Hydro Predict'2012

Risks of water supply schemes originating from climate change and land use changes:

The CC-WaterS project

H.P. Nachtnebel and G. Kuschnig

Objectives

- Assessment of the Impacts from Climate Change on Water Supply Schemes in SEE
- Assessment of Respective Land Use Changes on Water Supply Schemes
- Risk Assessment and Identification of Mitigation Strategies

The Project Areas

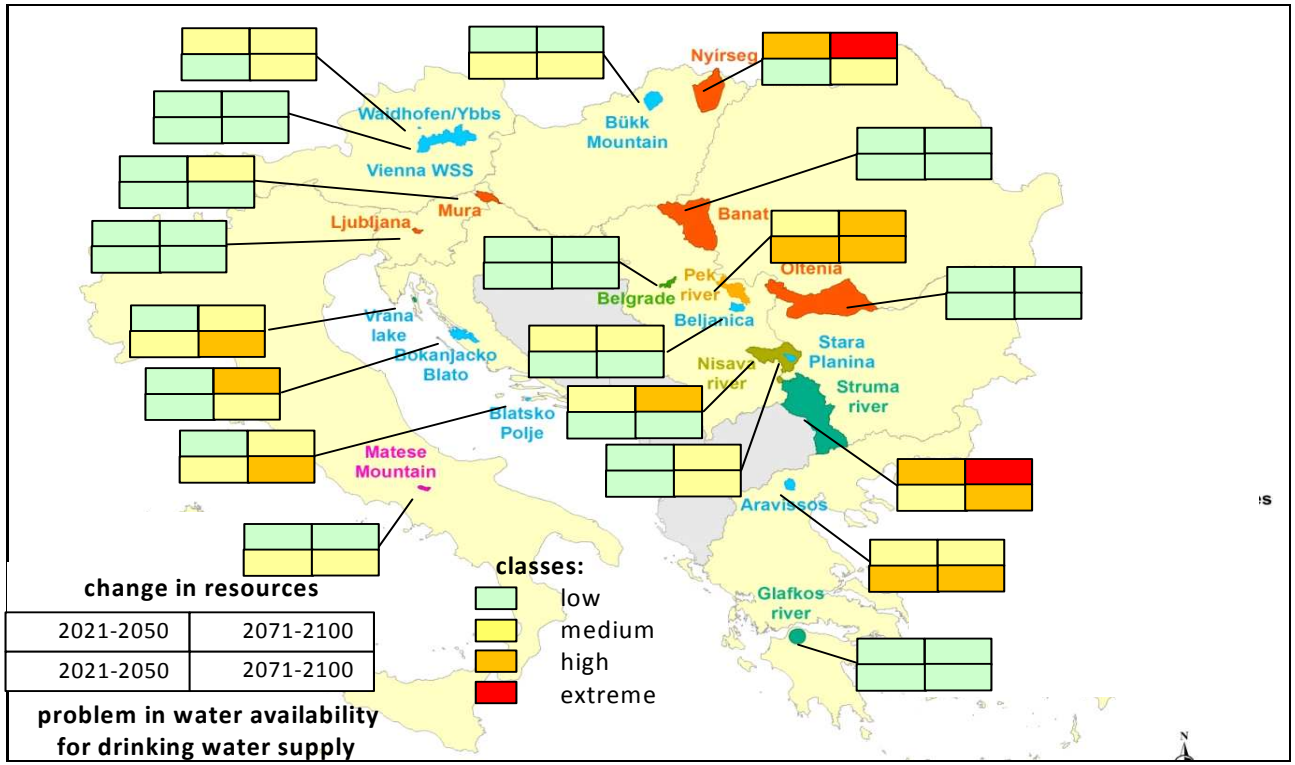
Partner countries:

Austria
Hungary
Slovenija
Croatia
Serbia
Romania
Bulgaria
Italy
Greece

Overview of water intake areas

- Quite hetereogeneous landscapes and landuses
- Quite different climatic conditions
- Institutional aspects: All countries are EU members and share some joint principles related to water and environment

Results for Water Supply Schemes Under Risk



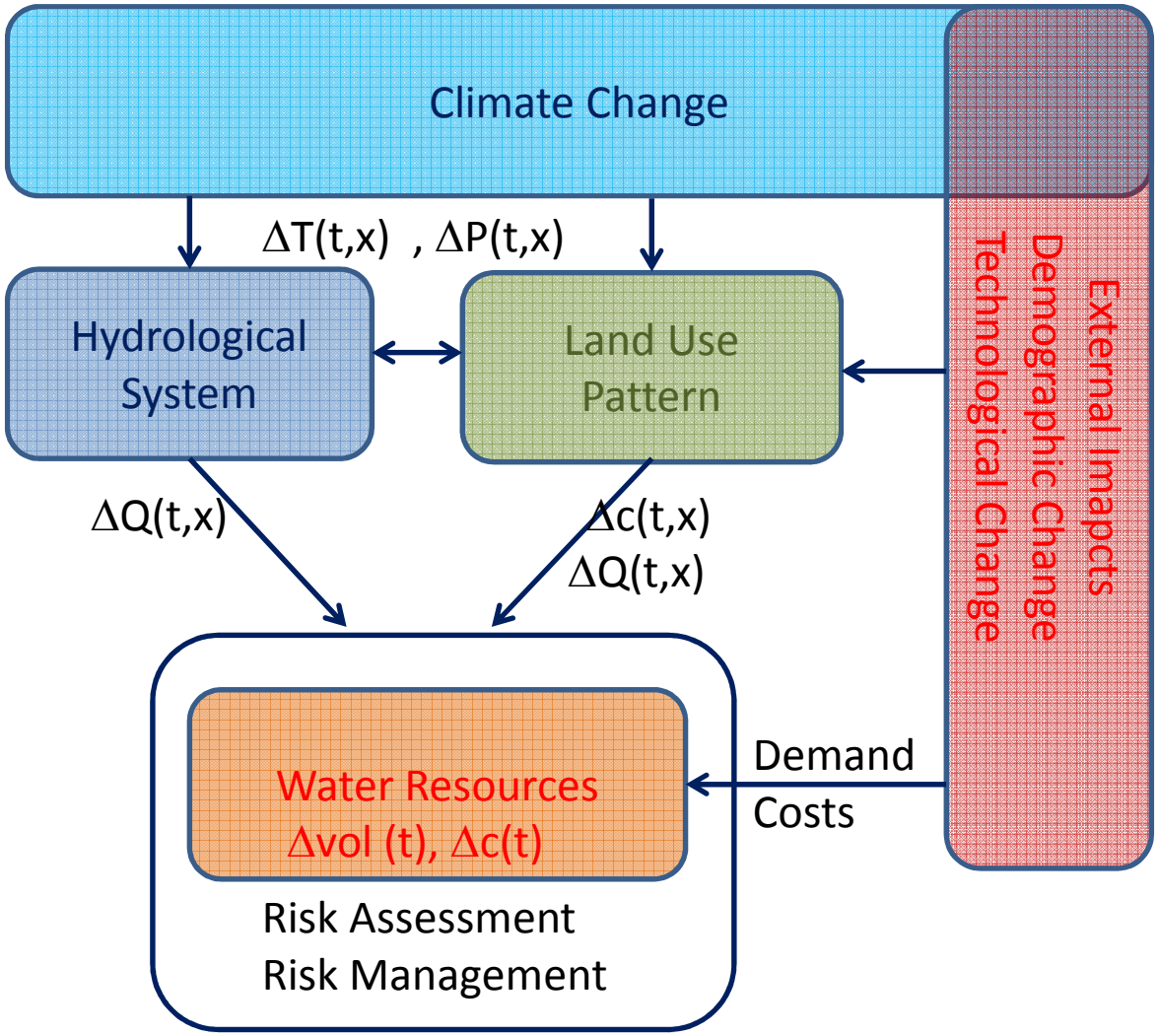
(Szimonffy, 2012)

Classification of the test areas according to water availability problems in particular related to drinking water supply and respective consequences

How did we Achieve these Conclusions ?

