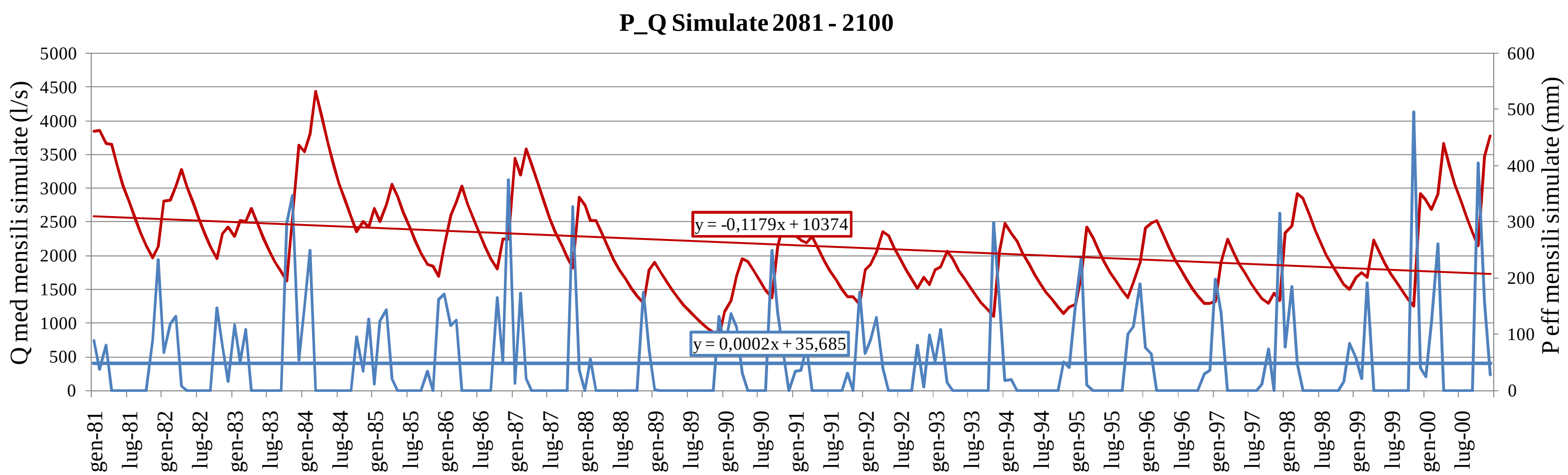
Evaluation of the impact on the spring regime

Impact =Out (S) – Out (R)



The flowrate trends beetween XX e XXI cen. are similar.

	Peff (mm)	Qm (l/s)
Observations	900	3000
XXI century	450	2500



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This feature is highlighted comparing annual trends of mean and simulated effective precipitations and flow rates.

