Copernicus Climate Change Service
Requirements from water resource management

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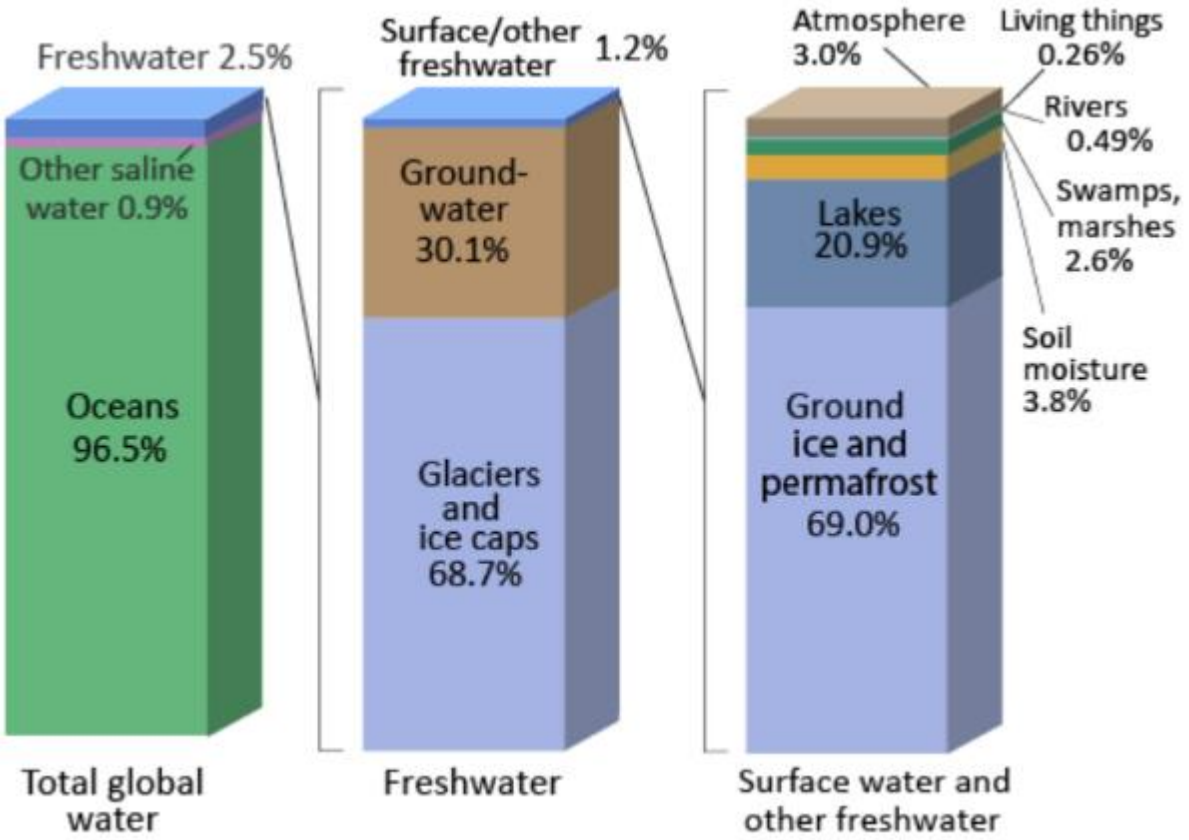
Serving society
Stimulating innovation
Supporting legislation

Presentation

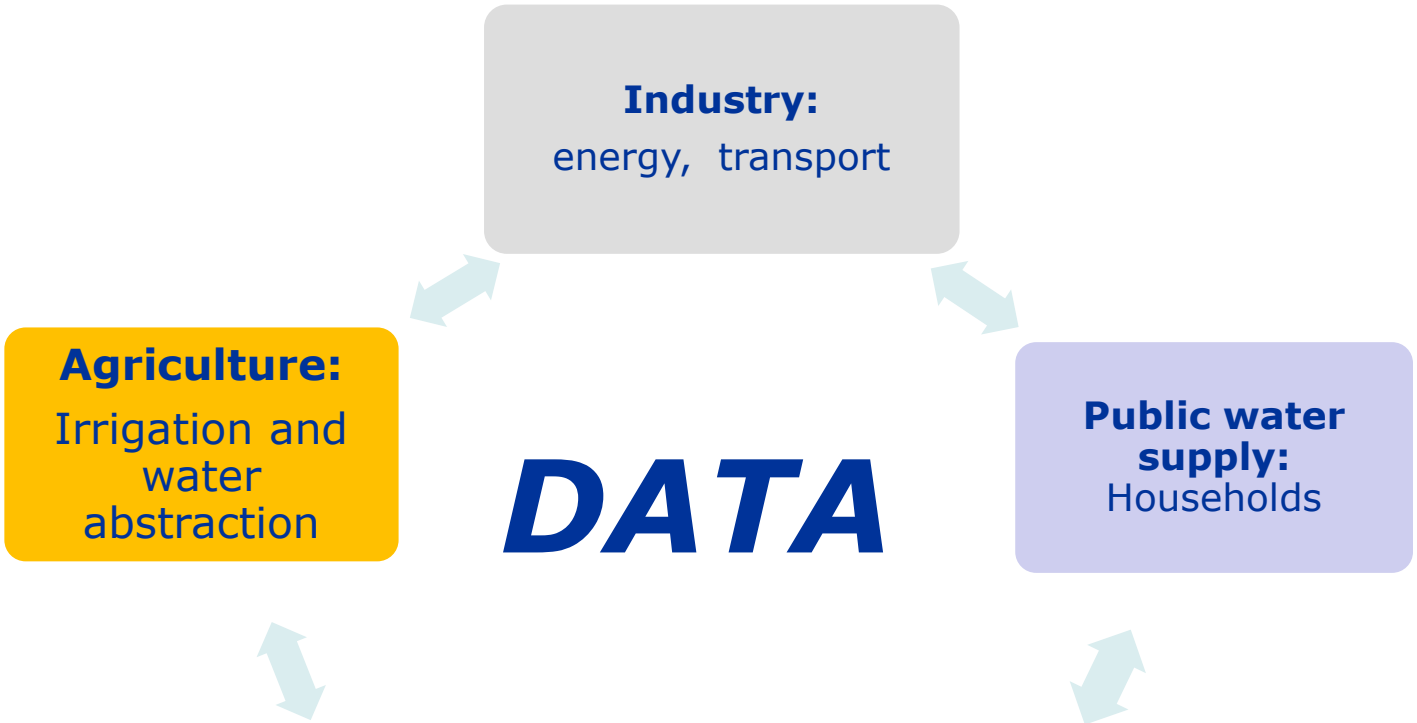
- A short Introduction to water resources
- A few examples of applications
  - Water resource modelling
  - Water quality
  - Drought monitoring and forecasting
  - Flood monitoring and forecasting
- List of requirements

Where are our water resources?