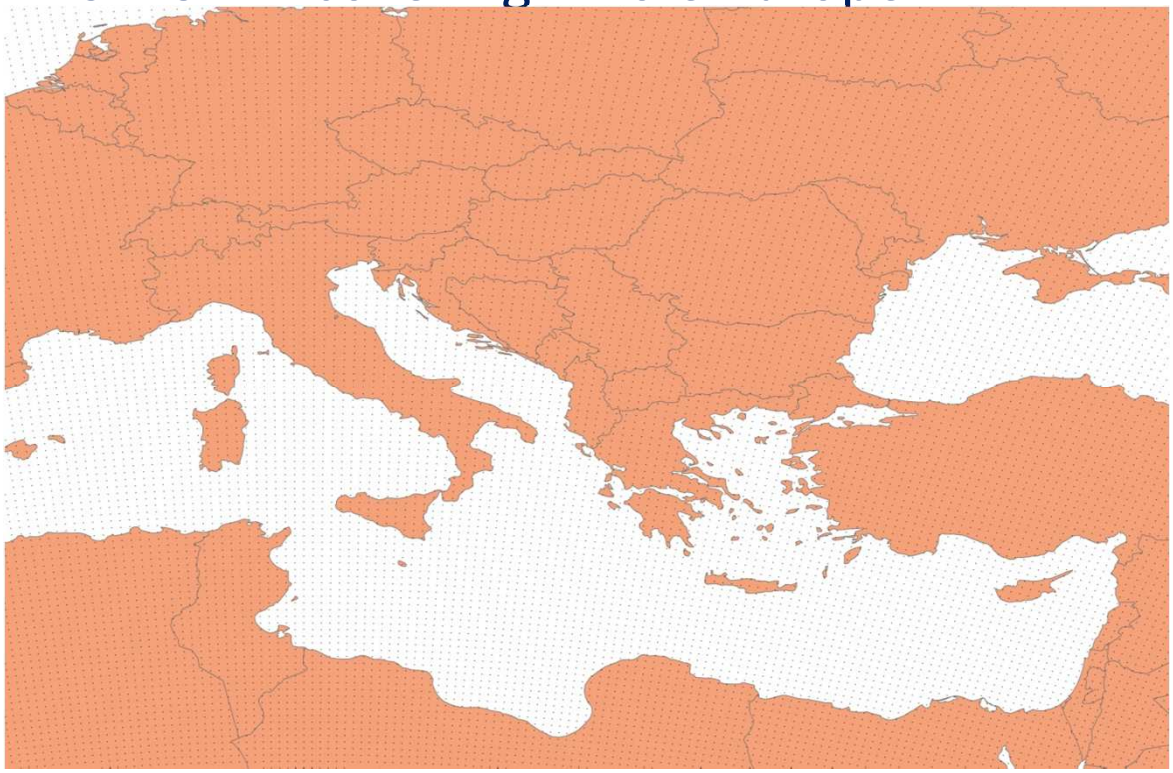
- General systems description
- Selection of climate drivers (1950-2100)
  - Selection of RCMs and data assimilation
  - Downscaling to local conditions
- Development of story lines for land use related changes
  - Identification of external factors (economic development, migration,…)
  - Linking Climate Change with local hydrological processes
- Identification and quantification of impacts on water management
- Risk assessment and management

General Description of the System



Climate Change

- ENSEMBLES project (http://ensemblesrt3.dmi.dk/) recently made available simulation results of several RCMs with a resolution of 25x25 km covering whole Europe



CNRM ALADIN-ARPEGE RCM

Climate Change

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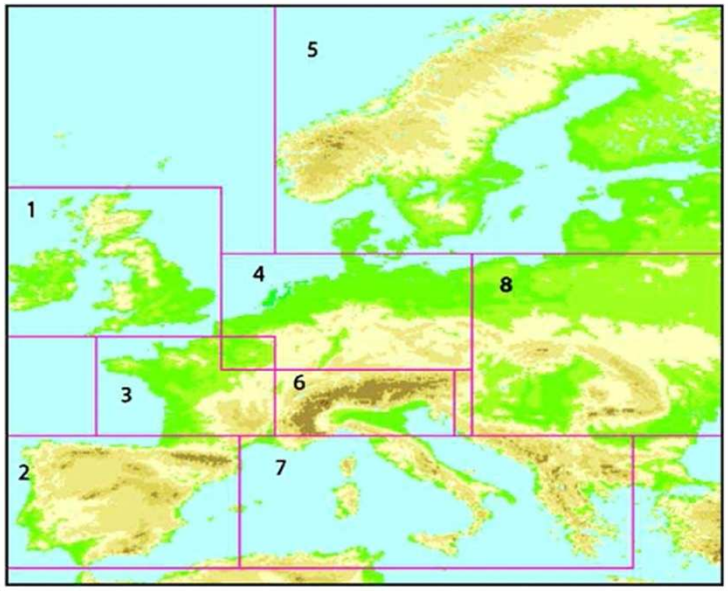
- Many different scenario simulations are available (Emission scenarios and GCM model scenarios)



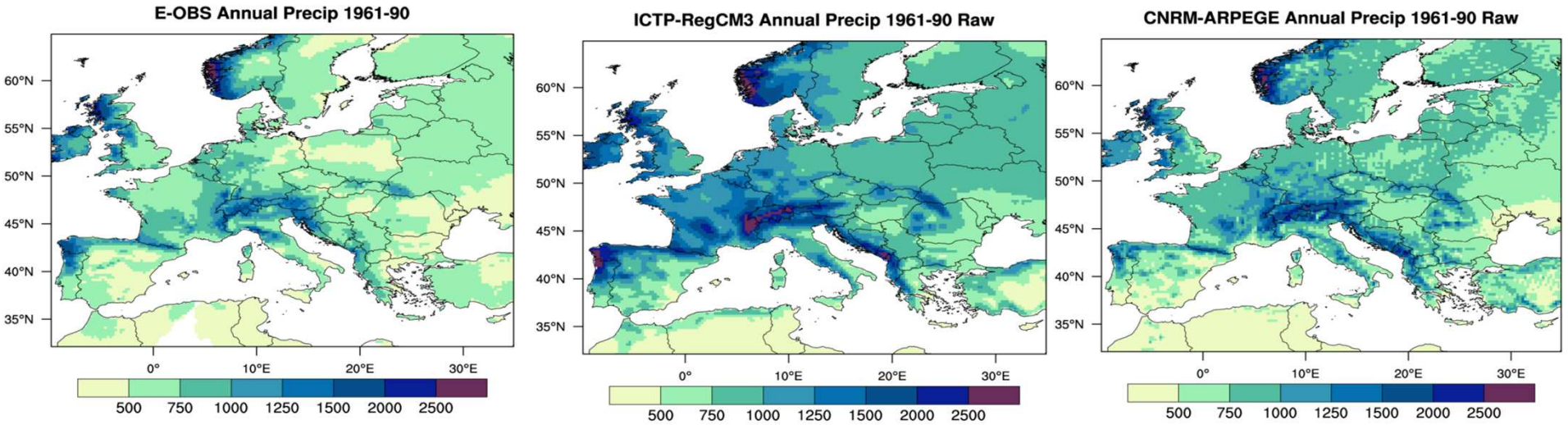
Intercomparison by Jacob et al. (2007)

