HyMeX
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Consequences of climate change upon water scarcity on the Mediterranean region

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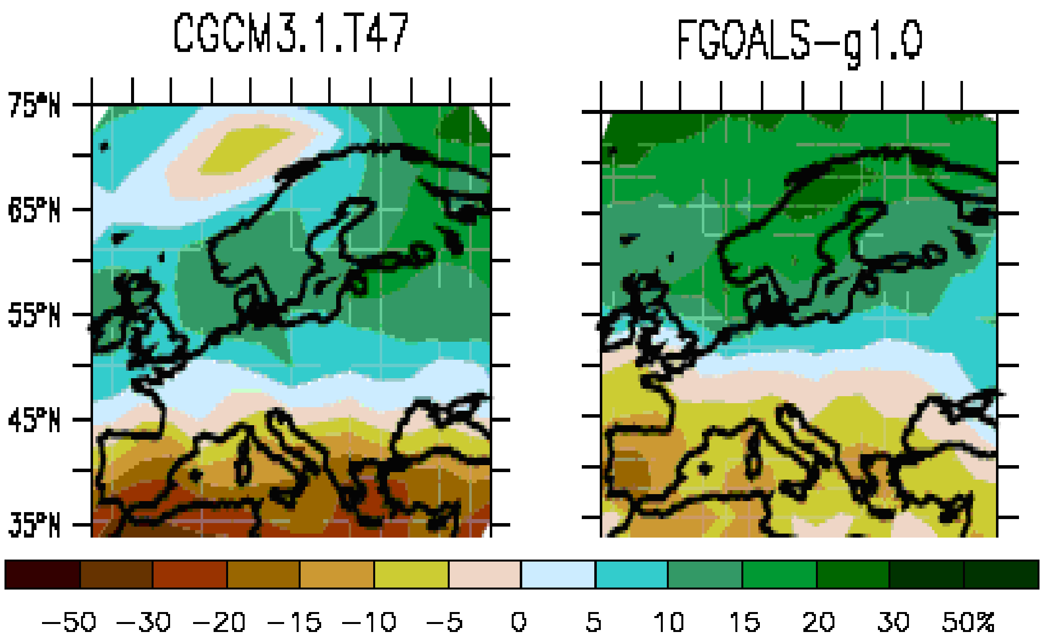
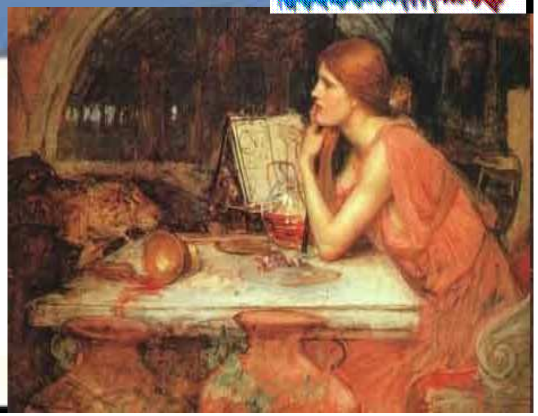
Mediterranean region, climate change and water resources

- 7% of world’s population
- 3% of water resources, spatial and temporal variability
- What will be the impacts of climate change?
- Change of precipitation’s regime, accrued drought risk?





Can reservoirs operating rule adaptation reduce climate change impacts?

- No use of terrain information ➔ generic model
- Determination of available water resources with and without climate change on the basis of operating rules adaptation
- Existing unchanged reservoirs
- Future Demands:
  - Exogenous scenarios for domestic, electricity and industrial demand
  - Present irrigated areas, climate change effect on irrigation

Methodology

- Demands location (CIESIN, CARMA, Global Map of Irrigated Areas Aquastat)
- Demands projection
- Reservoirs network, sub-basins, inflows (hydro1k, ICOLD, CIRCE climatic models)
- Reservoirs, demands links
- Operating rules

Demands projection

- Exogenous scenarios (based on WATERGAP) :
  - Domestic: GDP, population (IMF), past consumption (Eurostat, Plan Bleu)
  - Water cooling of electric power plants: electricity production, water use intensity
  - Industry : Added value (Enerdata, GTAP + POLES/IMACLIM-R), past intensity (Eurostat, Plan Bleu)
- Irrigation : Present surfaces, climate change
  - Land use (FAO Agromap, Faostat)
  - Phenology: Growing degree days
  - Evapotranspiration : Heargrave (FAO Irrigation and Drainage paper N°56)
  - Irrigation fills the deficit between evapotranspiration and effective precipitation