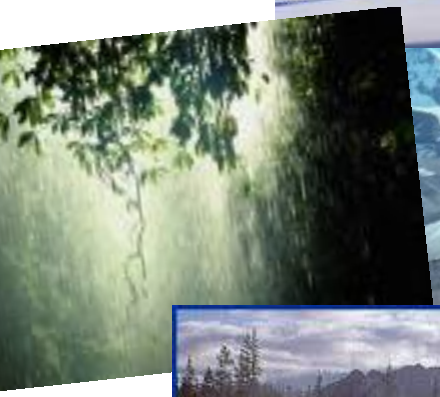
[from I. Shiklomanov (1993) in" World fresh water resources of P. H. Gleick (ed) "Water in crisis: …"

Water Resources for different sectors



Freshwater hydrological processes

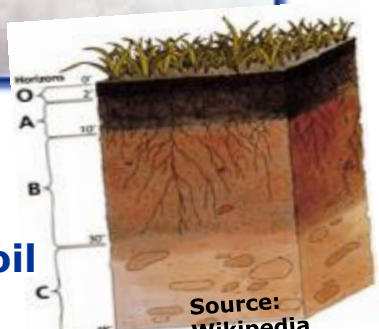
Atmosphere



Management

Surface

Quality

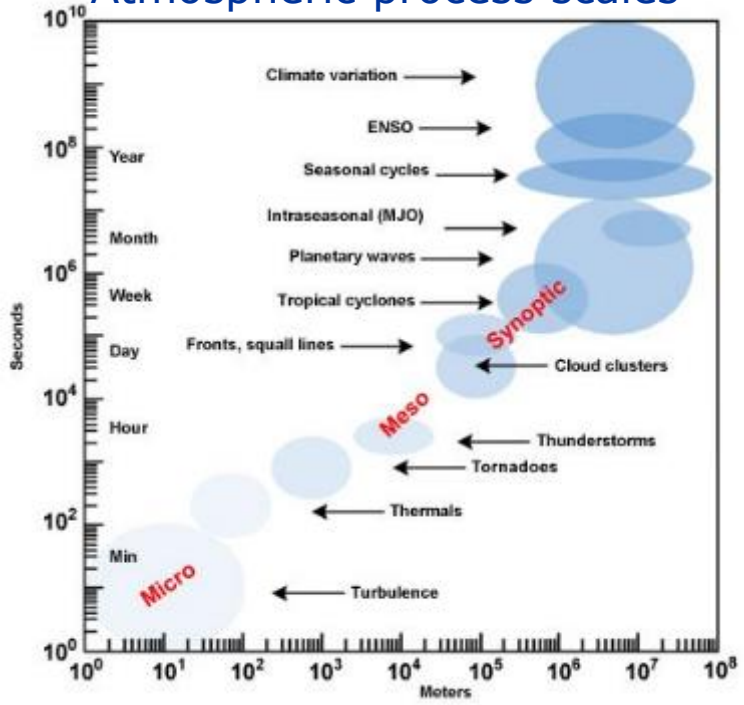


Soil

Groundwater

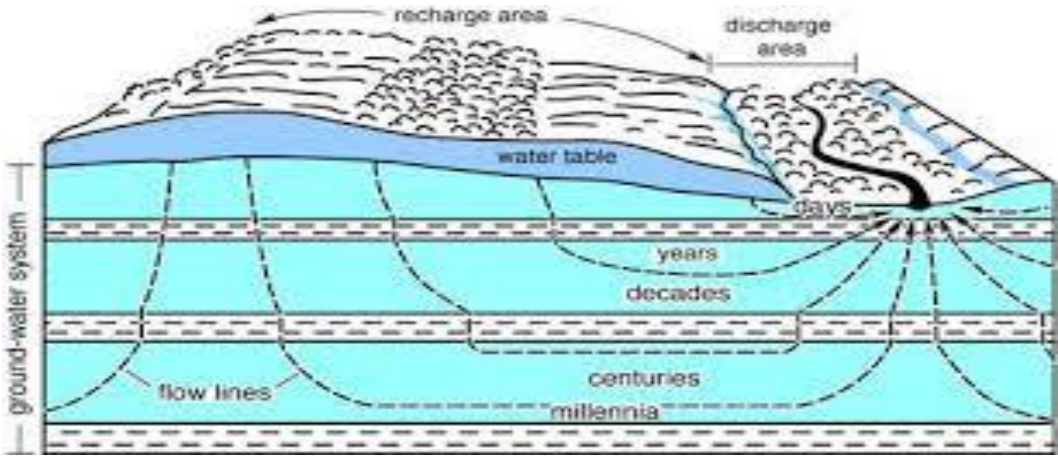
Spatio-temporal dimensions

Atmospheric process scales



[from: www.climatechangeinaustralia.gov.au]

Both atmosphere, surface and soil processes range over large spatial and temporal scales



Land-soil process scales [from www.kgs.ku.edu]