Climate Change

- ENSEMBLES project (http://ensemblesrt3.dmi.dk/) recently made available simulation results of several RCMs with a resolution of 25x25 km covering whole Europe
- Many different scenario simulations are available (Emission scenarios, GCM model scenarios
- We selected the A1B scenario and 3 different driving GCMs
  - RCM ALADIN driven by GCM ARPEGE (CNRM Arpege)
  - RCM PROMES driven by GCM HadCM3Q0
  - RCM RegCM3 driven by GCM ECHAM5-r3

Results for Precipitation

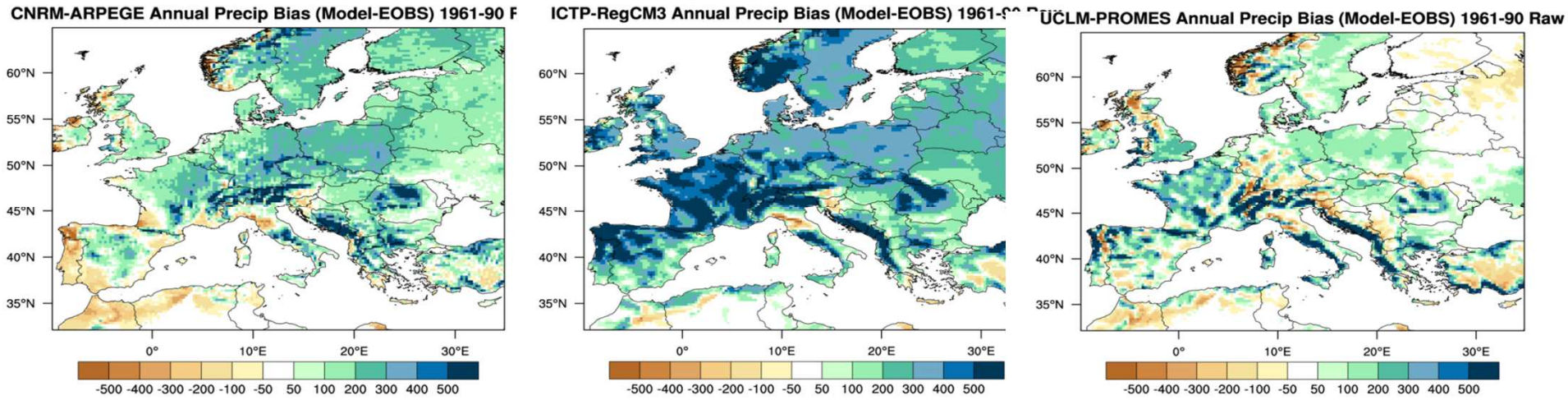
Comparison of simulation for the control period (1960-1990, 2000)



Major Differences among the RCMs

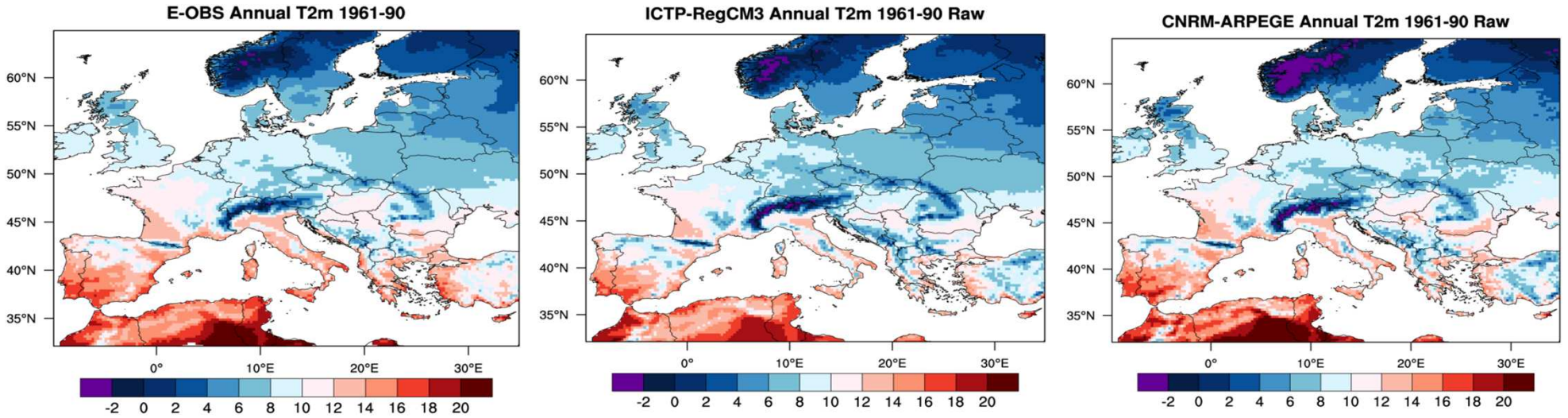
Large differences between OBS and simulation (may go up to 100 %)

Differences Between Obs and Simulated



Absolute bias in mean annual precipitation of GCM precipitation control period 1961-1990.

Results for Temperature



Comparison of observations of mean annual temperature (upper left) with raw GCM simulations for the control period 1961-1990

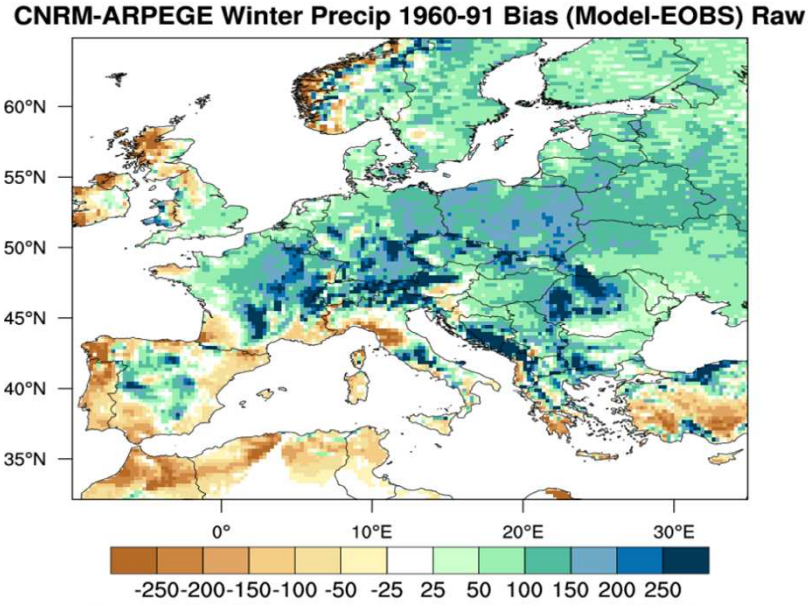
Differences between Obs and RCMs are smaller but bias with respect to altitude

