

HydroPredict' 2010

2nd International Interdisciplinary Conference on Predictions for Hydrology, Ecology, and Water Resources Management

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Impact of climate change on hydrological regimes and water resources in TRUST (LIFE + 2007) project



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1. Introduction
2. Climatic model
3. Hydrological model
4. Drought mitigation strategies
5. Conclusions



Tool for Regional – scale assessment of groUndwater Storage improvement in adaptation to climaTe change (Gen 2009- Dec 2011)

Project funded by

European Commission Under The Life+ Programme 2007

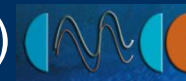
Ministry For The Environment And The Land And Sea



BENEFICIARY AND COORDINATOR:
River Basin Authority Alto Adriatico

PARTNERS:

European-Mediterranean Centre for Climate Change(CMCC)



SGI Studio Galli Ingegneria S.p.A. (SGI)





TRUST project

ISSUES

- *Groundwater in the **Upper Plain of Veneto and Friuli Regions** have been exploited for decades for agricultural and industrial and waterworks uses*
- *In recent years, aquifers, affected by growing water demand, showed a significant lowering of groundwater levels and artesian depressurisation*

Art.4 WFD 2000/60/CE:

“Member States shall protect, enhance and restore all bodies of groundwater, ensure a balance between abstraction and recharge of groundwater, with the aim of achieving good groundwater status”

GENERAL OBJECTIVES

- Incorporate climate change scenarios in the river basin management in accordance with WFD 2000/60/CE
- Examine issues related to the development of water management strategies at river basin scale (WFD) in relation to the CC scenarios

Tool for large scale groundwater balance

Geo-Database designed to characterize the underground aquifers (and the related balance terms) to regional scale

Hydrological geomorphoclimatic model
(river basin analysis)

Model simulating the unsaturated zone & water used by
crops (Remote sensing – land use mapping)

Groundwater balance model (MIKE SHE)

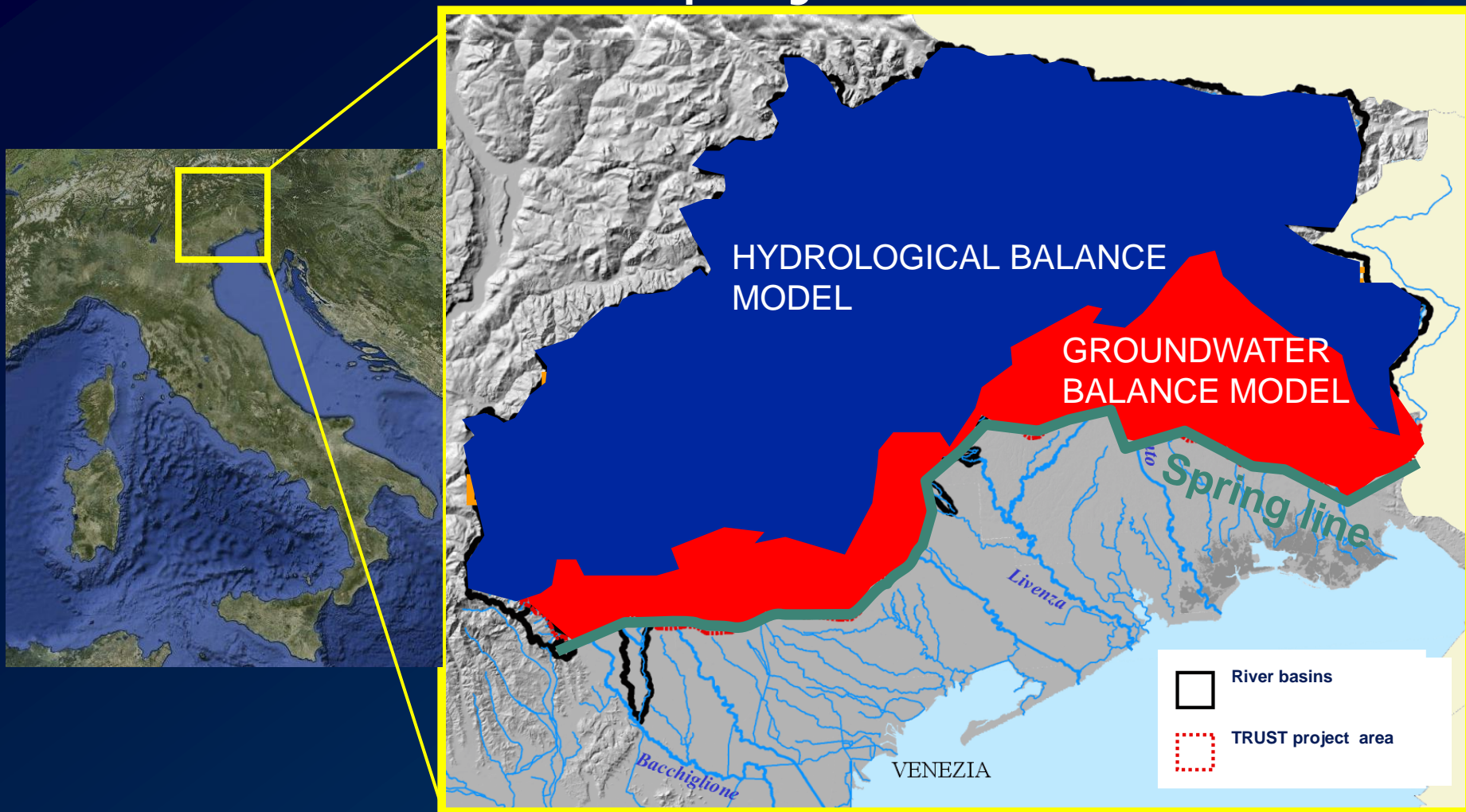
CLIMATE CHANGE SCENARIOS

Evaluation of objectives and measures for artificial aquifer
recharge – MAR (Managed Aquifer Recharge)