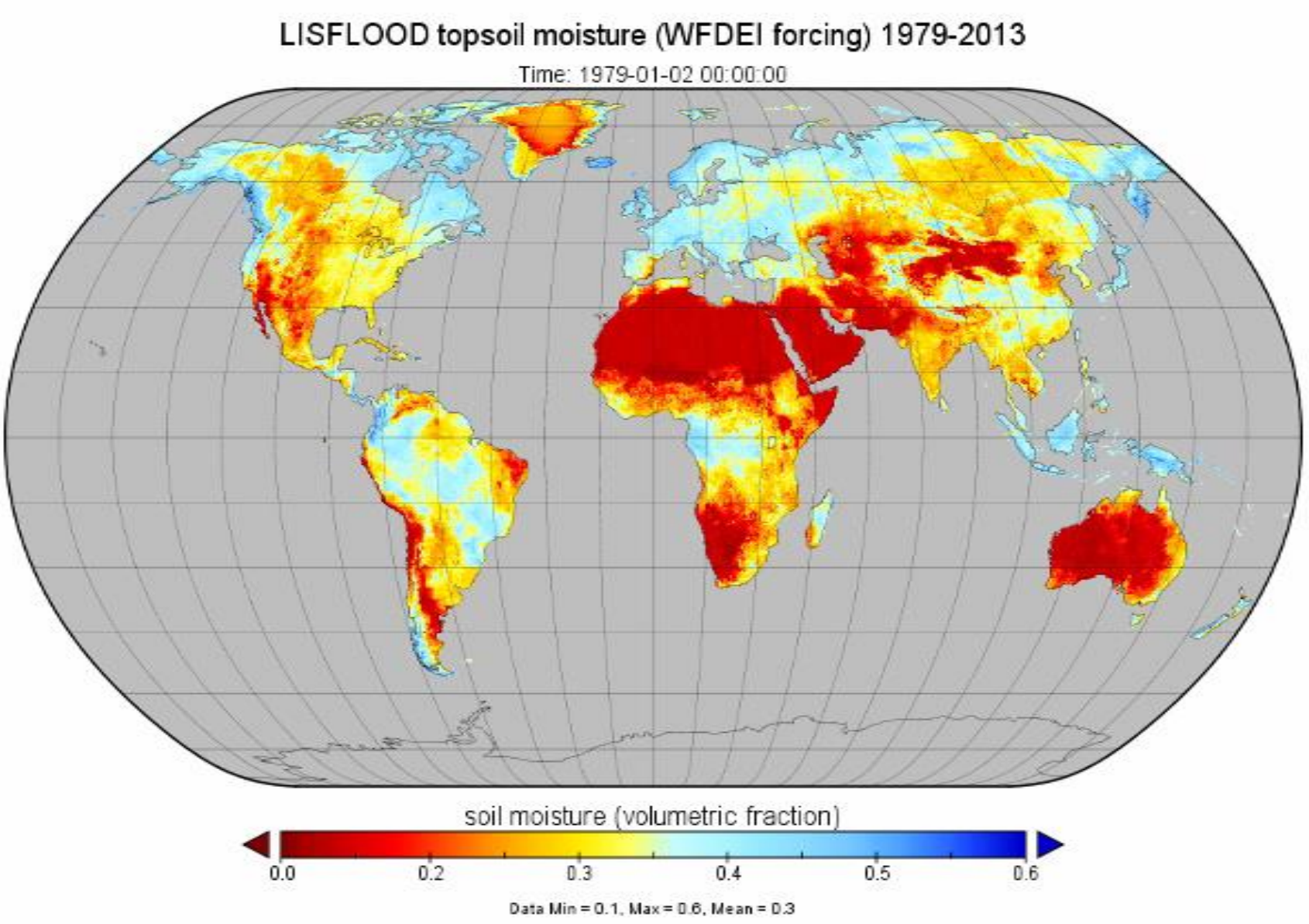
Relevant processes in water resource modelling

- **Meteorological inp**uts (precipitation, temperature, humidity, …)
- **Surface processes** (evapotranspiration, interception, infiltration, nutrient flow, …)
- **River flow**
  - water quantity (structures, abstraction (irrigation, transfer, …), …
  - water quality
- **Soil processes** (subsurface and flow in soil layers)
- **Ground water** flow (ground water flow and abstraction)