Bias Correction of Simulations

- The use of raw RCM data in models is seen critically
- Simulations need adjustment (not only in the mean)
- The grid resolution of 25 km * 25 km is to coarse for a heterogeneous environment, like the mountains
- Large errors of RCMs in mountain terrain

- We applied quantile mapping (Déqué, 2007)

Bias Correction of Simulations



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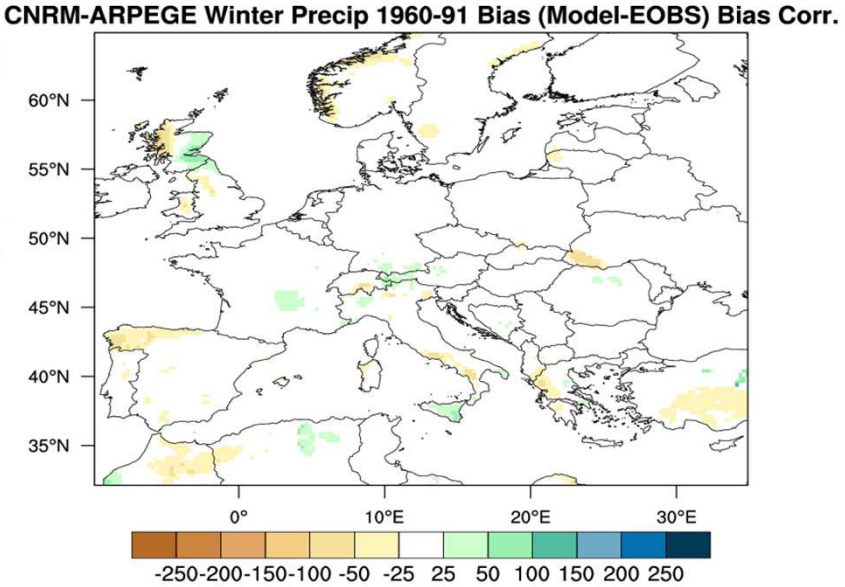
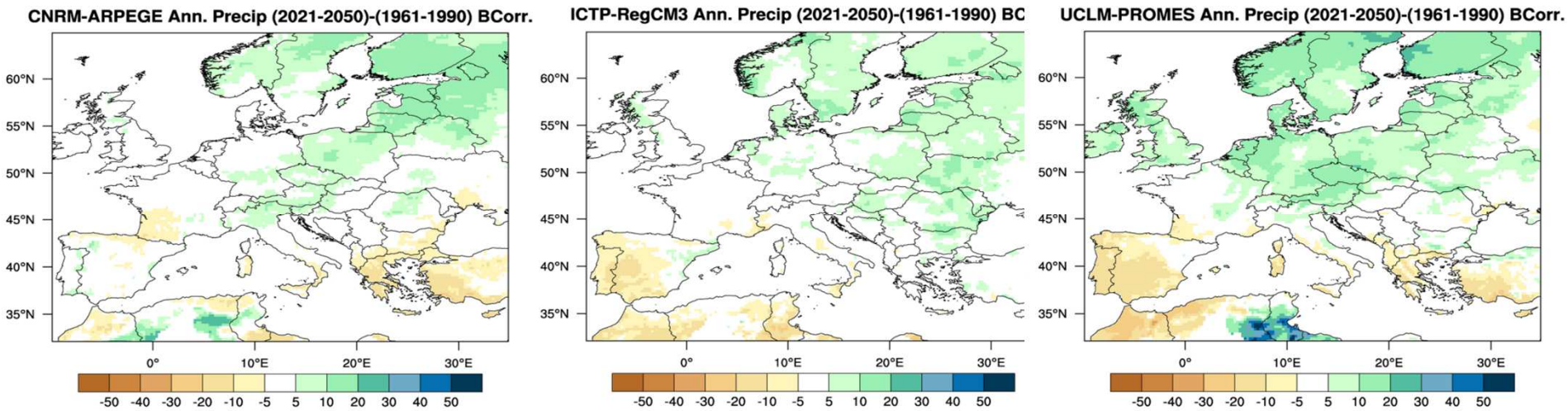
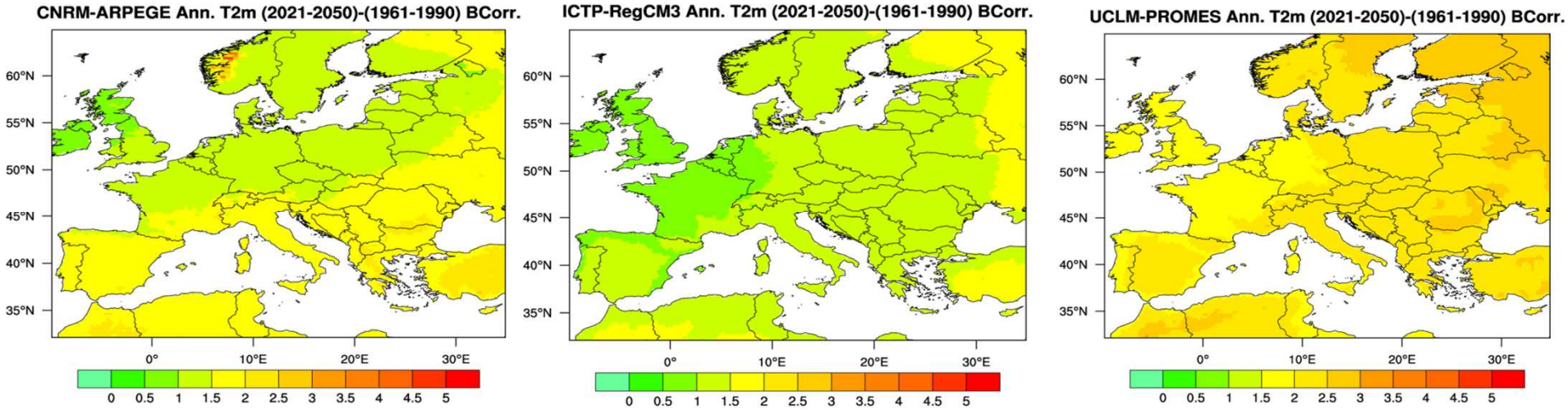


Climate Change Signal until 2050



Bias corrected climate change signal - mean annual precipitation for the period 2021-2050

Climate Change Signal until 2050



Bias corrected climate change signal - mean annual temperature for the period 2021-2050

Summary of Climate Change Simulations
Deltas in Precipitation until 2050

- Spatial precipitation pattern over Europe is similar in the different RCMs
- an increase in mean annual precipitation towards the North while a decrease can be expected in the South, especially in the South-West of Europe.
- ARPEGE model: annual rainfall over central Europe (Austria, Slovenia) is expected to increase by about 10-20 %.
- No changes were detected for major parts of Romania, Serbia, Croatia and Hungary while a decrease by about 20-30 % is found in Bulgaria and Northern Greece.
- RegCM3 model: stable conditions and in some countries like Hungary, Romania, Bulgaria a slight increase.
- PROMES model: an increase in annual precipitation for central Europe (Austria, Slovenia) by about 10-20 %, and stable conditions for the rest of the Balkans except Greece where the rainfall should decrease by about 20 % (Fig.11).