THECNICAL BOARD(stakeholders)



TRUST project Area



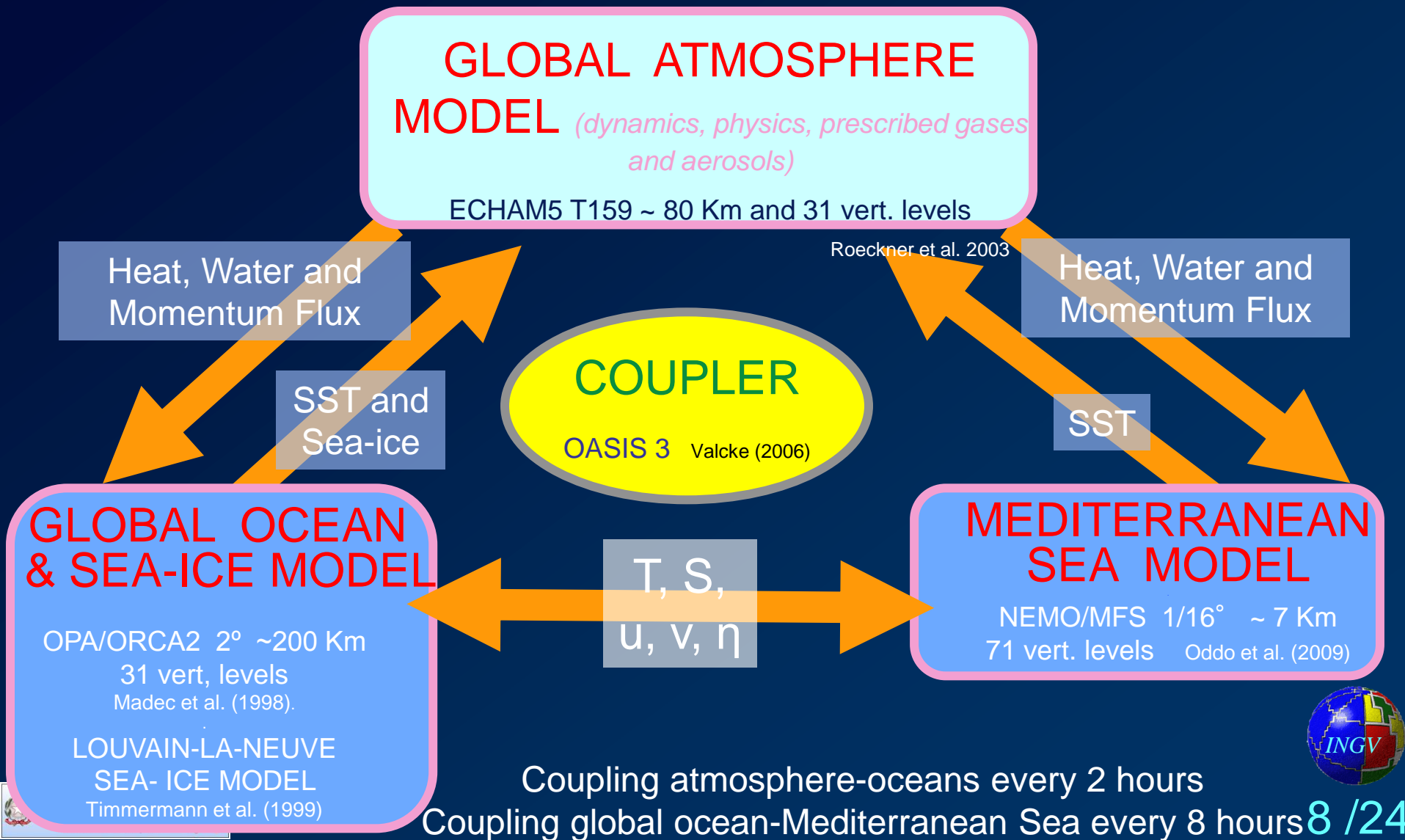
Acquired Data: 250 meteorological, 21 nivometric, 60 hydrometric stations