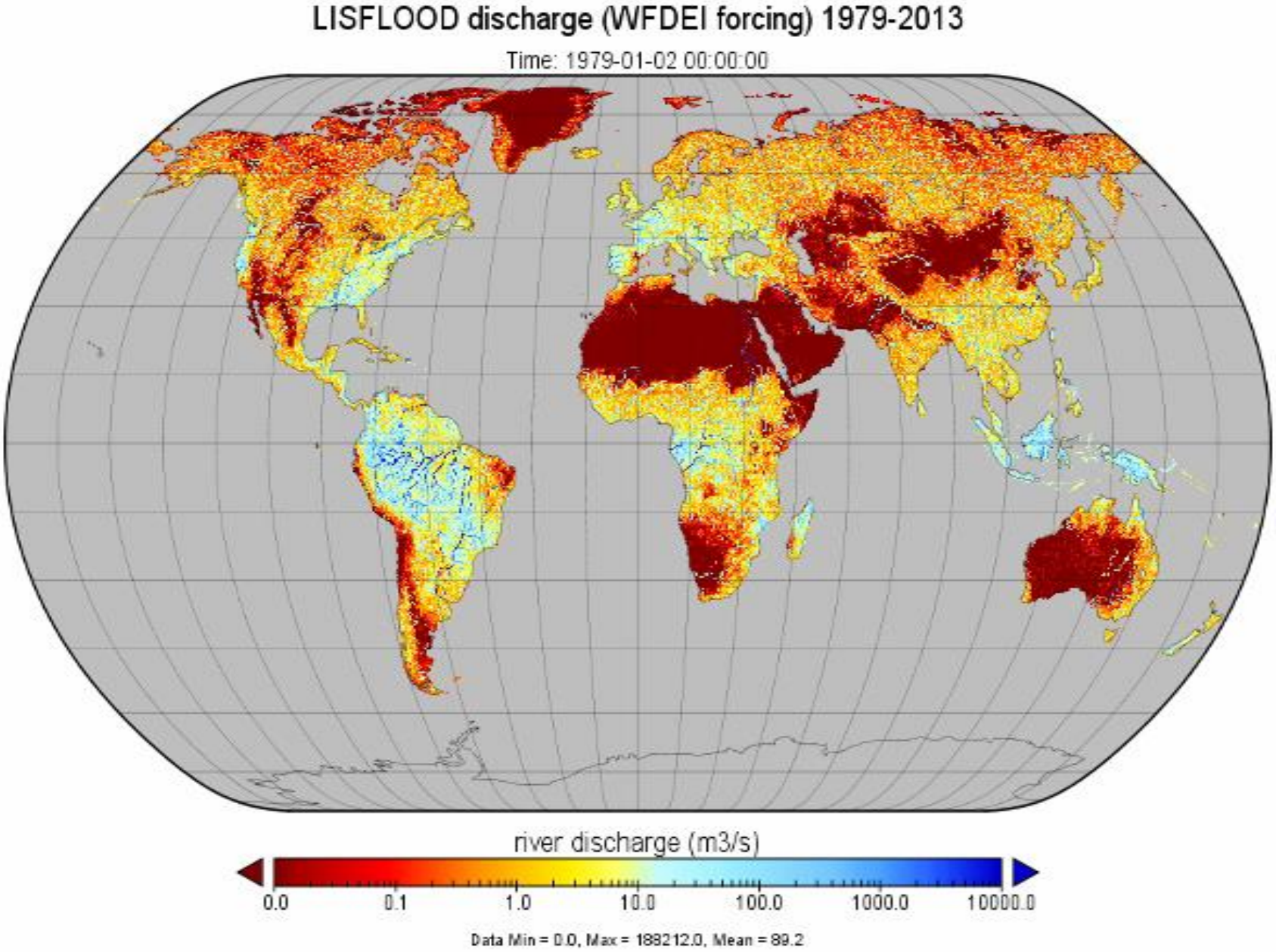
Applications - Modelling

- Water resource modelling
- Water quality modelling
- Flood monitoring and forecasting
- Drought monitoring and forecasting

The LISFLOOD water resources model

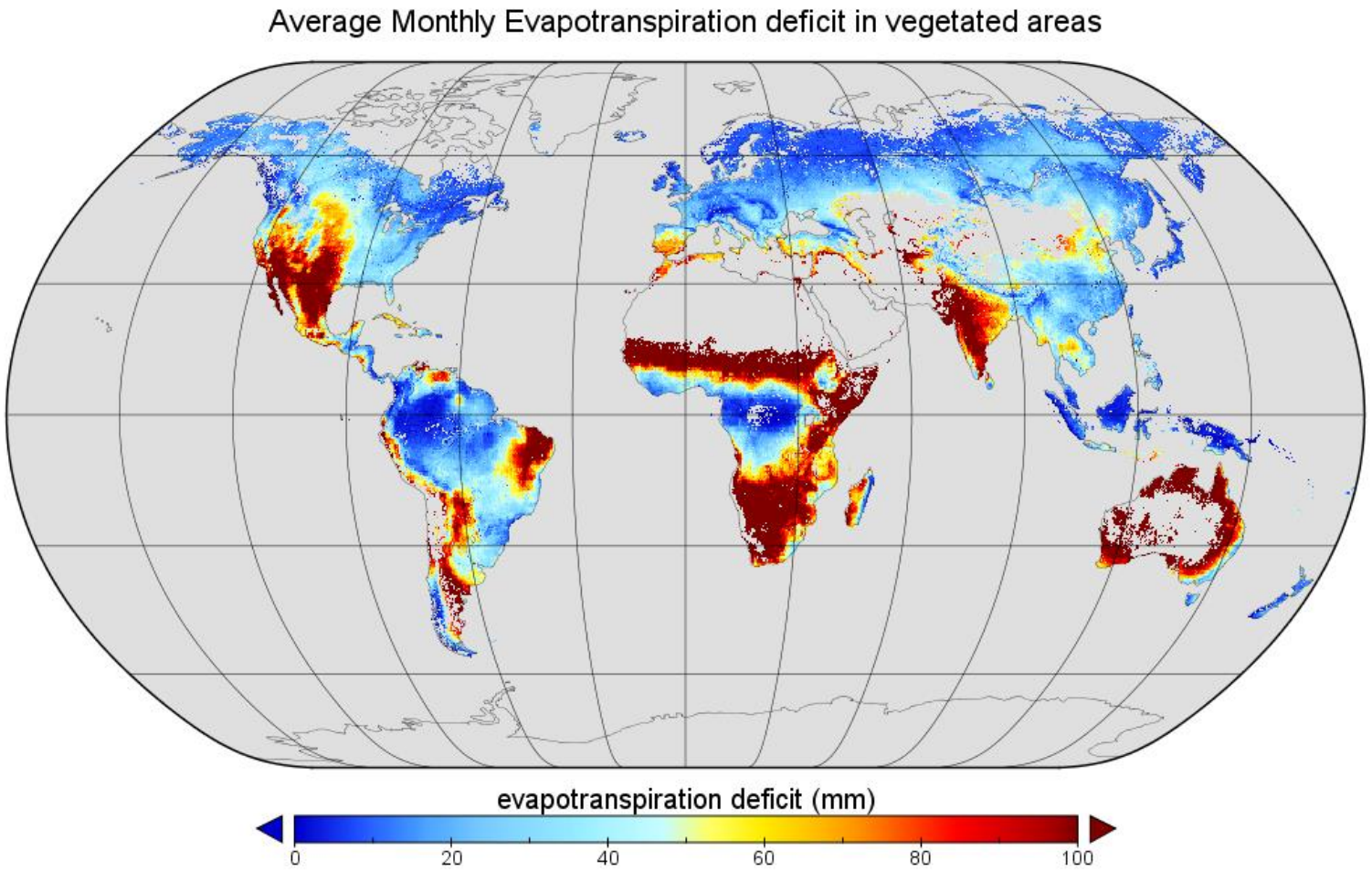


The LISFLOOD water resources model



Evapotranspiration deficit[1]