- **It can be summarized that the climate change signal in precipitation is rather weak and it is also differently reflected by the selected models.**

Summary of Climate Change Simulations
Deltas in Temperature until 2050

- The ARPEGE and the RegCM3 model yield an increase of about 1 – 1.5 °C in the mean temperature for the winter half year
- PROMES model: the increase is about 2 – 2.5 °C.
- ARPEGE and the PROMES model: the increase in the summer half year is higher and goes up to 3 °C.
- RegCM3 model: similar results for the winter and the summer period

- **Temperature simulations are more consistent**

Hydrological Simulation

- Model depends on the features of water intake areas
  - Groundwater systems
  - Karstic springs
  - Catchment models
  - Interaction between surface and groundwaters

Hydrological Simulation

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  - Catchm
  - Interac

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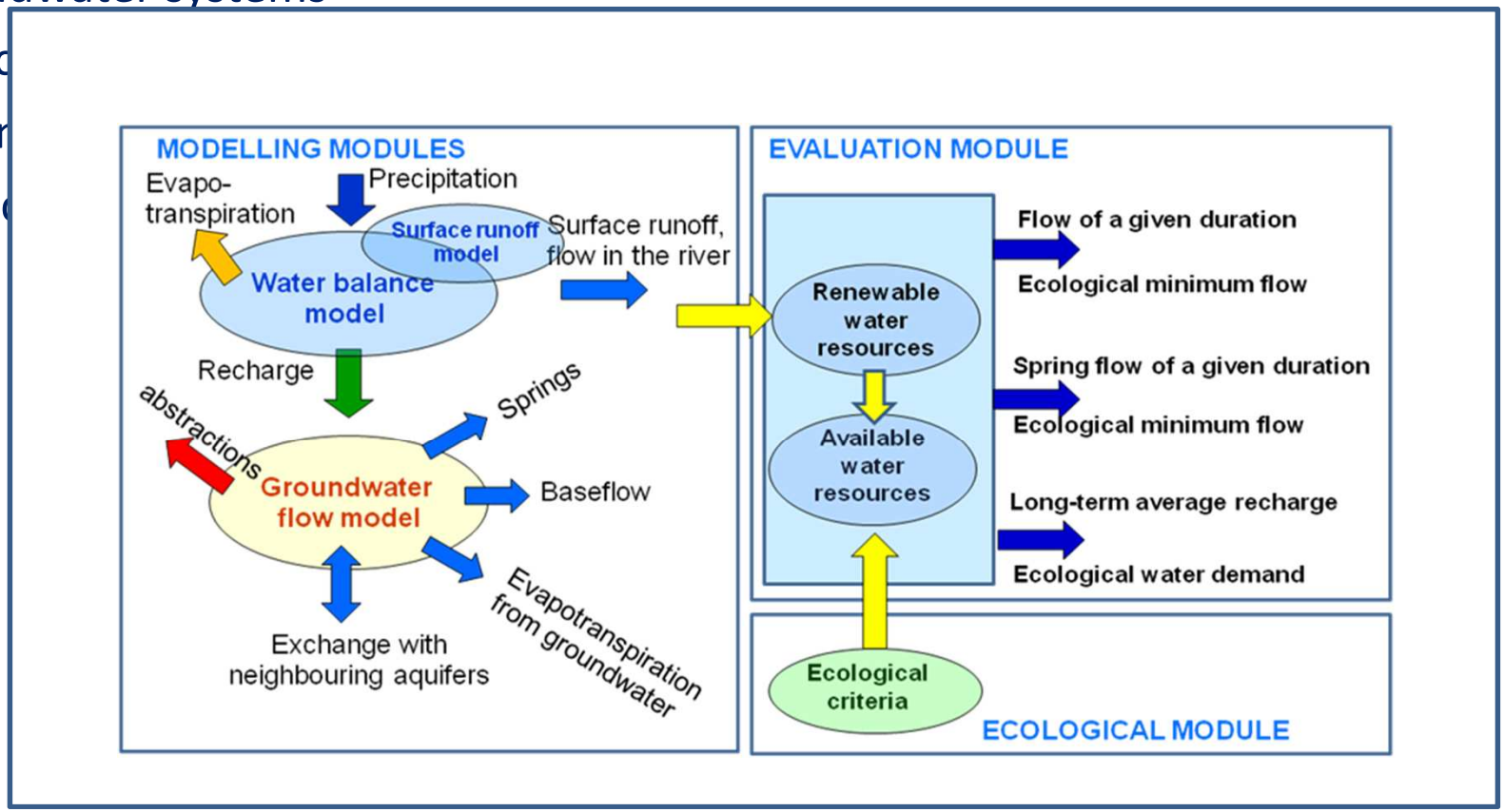
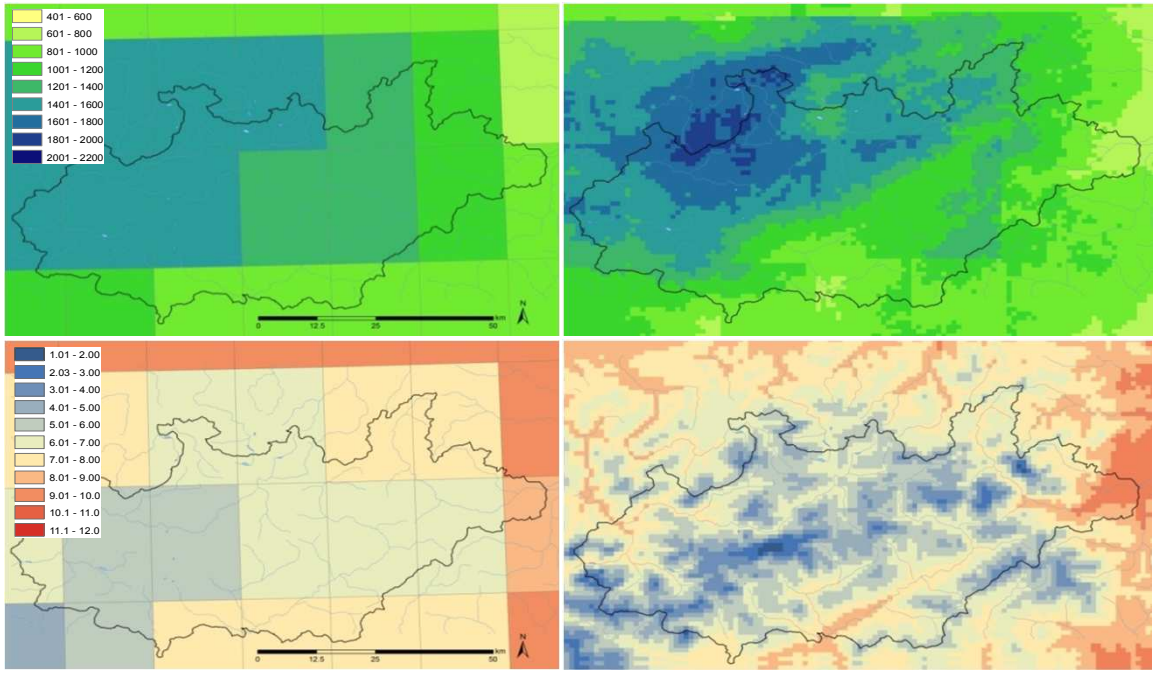