Monitoring period: 1/1/2000 – 31/12/2008

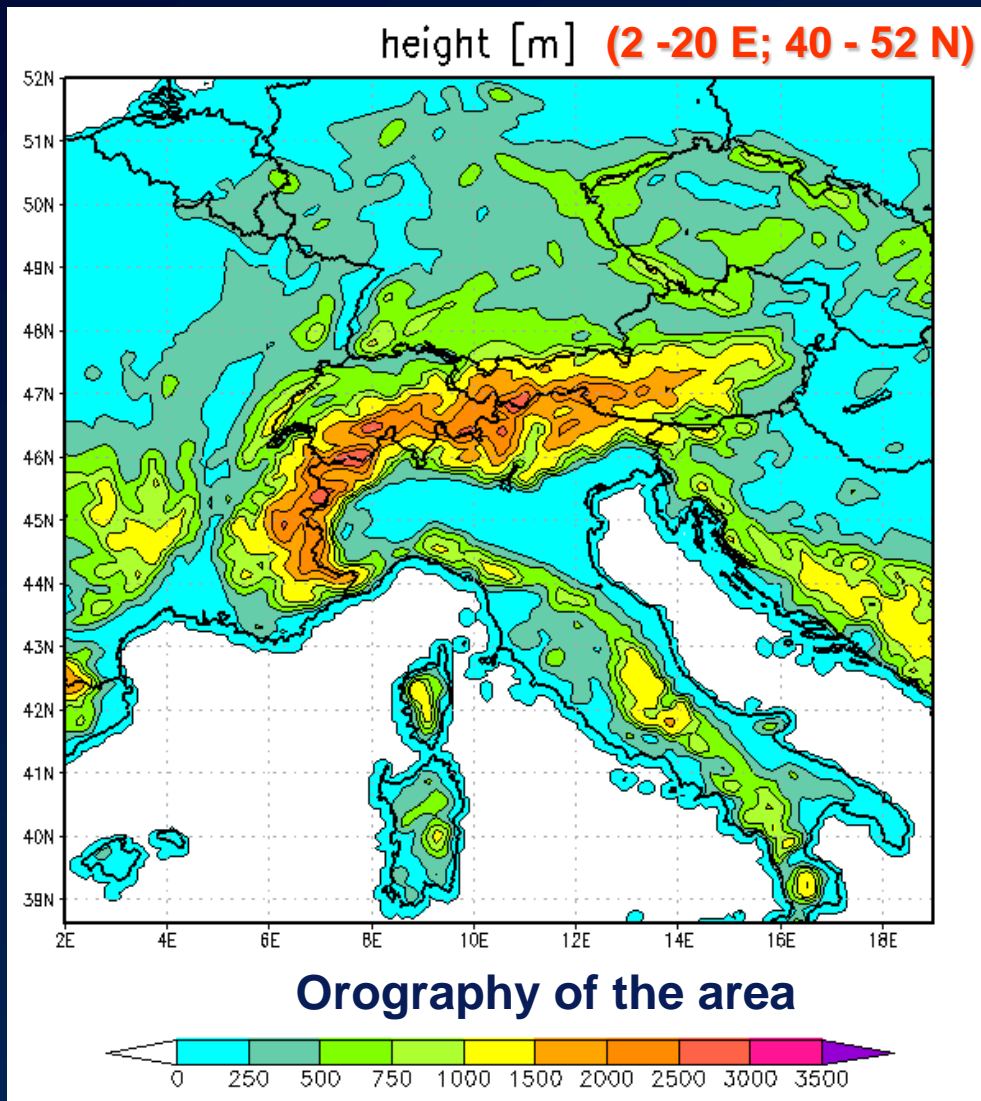
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The CMCC-MED MODEL: a global climate model with a fully resolved interactive Mediterranean Sea developed in the framework of CIRCE (EU-FP7)