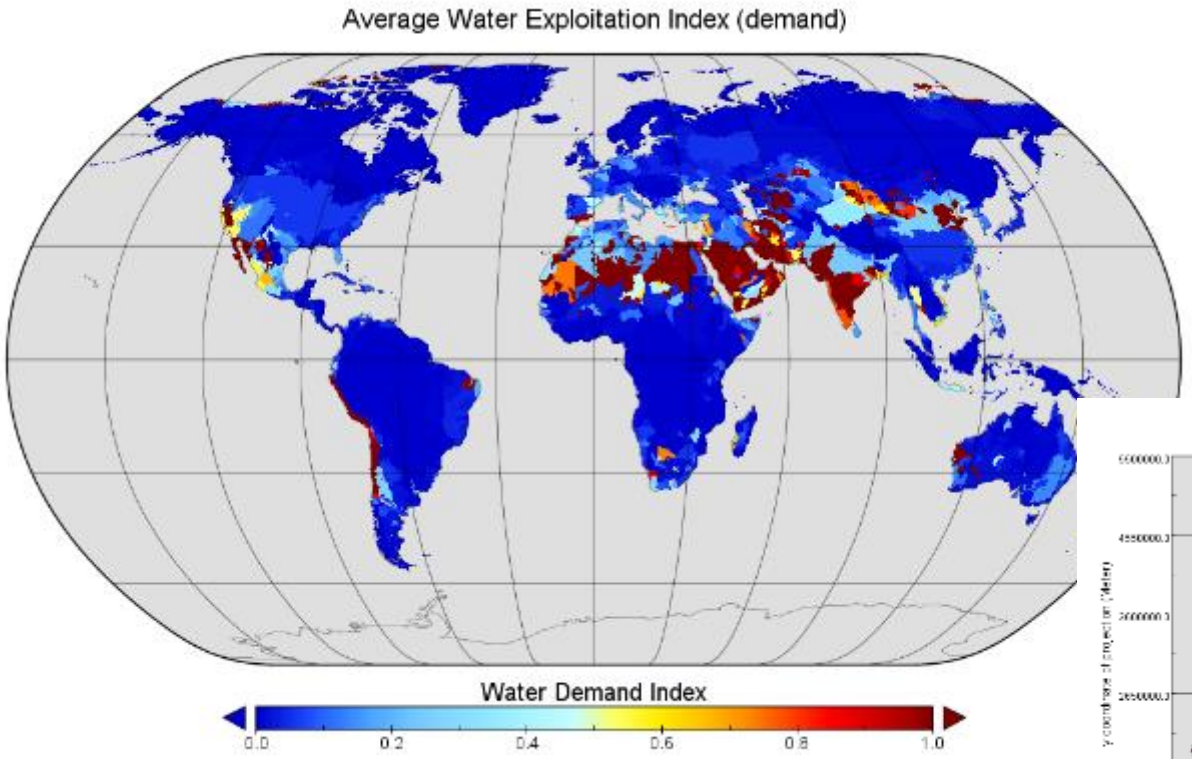
Indicator of rain-fed agriculture water scarcity

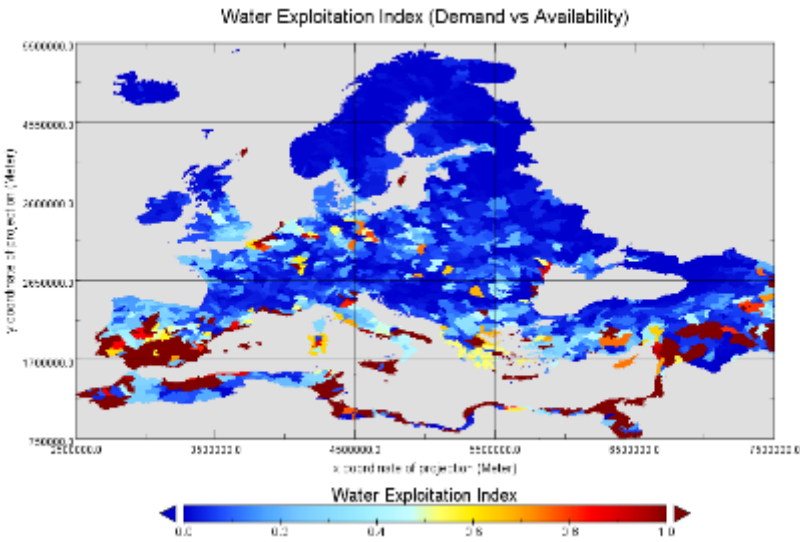


[1]'Climatic Water Deficit' (Stephenson 1998)