Hydrological Simulations

- In several regions a higher spatial resolution is required (e.g. in mountains)

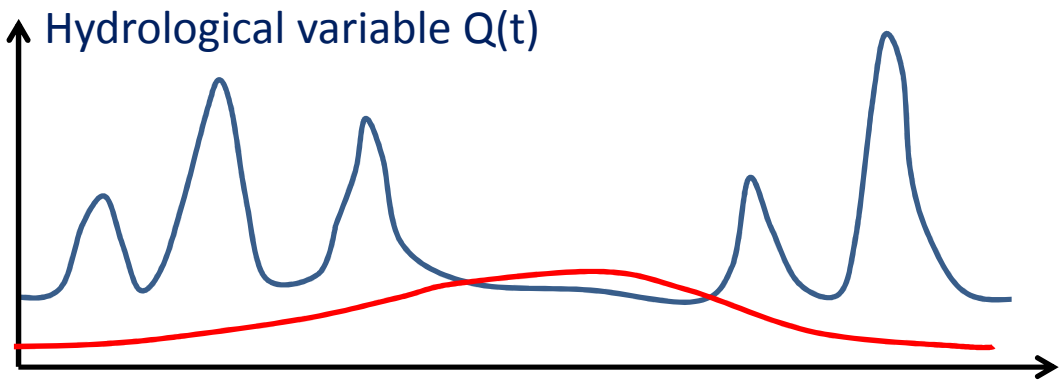


Precipitation

Temperature

RCM scale **downscaled data**

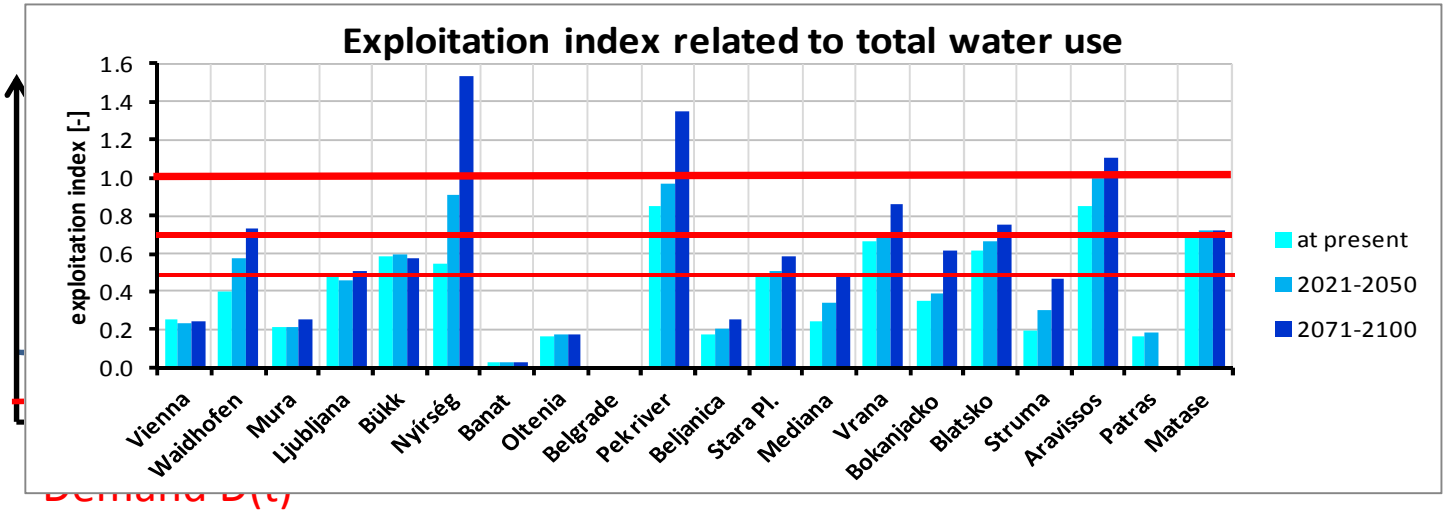
Water Resources System

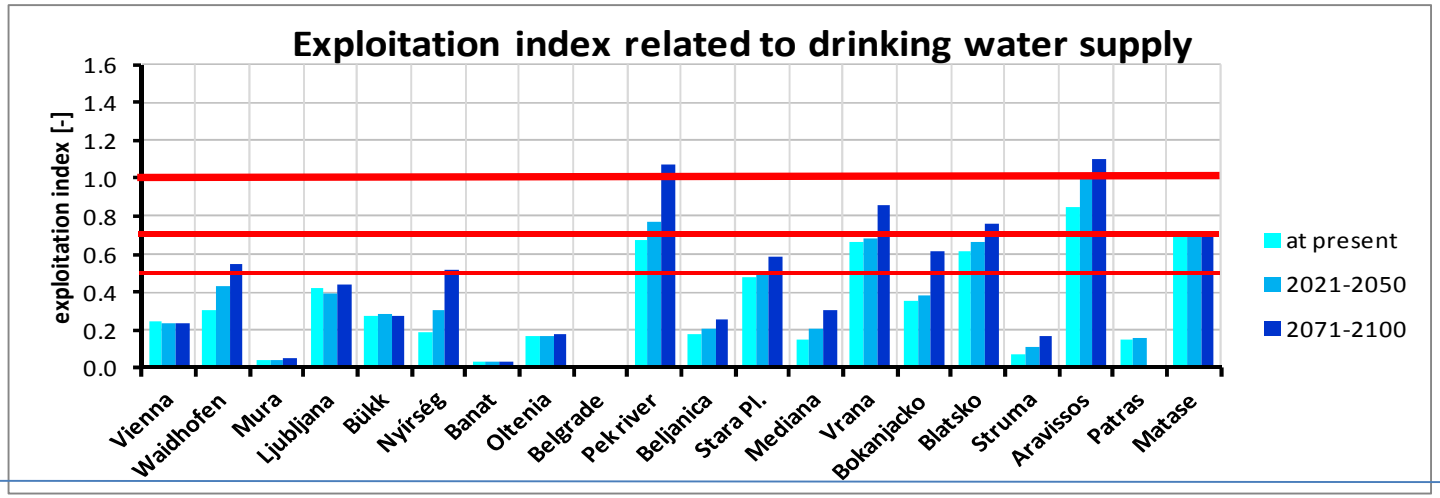


Criteria:

Ratio between demand and water availability
Frequency of critical events (floods and droughts)
Persistence of critical events (duration of drought periods)