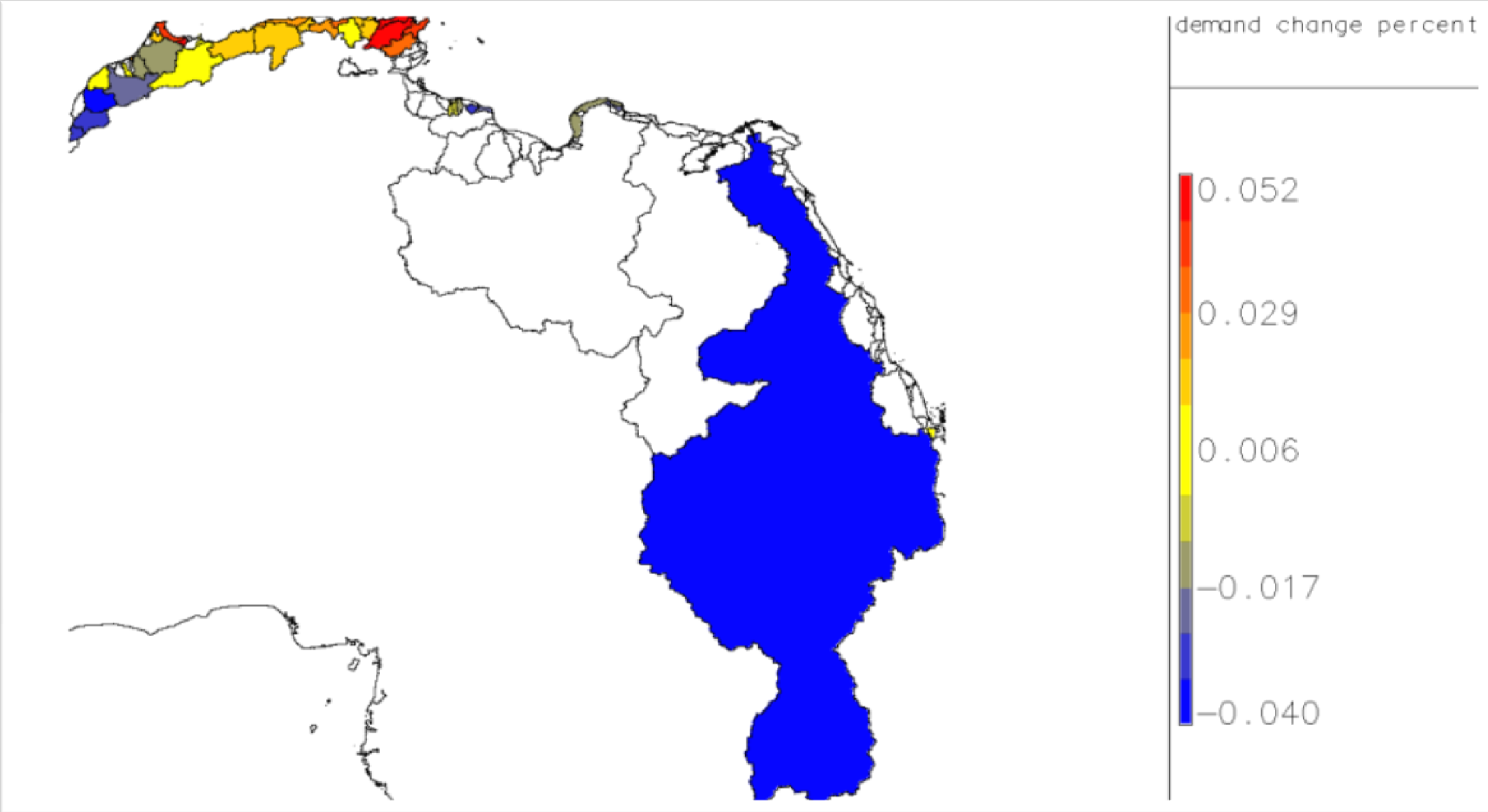
Associating reservoirs and demands without having network information

- Reservoirs Demands: cost function, penalizing distance and altitude difference
- Only one reservoir is selected for each demand , cost minimization, mean inflow =mean demand
- African region, for a 160m gradient the demands percentages associated to reservoirs are:
  - 89% of power plants
  - 81% of irrigated surfaces
  - 87% of population