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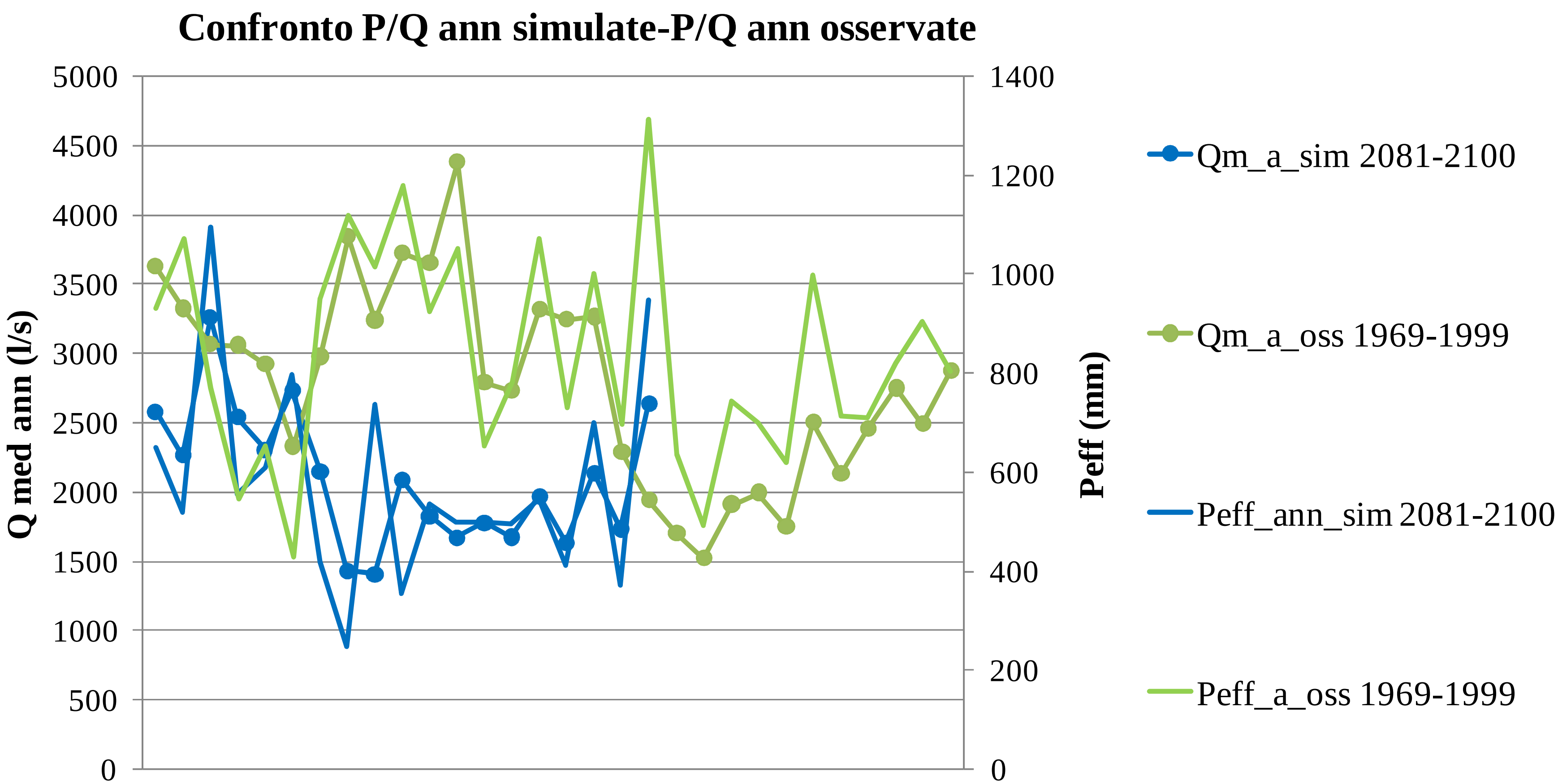

The gap between observations and projections is about 30% for flow rate and 50% for effective precipitation.

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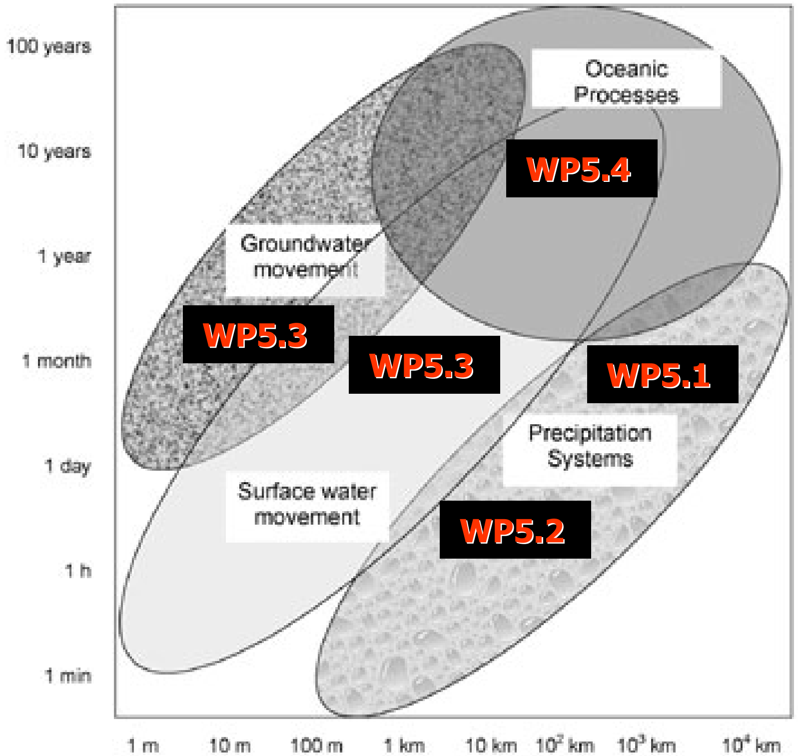
Impacts on Water