Water Use and Availability

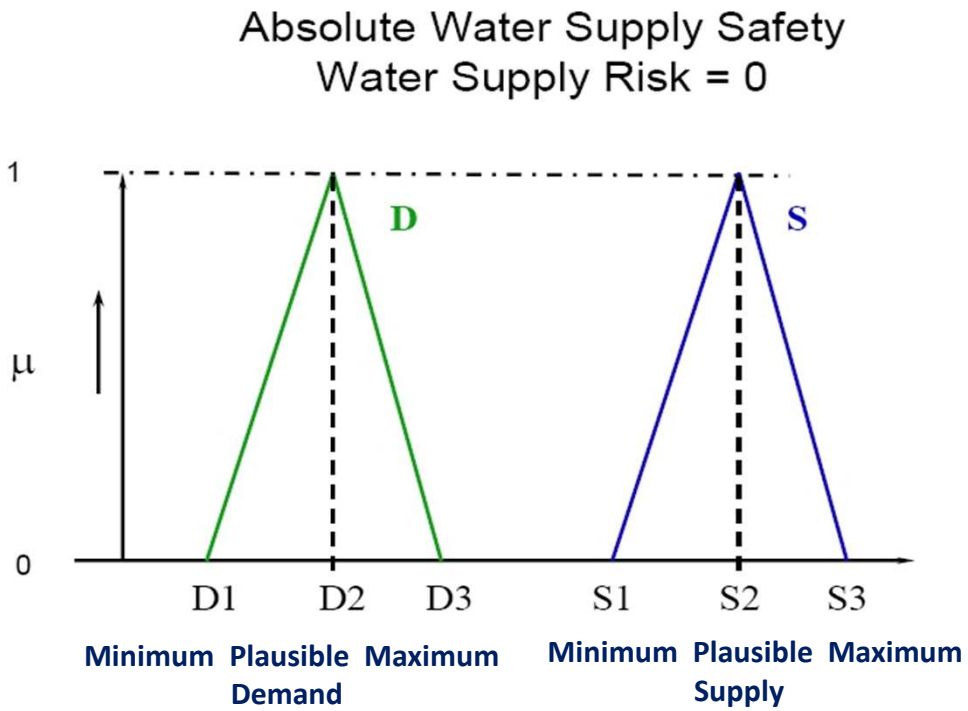




Risk Assessment

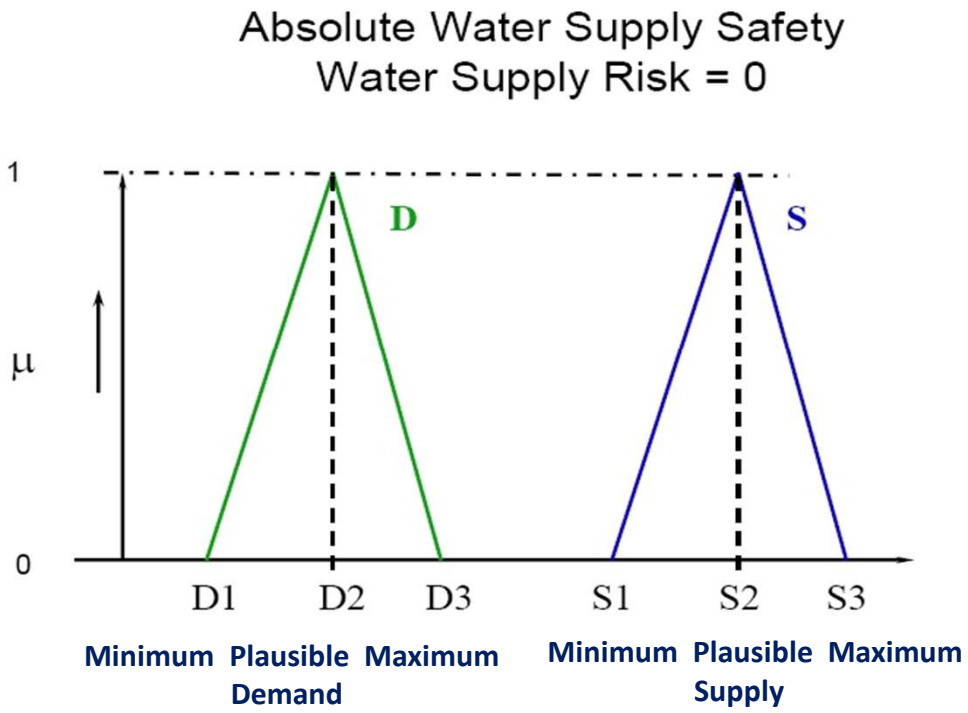
- Regional development (described by story lines)
- Projections of water availability and water demand
- Identification of critical events
  - Floods
  - Droughts
  - Demand> Supply
- We dont have a pdf but we „know“ about maxima (worst case) and minima (best case) and plausible case
- Risk = event (water shortage) * consequence (costs)
- Fuzzy approach

Risk Assessment (Fuzzy Approach)



(I. Bogardi, 2012)

Risk Assessment (Fuzzy Approach)