European Commission

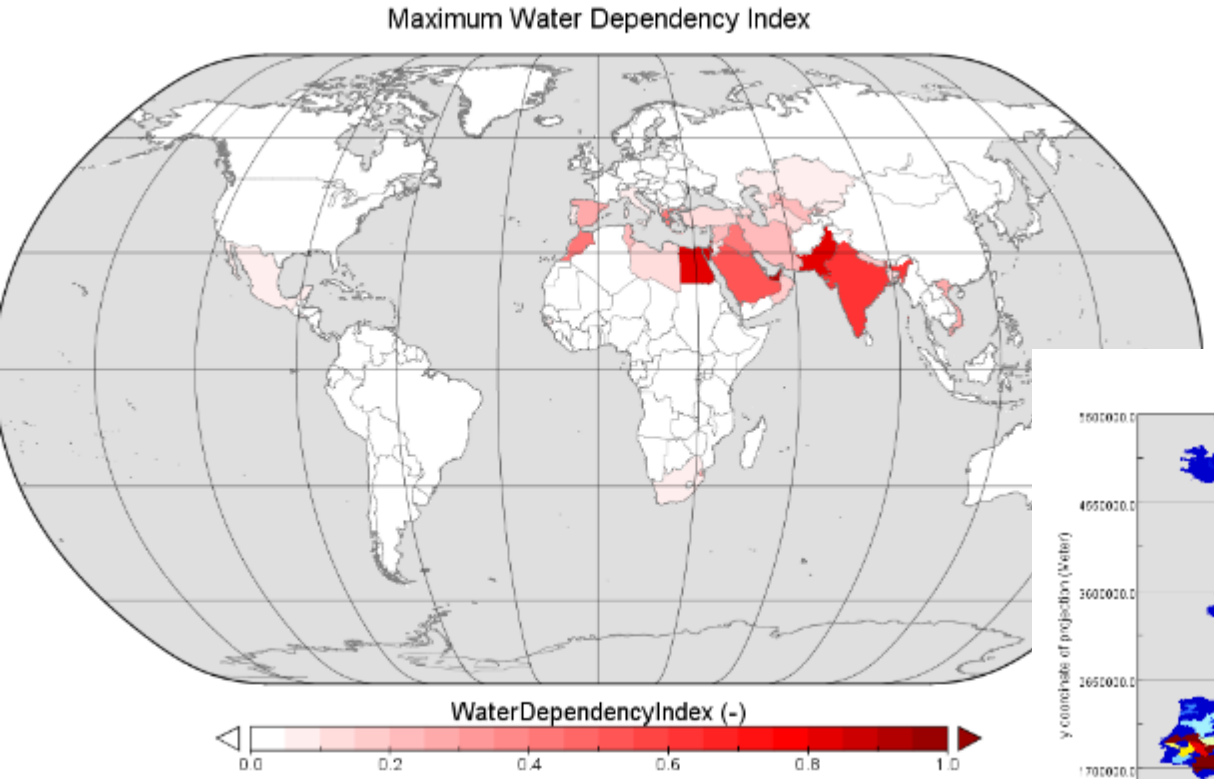
Water Demand versus supply



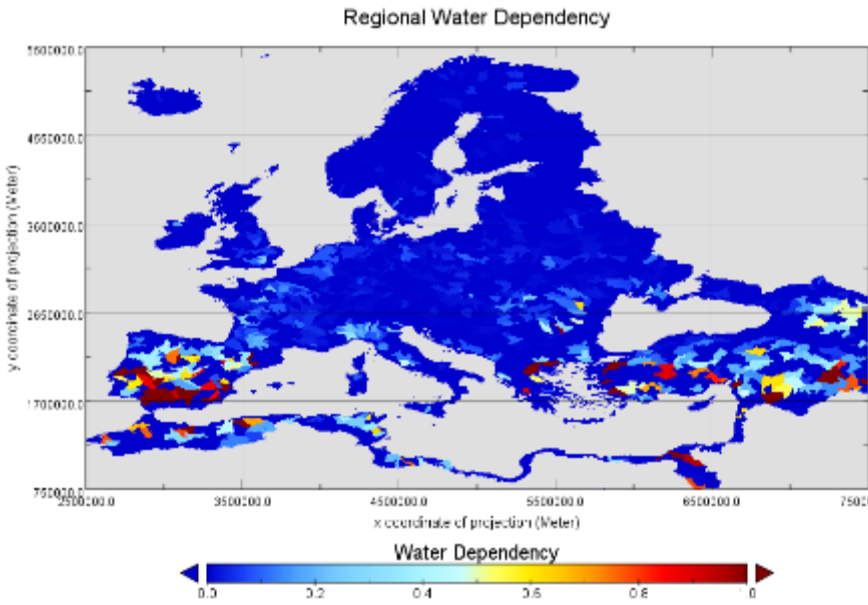


Joint Research Centre

Water Dependency (country based)



The dependency of water from outside the region



Water Quality modelling

Prediction of concentrations (indicative of status of rivers/lakes) and **loads** (critical for lakes/coastal areas) of

- ***Water quantity***
- ***Nutrients*** (Nitrogen, phosphorus) causing eutrophication
- ***Chemicals*** causing harm to human health and ecosystems
  - *Organic chemicals (pharmaceuticals, pesticides, POPs, solvents …)*
  - *Metals*

Chemical status contributes to the status of water bodies

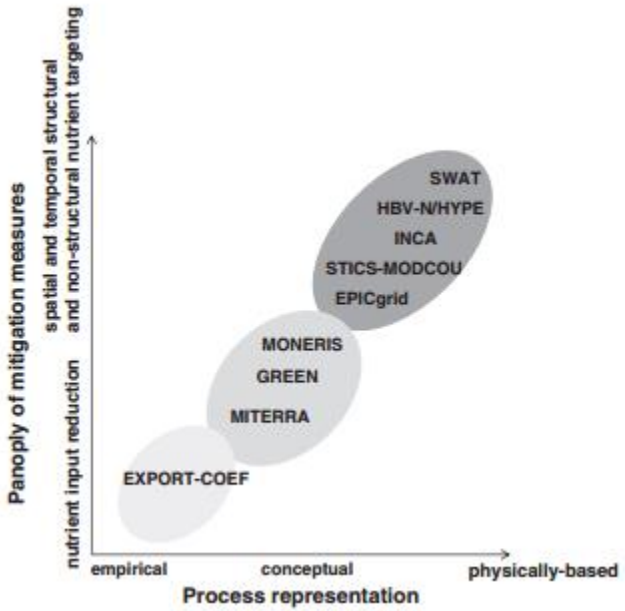
- in Europe, mandated to be "good" by 2015 under the Water Framework Directive; similar goals under the Marine Strategy Framework Directive

Water Quality modelling

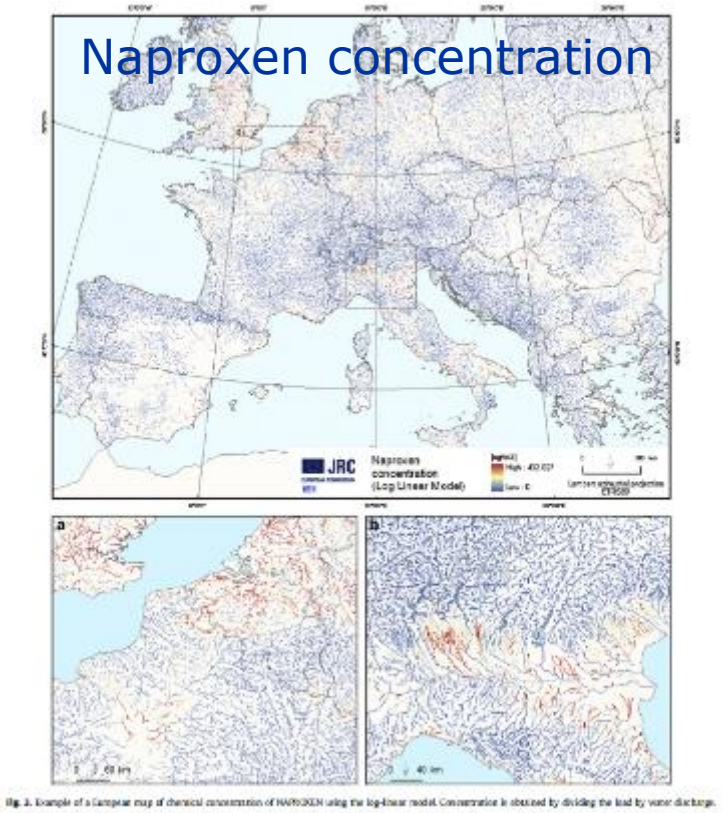
EPIC: field scale nutrients model

SWAT: catchment scale model (nutrients, pesticides)