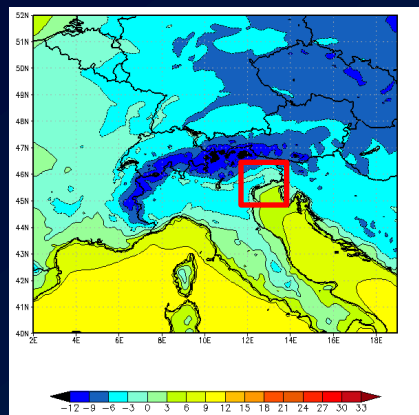


The COSMO CLM model

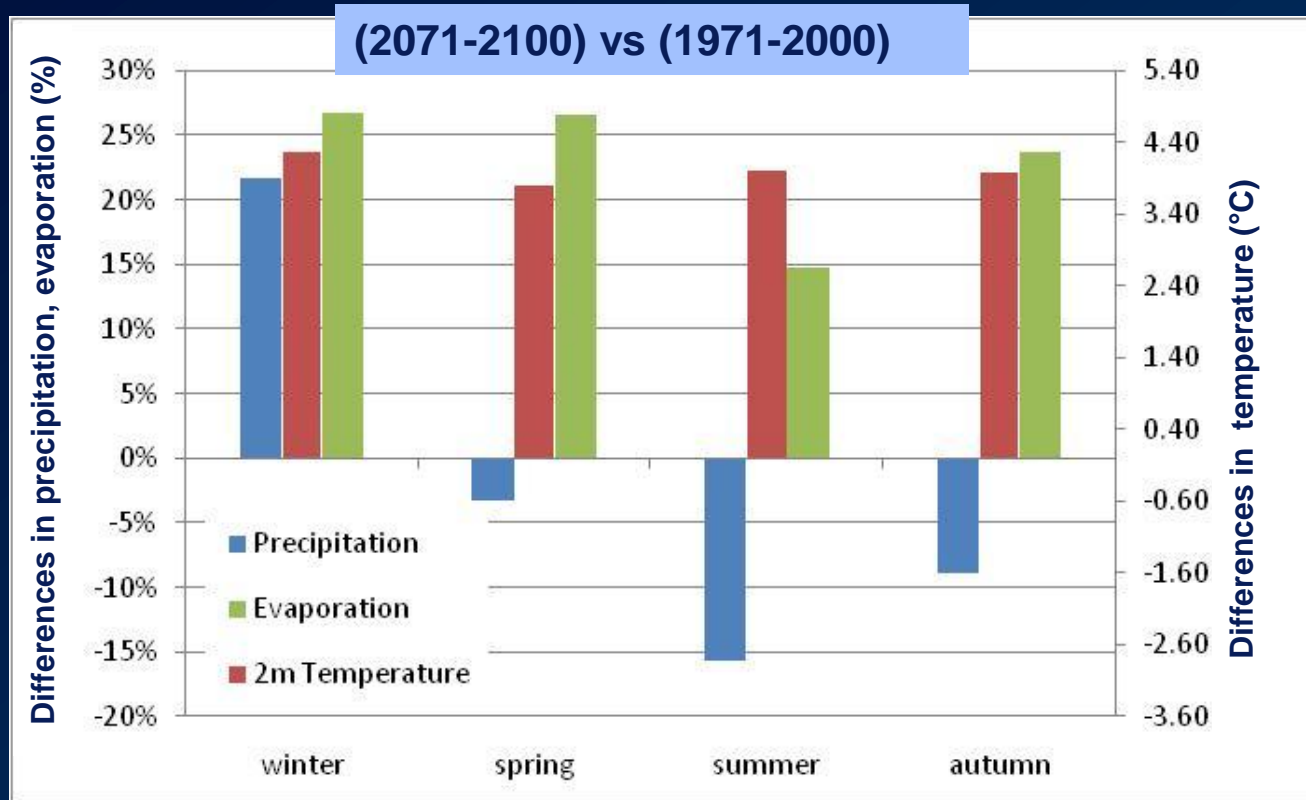


- climate simulations of the 2nd part of the 20th Century (1951-2000) validated with observed data (2mTemp and precipitation)
- During the 20th Century period of the simulations the distribution and concentration of the atmospheric greenhouse gases and aerosol have been prescribed from observations
- projections for the 21st Century (2001-2100)
- During the 21st Century period, two scenario simulations have been performed, according to the A2 and A1B IPCC-SRES

The Climate Change Projections in the TRUST Region: possible changes in 2m TEMPERATURE, PRECIPITATION and EVAPORATION



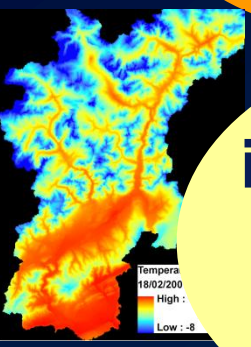
(A1B) scenario



- The changes in simulated evaporation and temperature show the same positive sign
- The surface temperature shows a rather uniform increase in all seasons of about 4°C
- The areal precipitation increases of more than 20% during winter and decreases in all other seasons

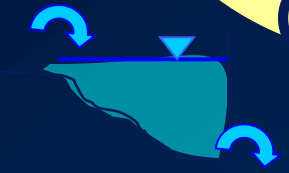


Calculation modules of the hydrological balance model



Network extraction from DEM

Spatial interpolation of climatic variables (kriging)

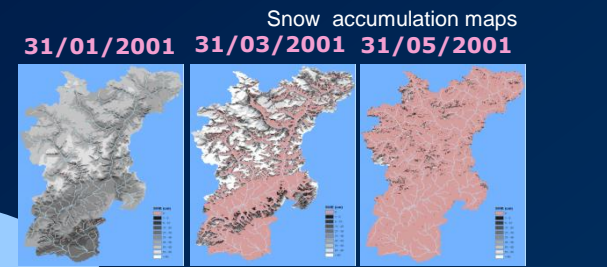


Reservoirs management module

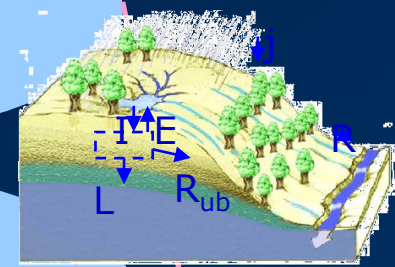
Snow melt module

Inflows – outflows transformation module

Outflows propagation module (geomorphoclimatic)



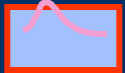
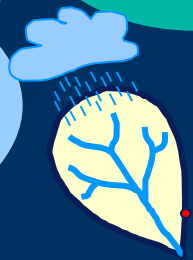
Utah Energy Balance Model (Tarboton et al. 1996)



(De Smeth et al. 2000)
(Liu et al. 2004)
(Laio et al. 2001)

BALANCE EQUATION:
 $S(t+\Delta t) = S(t) + I(t) - R_{sub}(t) - L(t) - E(t)$

Automatic calibration module

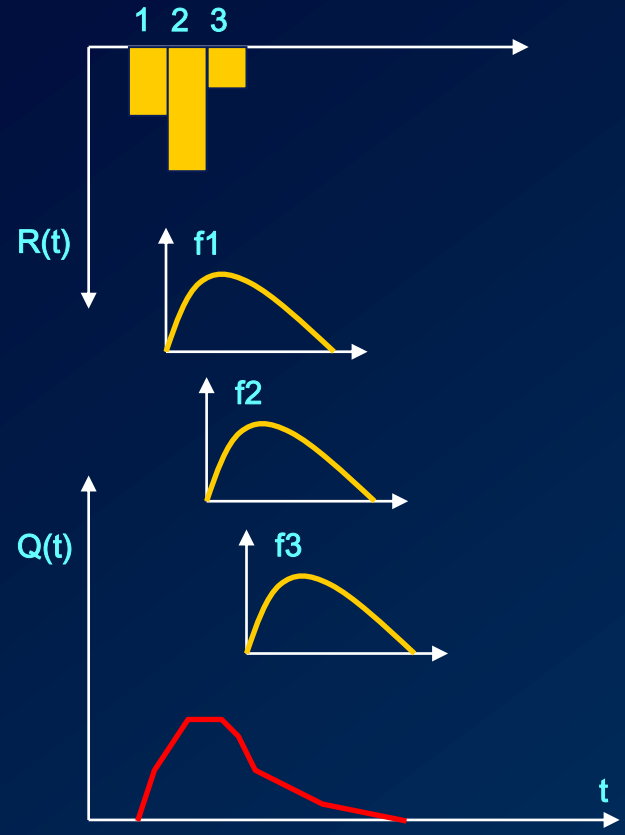
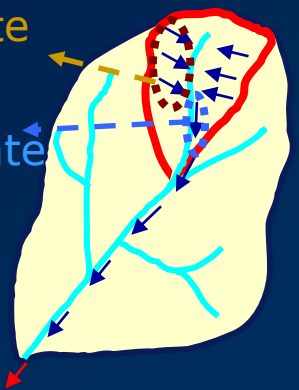