What are our expectations from CIRCE

This is a crucial field for the improvement of CC impact assessment in Mediterranean water cycle.



WP5.1 Atmospheric Water Budget

WP5.2 Precipitation Component of Water Cycle

WP5.3 Terrestrial Component of Water Cycle

WP5.4 Mediterranean Sea Water Cycle

Expectations

1) Integrate overlapping research questions having bordering scales of investigation and modeling.

2) Bridge scale gaps by completing the CC scenarios with information on fundamental climatological variables (local downscaling).

3) Sketch possible futures of fresh water resources in the Mediterranean by way of credible representation of processes at a problem-solving scale.

…Water managers' perception is that "the future is no longer as it used to be".

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.. and the drought management under climate change…

a risk management plan is devoted to support the implementation of mitigation measures

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Risk management approach…

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- It is the opposite of crises management: a proactive approach is taken in advance to drought.
- It implies to focus more on the causes of drought impacts than on the effects themselves.
- It cannot avoid the negative impacts of drought, but it reduces and mitigates .

- A risk management approach to drought management requires to introduce measures to reduce the system vulnerability, in order to reduce the drought impacts.

Risk management approach…

Drought Risk = Hazard x Vulnerability

The assessment of the hazard index requires the analysis (probability) of the physical characteristics of the phenomenon

The vulnerability assessment requires to examine the underlying environmental, economic and social factors influencing the severity of drought impacts.

Risk Management approach:

Benefits of stakeholders involvement

Stakeholders involvement

- Impacts assessement → Due to the complexity of drought impacts, the identification and assessment of such impacts is not an easy task. Local stakeholders are often better placed to detect and evaluate the drought impacts on the socio – environmental system.
- Mitigation policies → If mitigation actions are selected without considering the stakeholders' perceptions of the drought then the actions themselves could be considered as unsatisfactory by stakeholders or, even worst, not acceptable at all.
- Public awareness → The involvement of stakeholders in drought management could increase their knowledge about the phenomenon and could have positive effects on their awareness about their role in mitigation policies implementation.

Drought impacts and drought perception: The lake Trasimeno

- Drought impacts on the “perceived” environment and on the related water use activities strongly influence stakeholders' perceptions of drought.
- The involvement of stakeholders in impacts assessment requires the elicitation and analysis of the different drought perceptions.
- Facing a drought phenomenon, stakeholders adopt their own mental models to assess its severity, taking into account additional elements other than just water availability and climatic conditions.
- The elicitation of these mental models allow to structure the stakeholders' understanding (perception) of drought impacts.