MAPPE: GIS-based multimedia chemical transport model



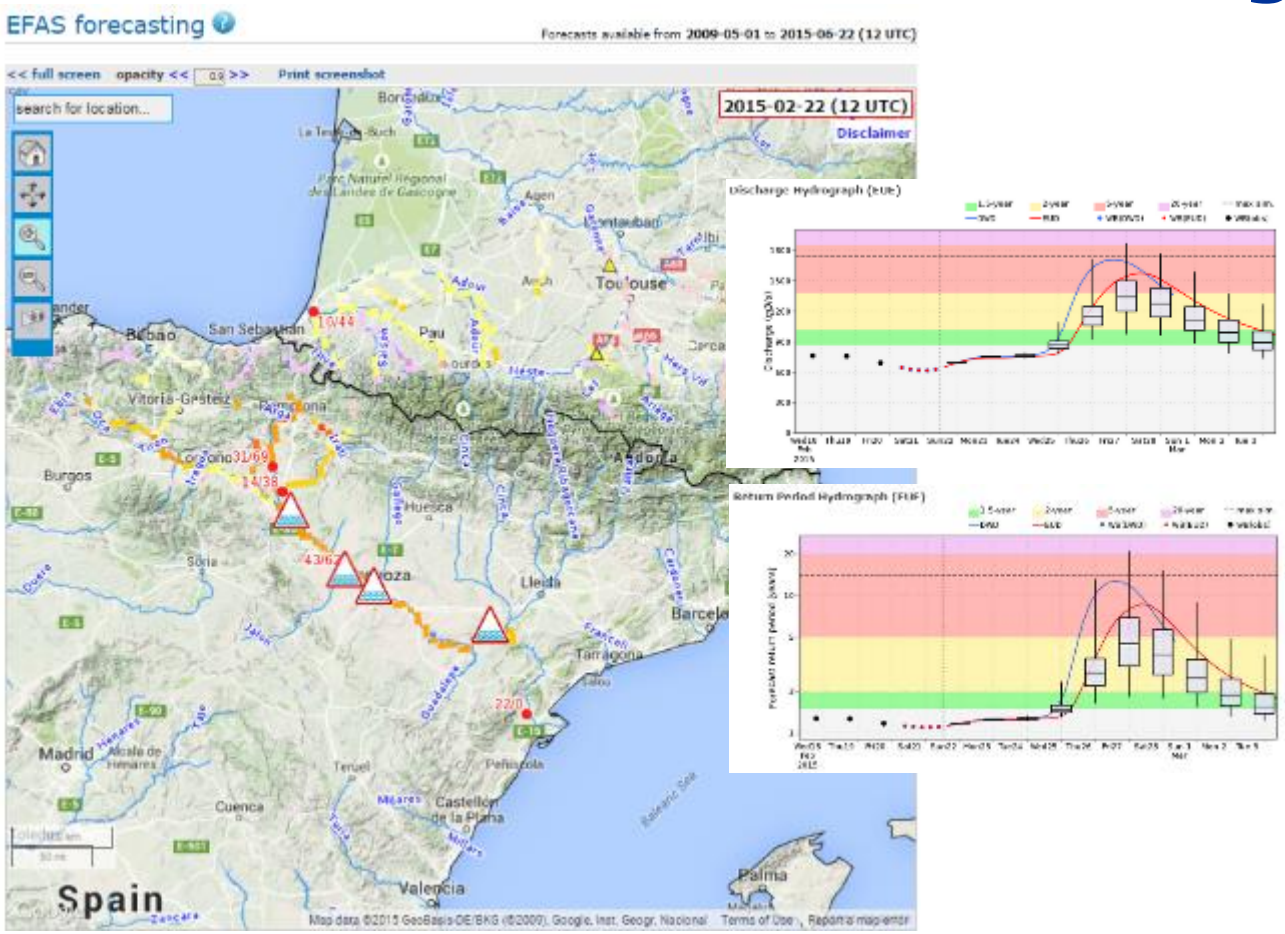
Bouraoui, Grizzetti, 2014



Pistocchi et al., 2012

Joint Research Centre

Flood forecasting



www.efas.eu

Input

- Precipitation
- Temperature
- Evapotranspiration

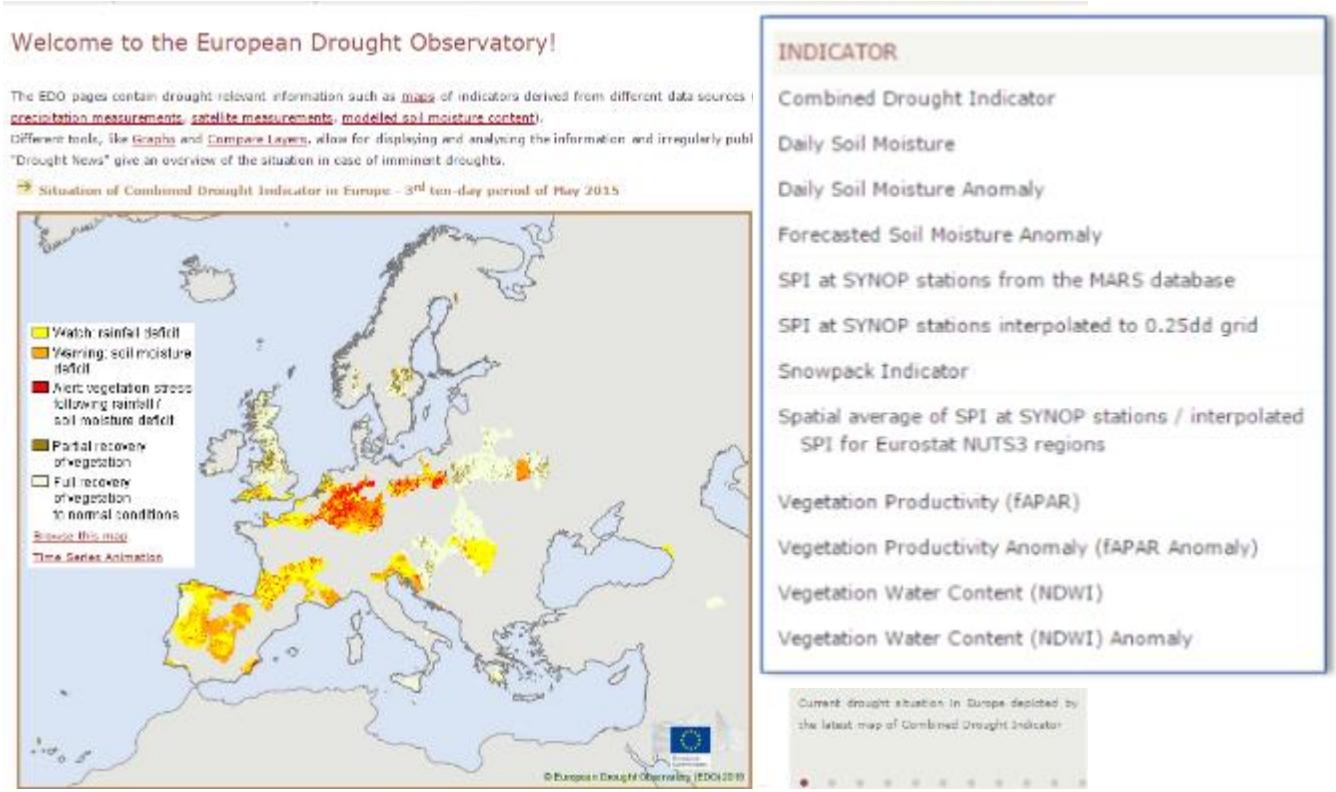
Output

- Discharge
- Soil moisture
- Ground water
- …

Type

- Real-time data
- Forecast data
- Climatologies (25 yrs ++)

Drought monitoring and forecasting



Input
- Precipitation
- Temperature
- Evapotranspiration
- fAPAR[1]

Output
- Soil moisture
- Indicators

Type
- 10 days- monthly
- Forecast data
- Climatologies (> 30 yrs)

http://edo.jrc.ec.europa.eu

[1]Fraction of Absorbed Photosynthetically Active Radiation

Requirements

- What kind of climate-related information products are used in the water sector?
- What observational data are used (or needed) for these products?
- What are the gaps, and what is needed for further development?
- What could/should be the role of Copernicus in this development?

Climate-related information products used in the water sector