GEOMORPHOCLIMATIC APPROACH FOR DETERMINING HYDROLOGICAL RESPONSE OF RIVER BASINS

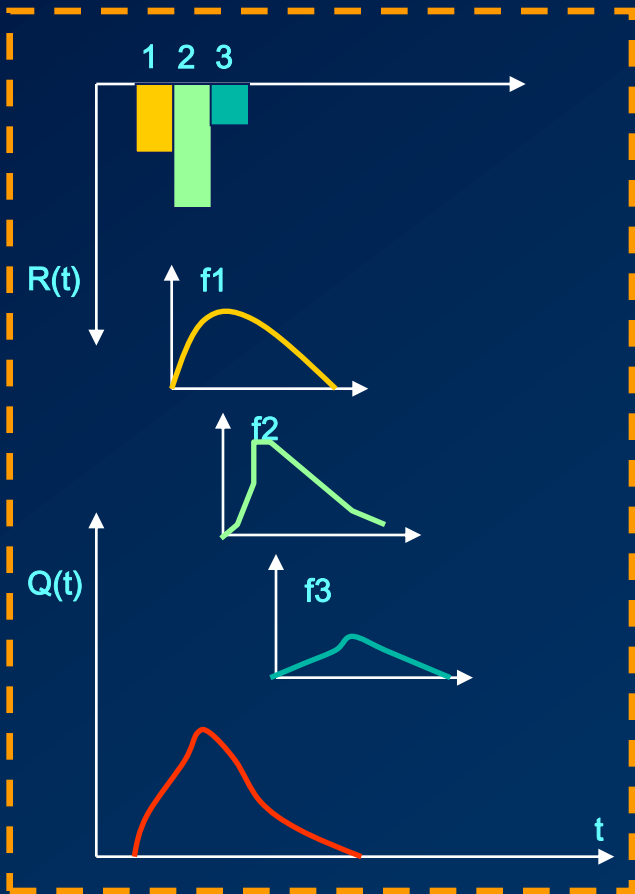
Geomorphoclimatic formulation

Hill state

Channel state



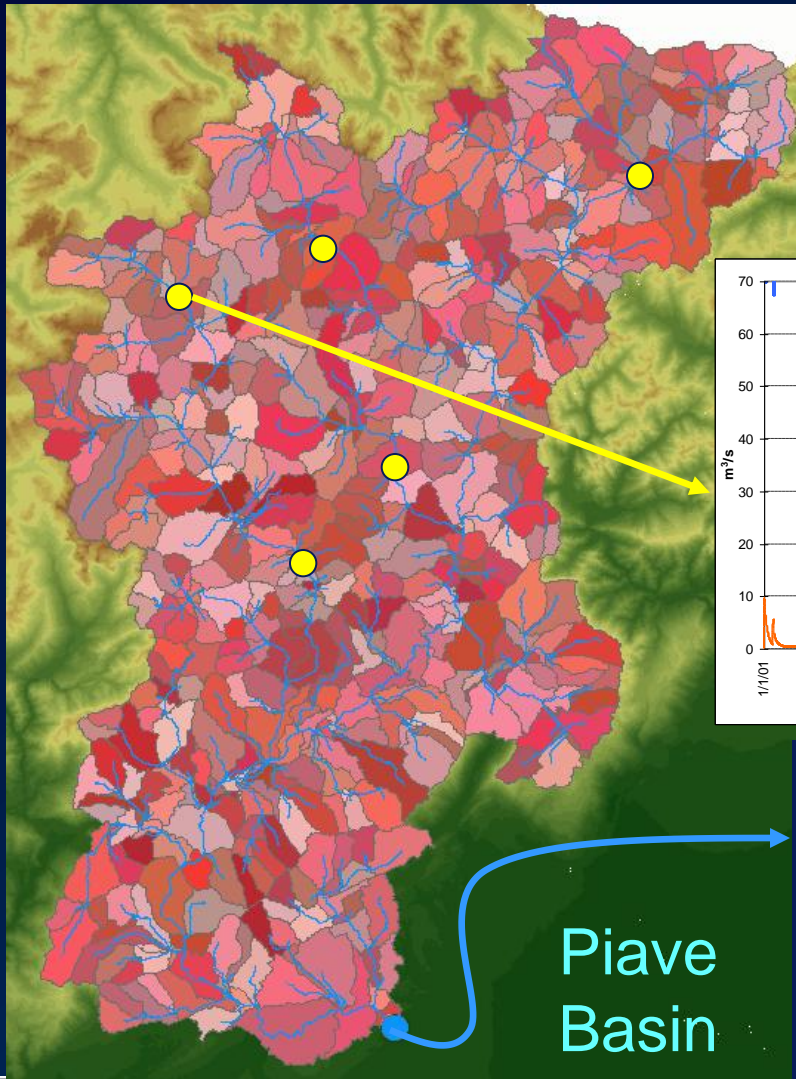
Traditional formulation



Geomorphoclimatic formulation