Drought impacts and drought perception: The lake Trasimeno

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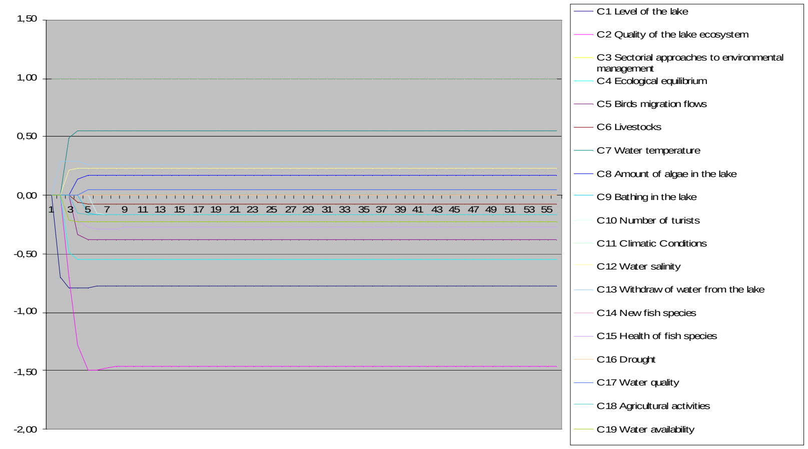
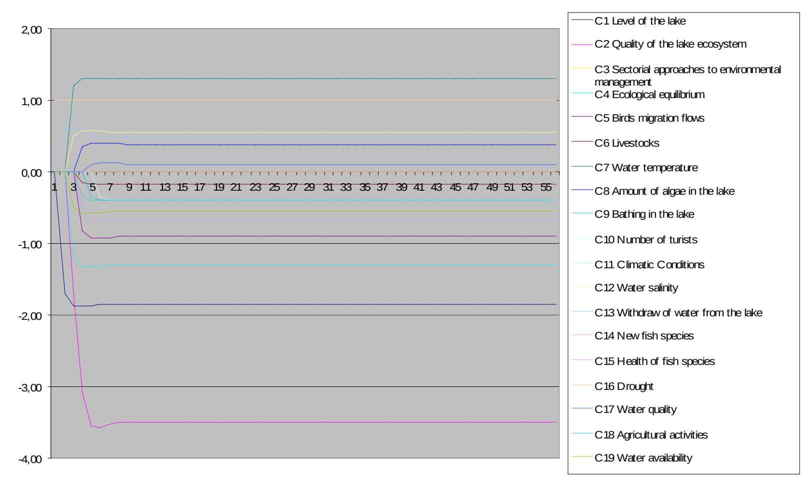
Stakeholders Cognitive Map representing his/her understanding of drought impacts.



State of the system before the drought onset according to the stakeholder's understanding



State of the system during the drought phenomena

Drought impacts and drought perception: The lake Trasimeno

- **The analysis of stakeholders' drought perception (nine categories) allows to define the main drought impacts according to their understanding.**
- **The integration of the different drought perceptions support the integrated assessment of drought impacts.**

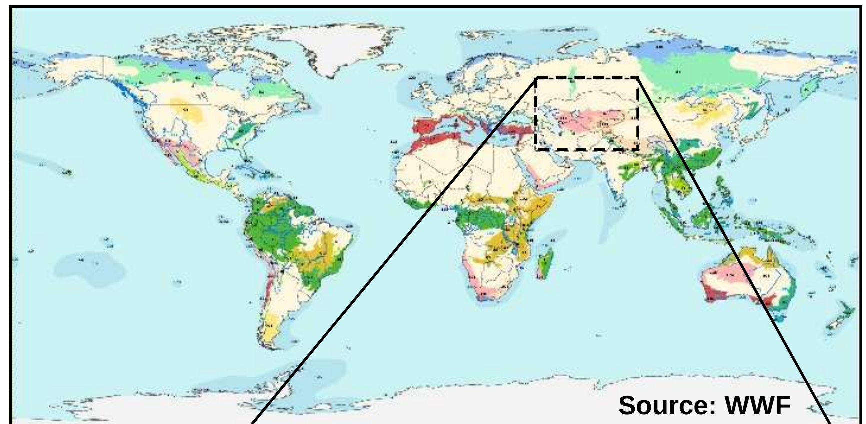
Stakeholder	Ruolo
Ente Parco del Trasimeno – Comunità Montana	Ente di pianificazione territoriale al fine di supportare lo sviluppo locale
Gruppo d'Azione Locale (GAL)	Ente di programmazione per lo sviluppo locale
ARPA Umbria	Agenzia di controllo del territorio e dell'ambiente
Coldiretti	Associazione di categoria
Servizio Turistico del Trasimeno	Associazione di categoria
Enti comunali	Enti locali di pianificazione e controllo del territorio
WWF	Associazioni ambientaliste
Regione Umbria	Ente locale di gestione delle risorse ambientali
Provincia di Perugia	Ente locale di gestione delle risorse ambientali
EIUT	Ente di gestione della rete di irrigazione