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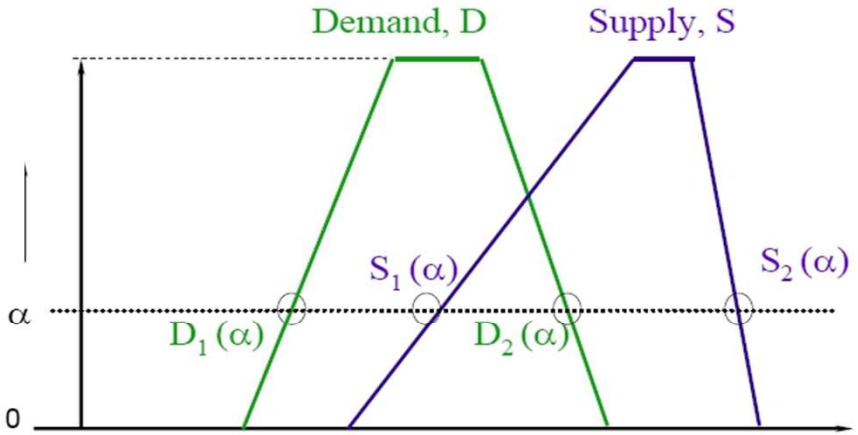
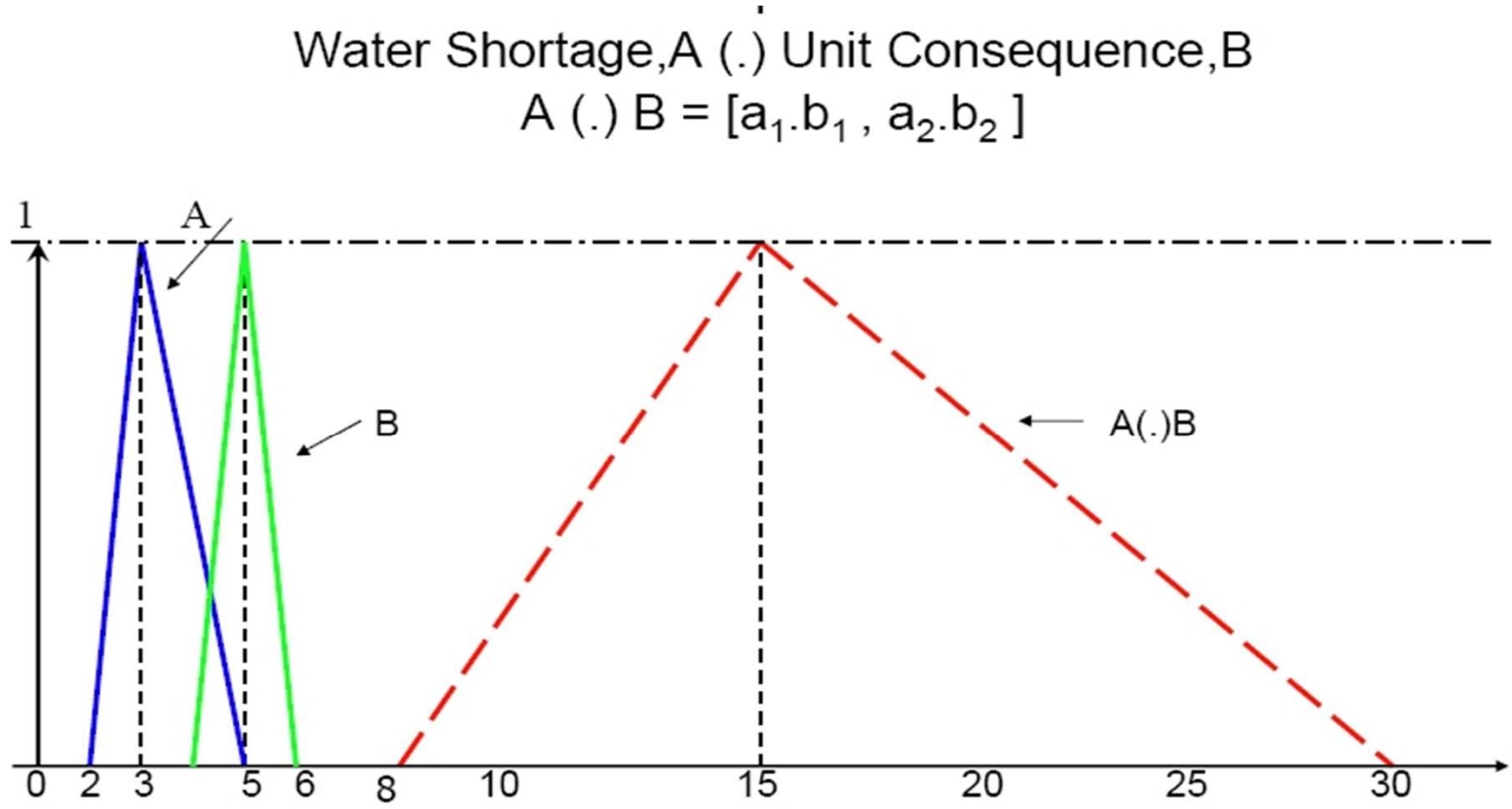


$$Z_1(\alpha) = D_1(\alpha) - S_2(\alpha)$$
Smallest — Smallest — Highest

$$Z_2(\alpha) = D_2(\alpha) - S_1(\alpha)$$
Highest — Highest — Smallest

Risk Assessment (Fuzzy Approach)



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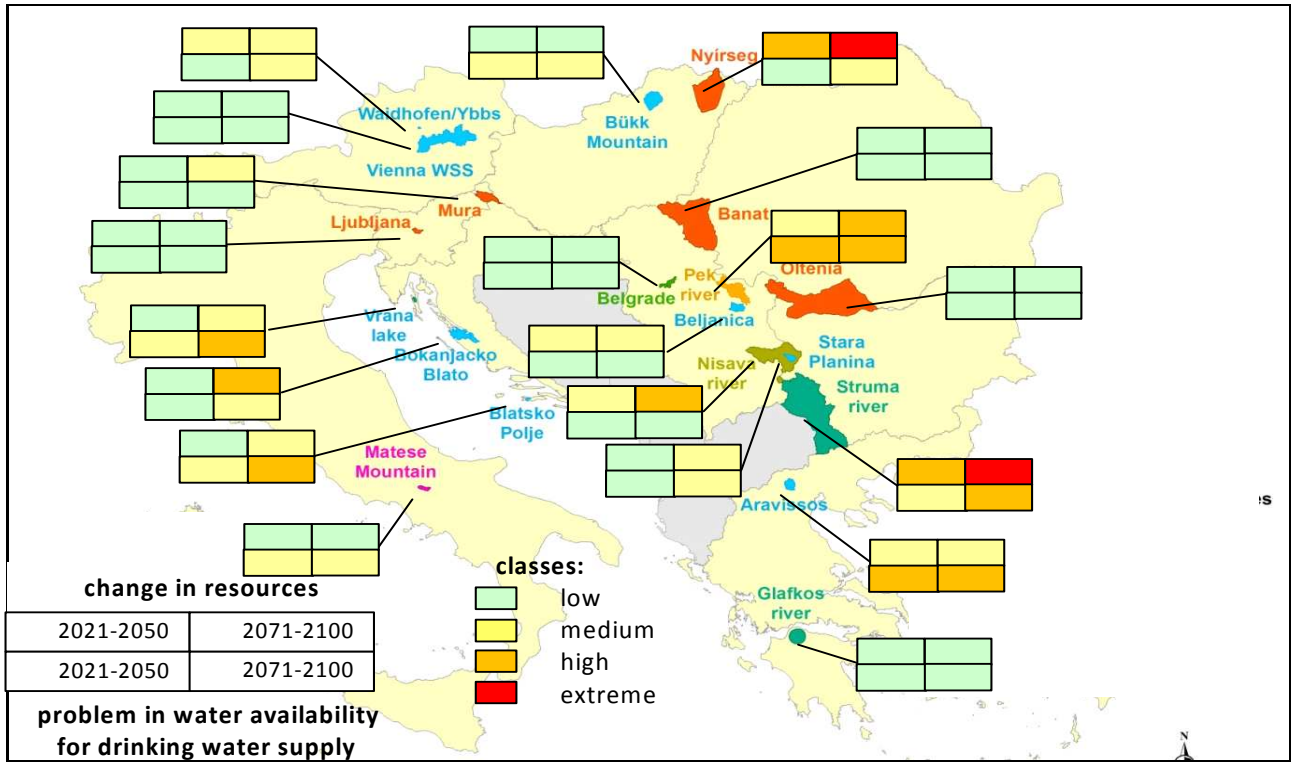
Risks for Water Supply



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Classification of the test areas according to water availability problems in particular related to drinking water supply and respective consequences

Conclusions

- Adjustment of RCM output (quantile mapping)
- Coupling a hydrological and land use model with Climate change model
- Description of regional development by story lines
- Assessing the impact of regional development, climate change and land use on water resources
- Assessing the impacts on water supply schemes
- Fuzzy approach to assess the risk of water supply schemes to land use changes and climate change

Conclusions

- A joint project of reseachers from universities, water managers and administrative institutions (ministries, city administration)

http://www.ccwaters.eu/