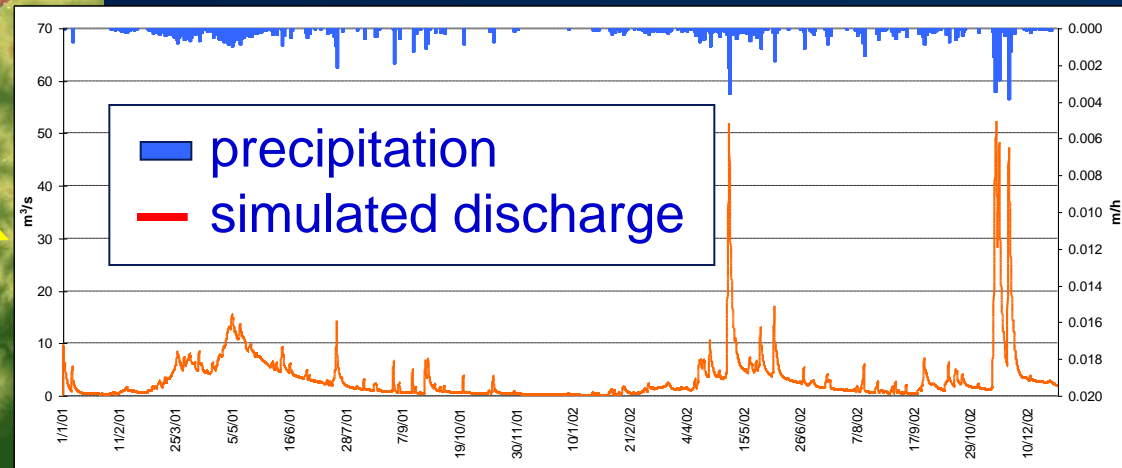
GEOMORPHOCLIMATIC APPROACH FOR DETERMINING HYDROLOGICAL RESPONSE OF RIVER BASINS



Basin closing section



Points of interest



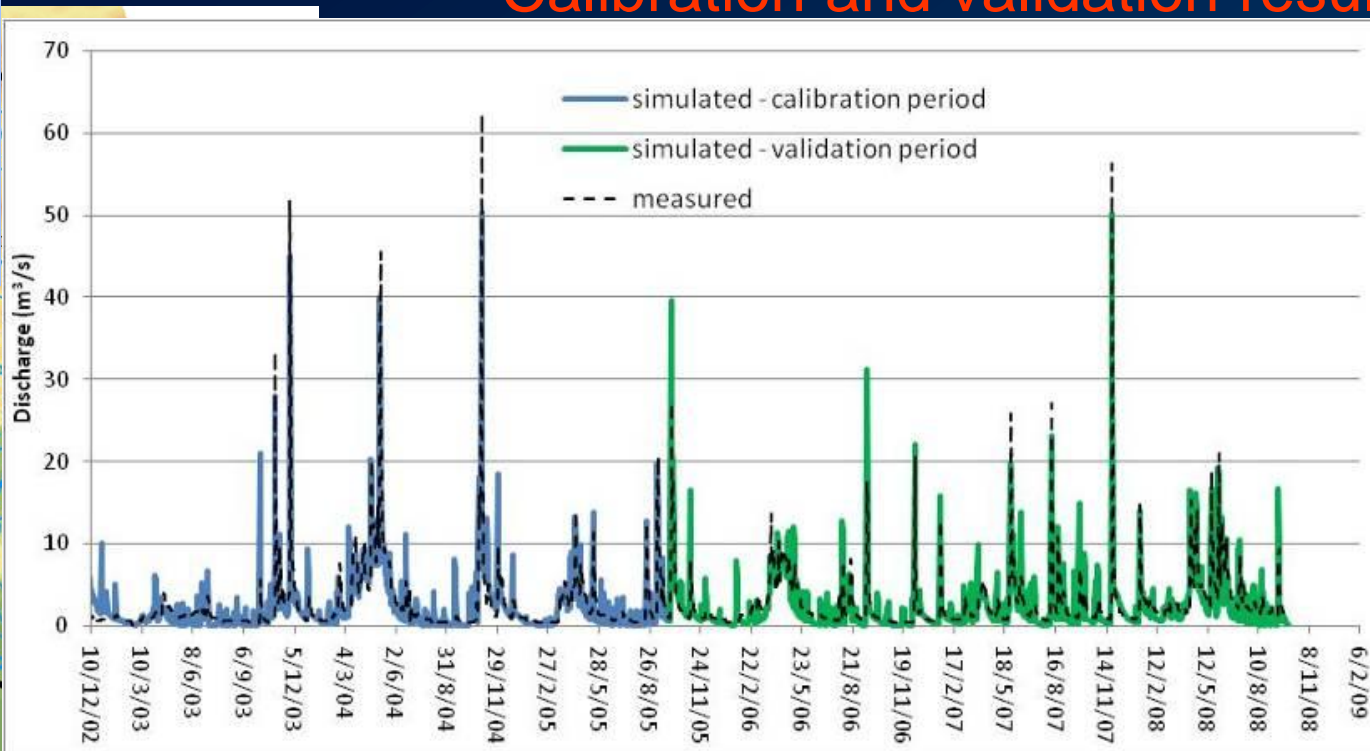
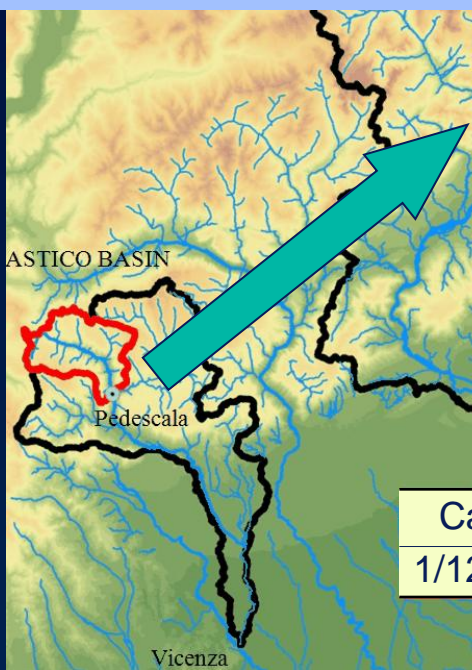
Annual hydrological balance