Stakeholders involvement drought impacts monitoring

- Taking into account the spatial and temporal scale issues, the assessment of drought impacts results in a demand to monitor a broad set of variables, with prohibitive costs if the monitoring is only based on traditional scientific methods of measurement.
- To address this issue in countries where, due to lack of financial and economical resources, it is infeasible to improve current monitoring system using only traditional scientific methods.
- Local communities can be seen as information providers in a monitoring system for drought impacts monitoring.

Stakeholders involvement in drought impacts monitoring

The soil salinity monitoring in Amudarya River Basin (Uzbekistan).



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Stakeholders involvement in drought impacts monitoring

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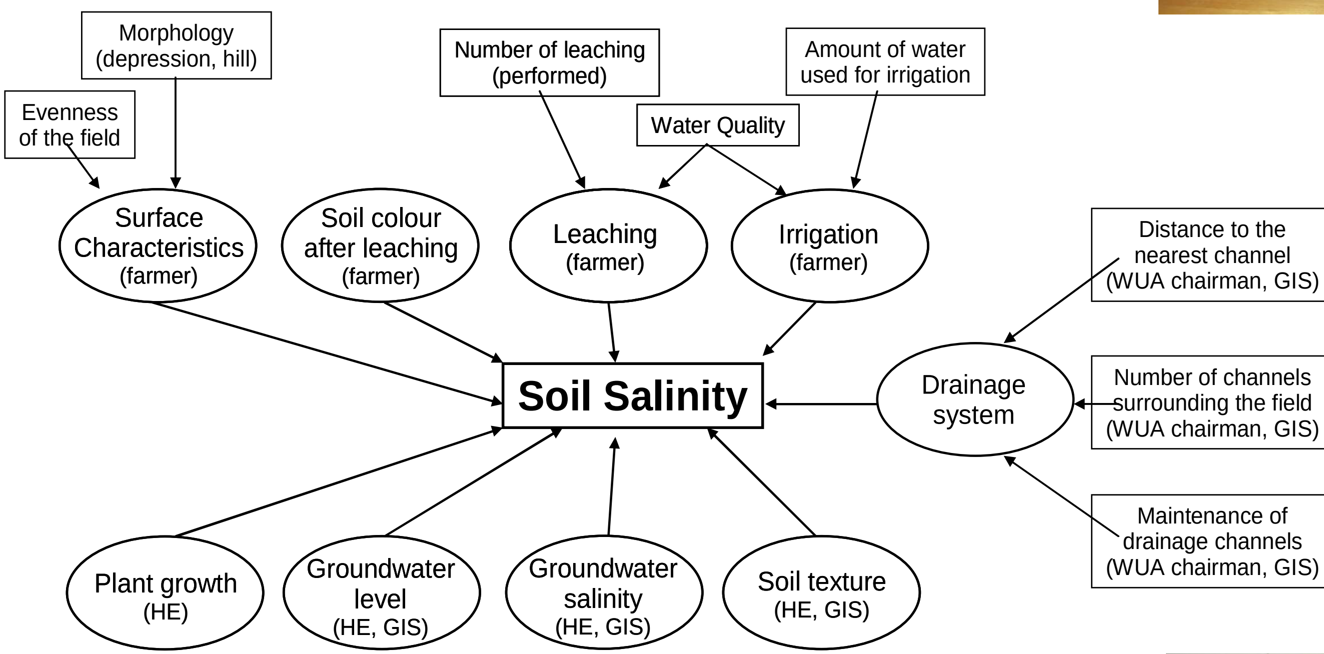