Operating rules

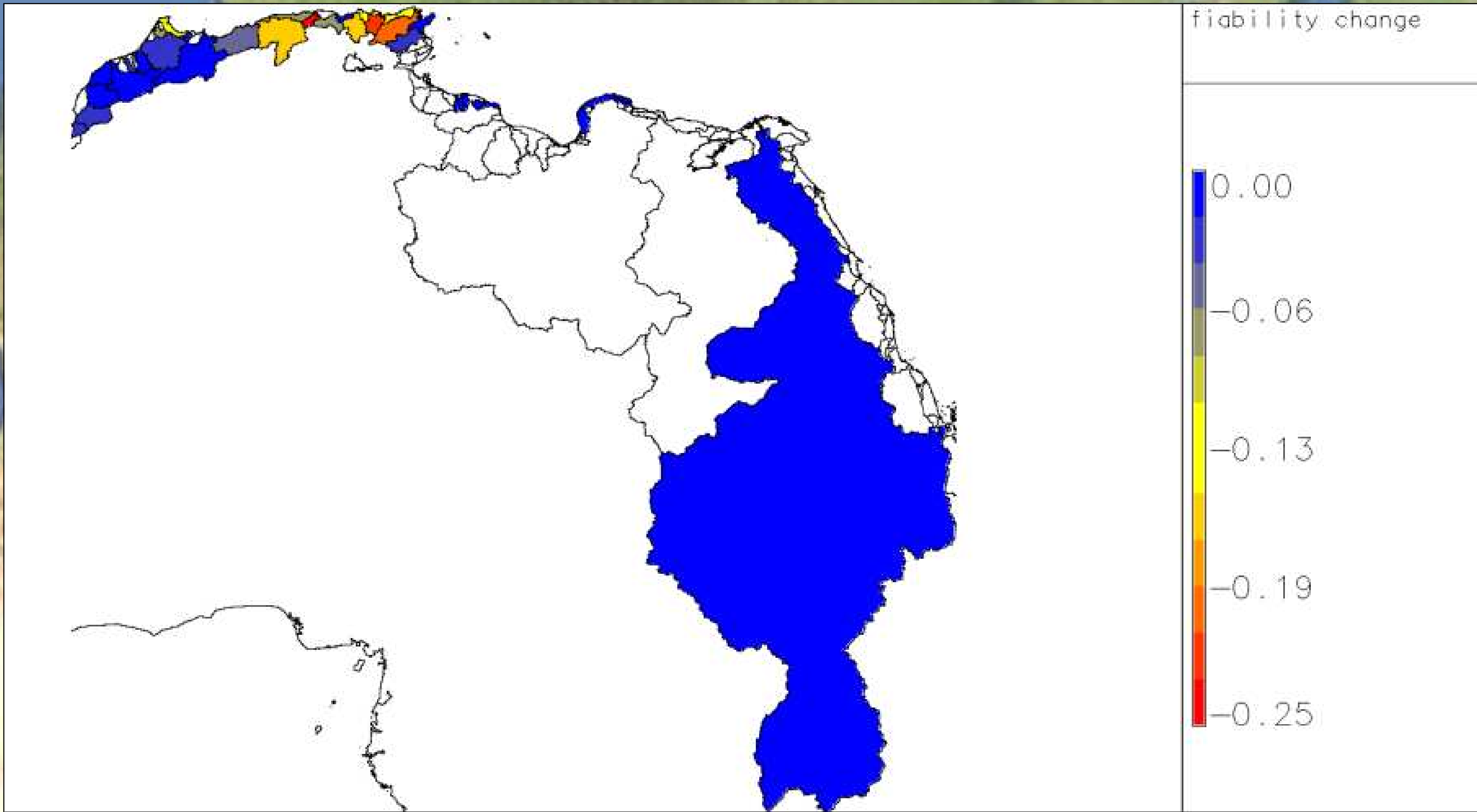
- No priorities among demands
- Reservoirs in series:
  - First we satisfy the most upriver demands
  - We drain the most downriver reservoirs
- Reservoirs in parallel (based on Nalbantis and Koutsoyiannis):
  - Generalization of the “space rule” by minimizing the probability of spill
  - Optimization of the parameters of empty space allocation among reservoirs

Preliminary results



$$Demand\_change(\%) = \frac{Demand_{cc} - Demand_{no\_cc}}{Demand_{no\_cc}}$$

Preliminary results



$$\Delta Reliability = Reliability_{cc} - Reliability_{no\_cc}$$

Perspectives

- Generalization at the worldwide level:
  - Demands data for all countries ?
  - Cultivation systems, multiple annual rotations (MIRCA2000)?
  - Regional climatic models?
- Take into consideration aquifers with a simplified model
  - Aquifers maps?
  - Exchanges between surface and ground water?
- Better representation of the soil in the irrigation model?
- Coupling with routing model (Orchidee/SECHIBA) like Haddeland

THANK YOU!