Impact of climate change on hydrological balance of a one mountain basin

Calibration and validation results

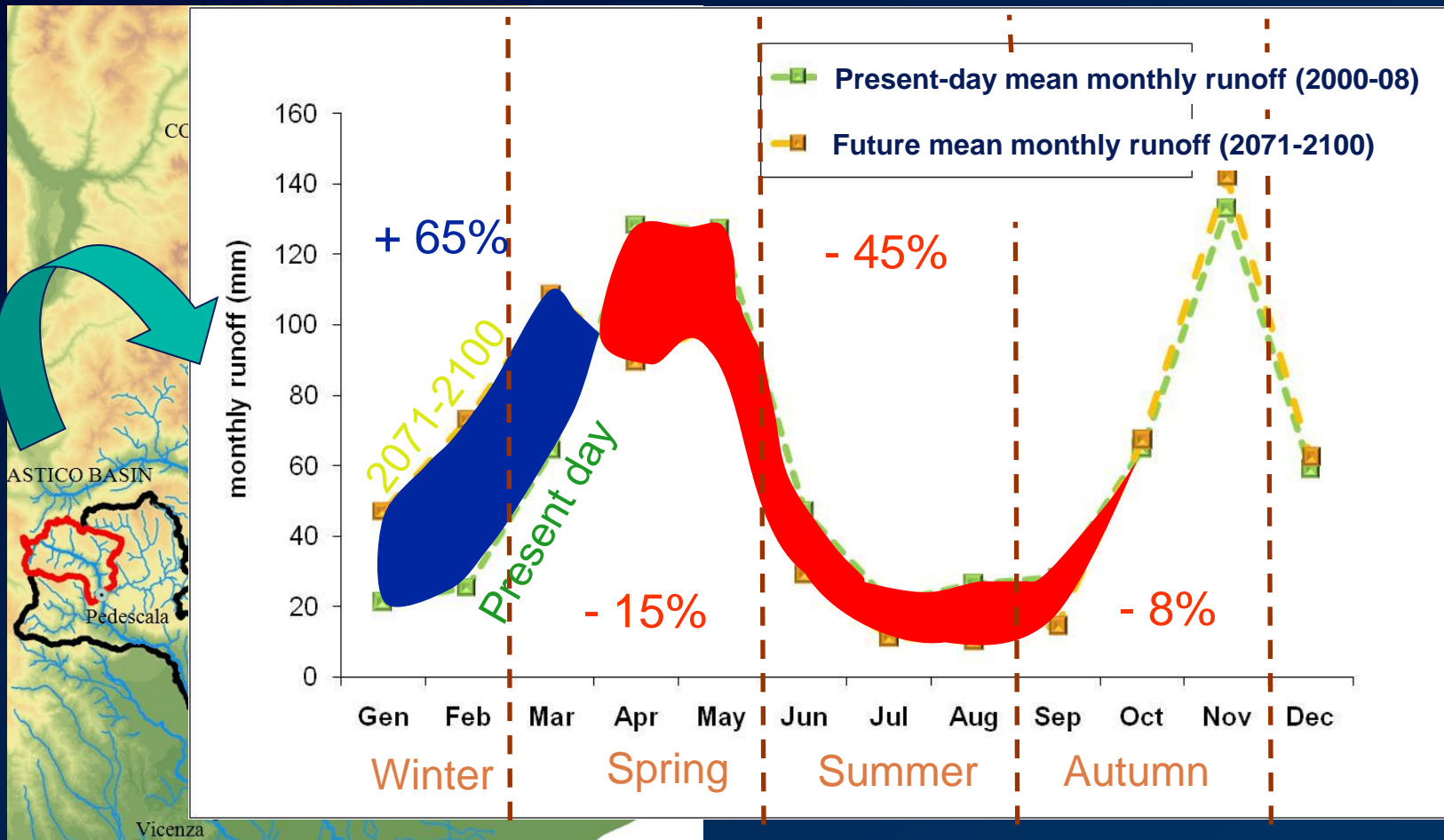
Astico at Pedescala
 (BACCHIGLIONE)
 137 km²
 310-1960 m s.l.m.
 1300 mm/year



Calibration period	E_{NS}	Validation period	E_{NS}
1/12/2002-1/10/2005	0.78	1/10/2005-1/10/2008	0.68

Impact of climate change on hydrological balance of a one mountain basin

Monthly runoff projection for the Astico River



(A1B) scenario

Impact of climate change on hydrological regimes in the TRUST area

- In the project area we expect a general reduction in annual runoff, a decrease in total snow and a reduction in runoff during spring and summer season by 2100. This will impact agricultural water use, especially in the dry season.
- The probably worsening of the groundwater status in the region, will be evaluated by coupling the hydrological model with a groundwater balance model.
- Based on results of measures and simulations a methodology to identify the extent and location of areas suitable for the development of appropriate **drought mitigation strategies** (based on water banking techniques) is being implemented.