Stakeholders involvement in drought impacts monitoring

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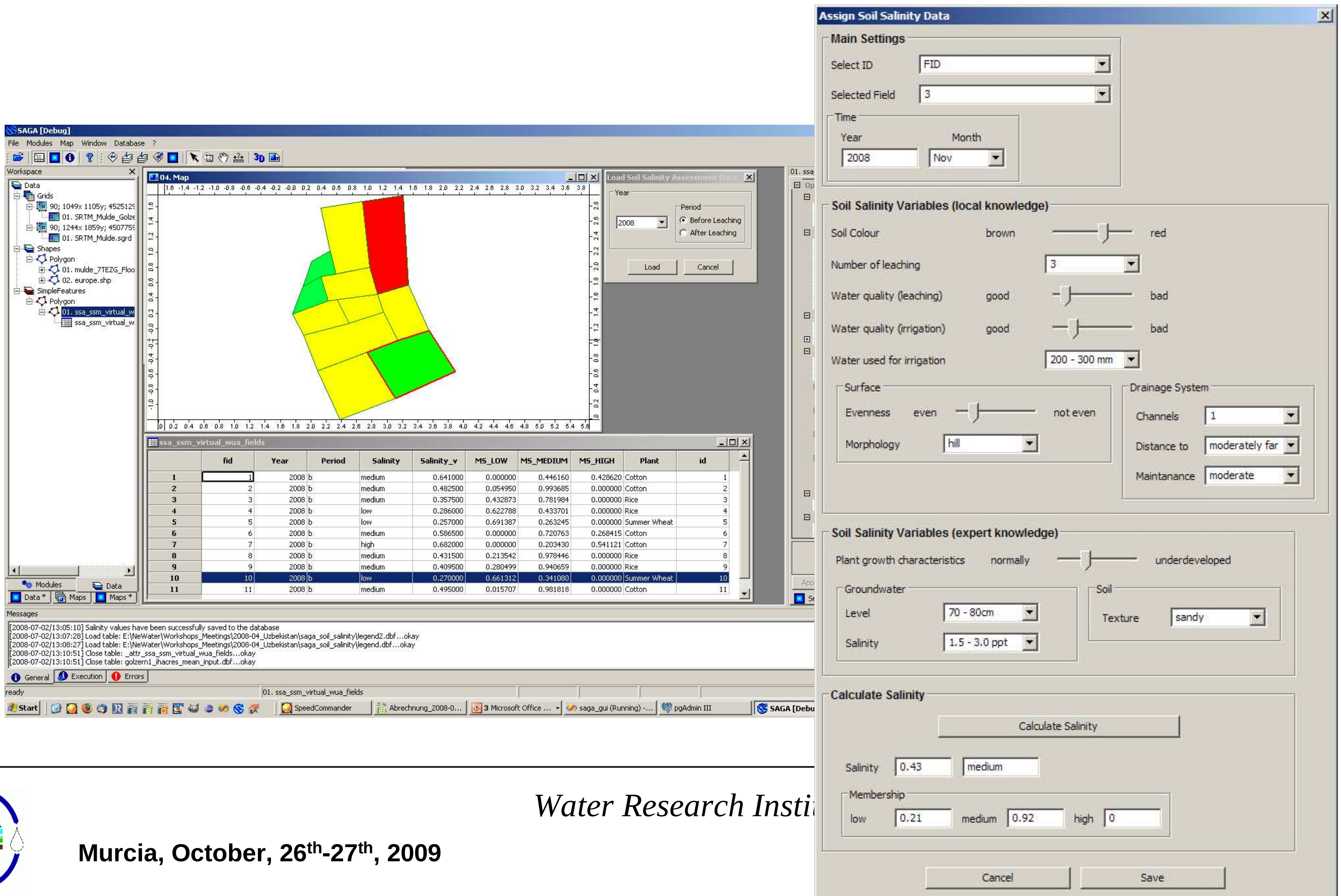

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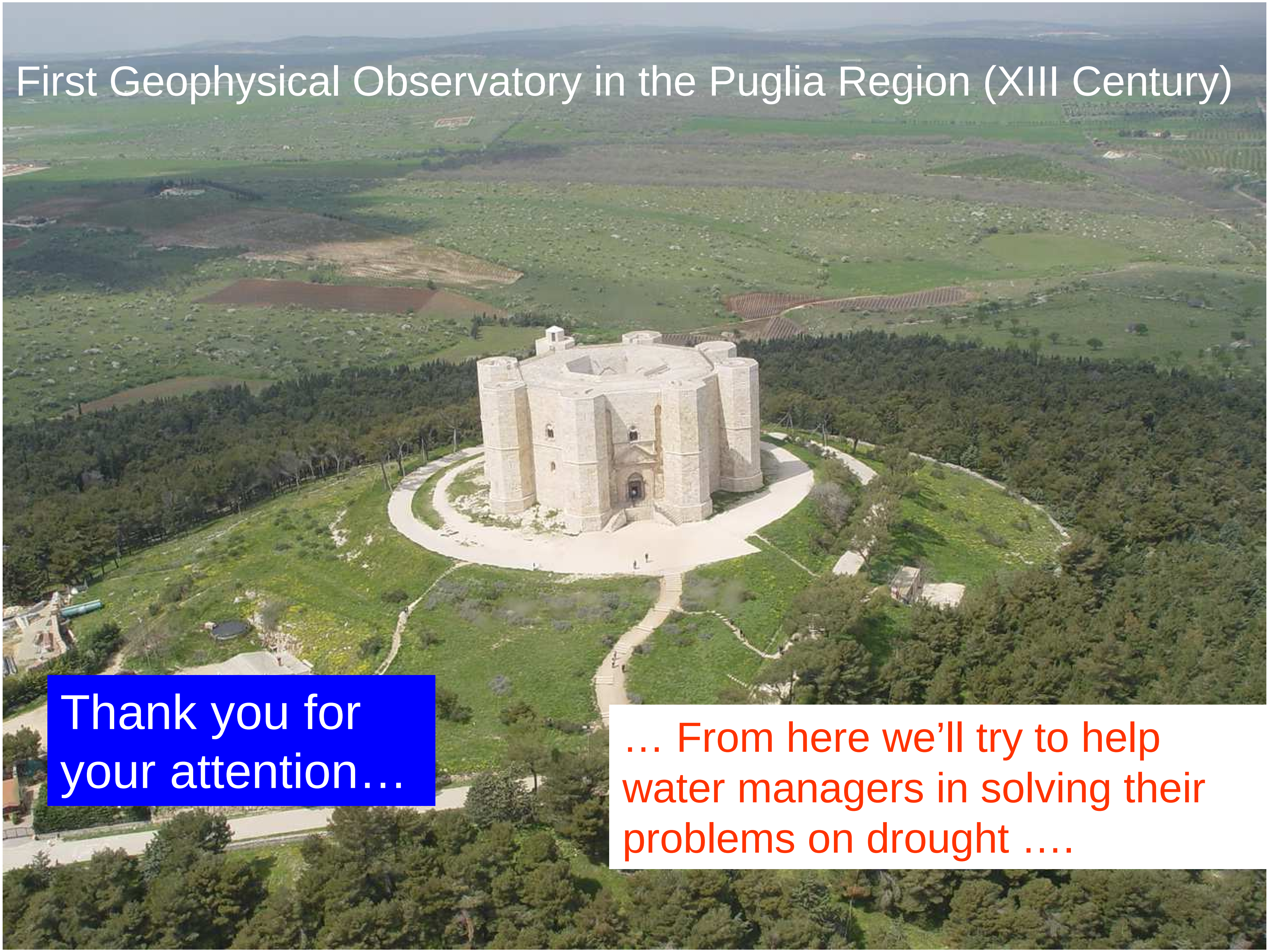
Conclusions

Requirements for natural risk management

- The prediction and quantification of the physical impacts of climate change in the Mediterranean area (1)
- The downscaling from GCM to RCM to HM (1)
- The adaptation strategies in water management under climate change (1)

Network of actors to better protect population

- The mitigation measures: technological and infrastructural and non-technical measures (2)
- The stakeholders involvement: mitigation policies and public awareness (2)


First Geophysical Observatory in the Puglia Region (XIII Century)
Thank you for your attention…
… From here we'll try to help water managers in solving their problems on drought ….