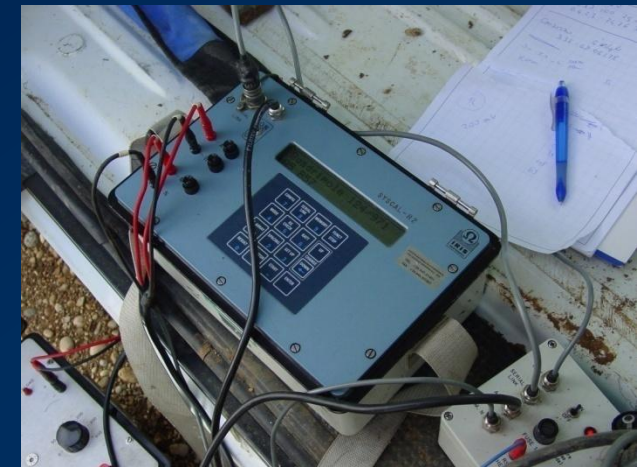
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Measures for artificial aquifers recharge and cost benefit analysis

Estimation at regional scale of:

- possible recharge targets,
- economic analysis comparing the "zero" option and the options for aquifer recharge



Develop tools and methods for introducing solutions
MAR (Managed Aquifer Recharge) for the enhancement
of groundwater in Veneto-Friuli Plain at river basin scale



FOREST AREAS OF INFILTRATION

The 1st TRUST Experimental area of Schiavon (VI).

In collaboration with the Brenta Consortium of drainage boards and irrigation)

- located in Vicenza Province, close to the Brenta River
 - 1 hectar, equipped with 200 meters long ditches
 - the infiltrating area of the ditch system is equal to 1200 m²



CORLO DAM (Cismon river basin)
Reservoir capacity: 50.000.000 mc

shows interesting values of (10-50 l/s/hectar) and extending the initiative to a larger area of about 100 hectares into groundwater a water volume of 50 million cubic meters per year, a very significant value.

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1. Introduction
2. Climat et eau: observations au 20e siècle
3. Climat et eau: simulations au 21e siècle
4. Drought mitigation strategies
5. Conclusions

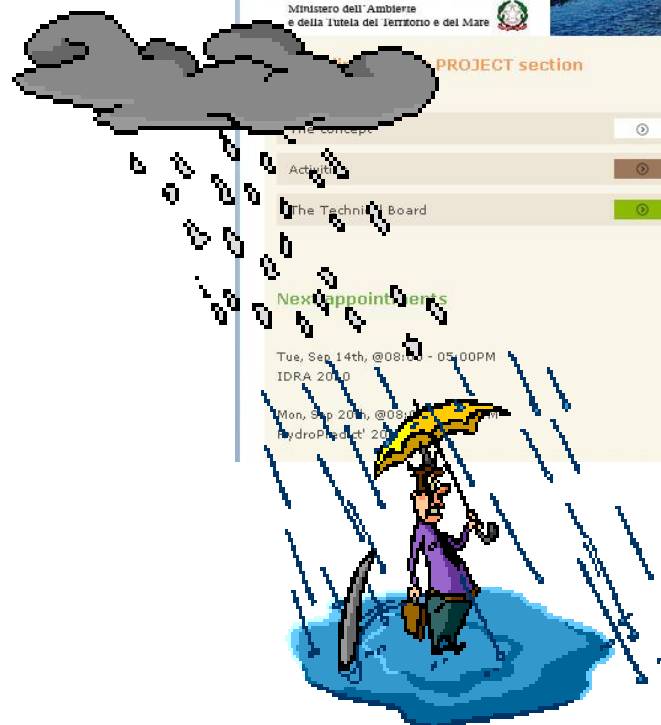
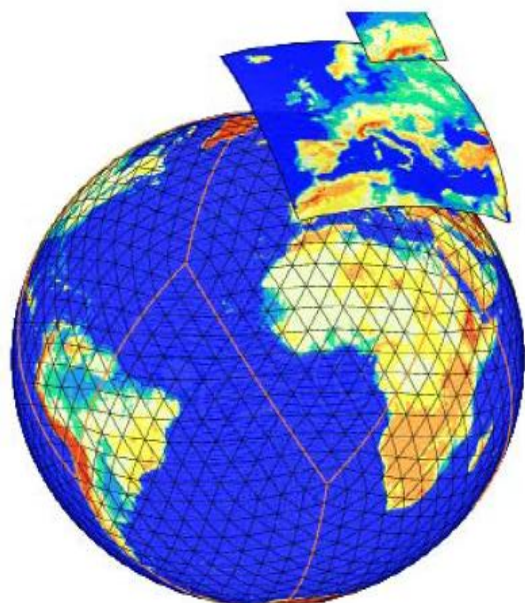
Conclusions

- ✓ The hydrological model, coupled with the climate model (CMCC-Med) at high resolution, is able to provide plausible scenarios of future water availability (up to 2100). In the project area we expect a probably worsening of groundwater status due to climate change that will be evaluated by coupling the hydrological model with a groundwater balance model.
- ✓ The objectives of the project, are in line with European Directive 2000/60/EC on water.
- ✓ Only the synergy taking place between agencies and institutions involved in water resource management (TRUST Technical Board), made possible the development of a predictive tool to support public institutions to promote measures (as drought mitigation strategies) to protect and preserve water resources on a regional scale.
- ✓ The possibility to use the tool developed in TRUST as standard tool for water management in Veneto and Friuli regions was discussed and shared during the 1st WORKSHOP (organized “in the field” on Thursday, May 13, 2010).



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Thank you for your attention!