Climate Change Impact Research: Water-related issues

after Milly et al., 2005. Nature, 438(7066), 347–350 [in IPCC 4AR]

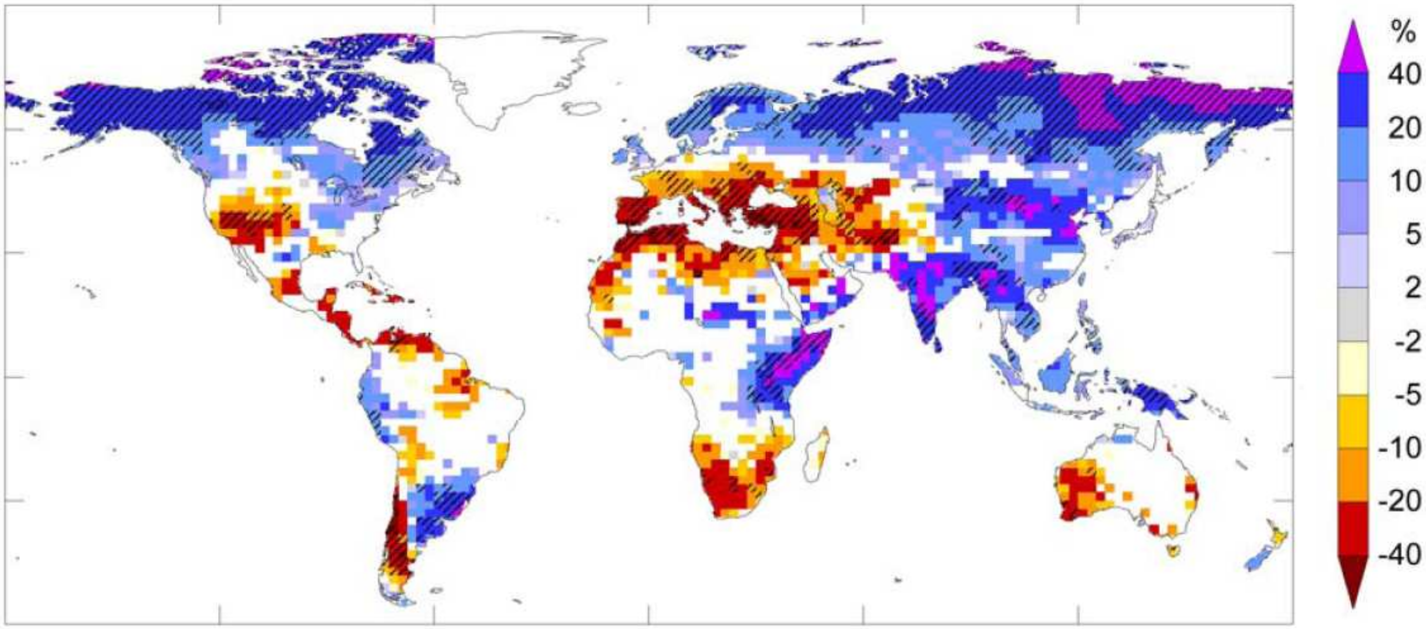


Figure 2.10: *Large scale relative changes in annual runoff for the period 2090-2099, relative to 1980-1999. White areas are where less than 66% of the ensemble of 12 models agree on the sign of change and hatched areas are where more than 90% of models agree on the sign of change. [SYR Figure 3.5, based on WGII Figure 3.4, Milly et al., 2005]*

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PDSI centennial global trend after Dai et al., 2004. [in IPCC 4AR]