- ✓ Meteorological information related to the water cycle
  - Observations of relevant variables *(in situ, remote sensing; real time-historic, subdaily-daily-monthly time steps, m-km resolution)*
  - Forecasts *(short-medium-monthly-seasonal & local, regional, global)*
  - Climate change projections *(regional, global)*
  - Re-analysis

- ✓ Hydrological information
  - Surface water quantity *(in situ, remote sensing, real-time-historic)*
  - Water demand *(public water needs, irrigation, transfer)*
  - Soil moisture *(in situ, remote sensing)*
  - Vegetation productivity *(faPAR)*
  - Vegetation water content

- ✓ Water quality information
  - Concentration and loads of nutrients and chemicals

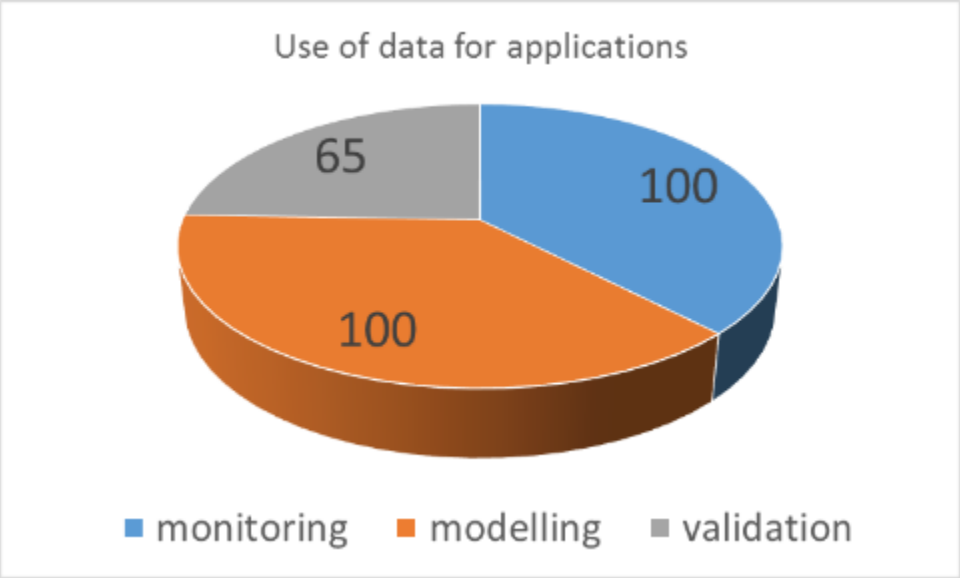
What observational data are used

Variables	Types	Spatial res.	Temporal res.
Rainfall (convective, stratiform)	In situ, RS	Point, gridded (1-25 km)	H, d, <30d
Snow (water equivalent, cover)	In situ, RS	"	H, d, <30d
Evapotranspiration (T, vv, dd, q, …)	In situ, RS, modelling	"	H, d, <30d
Soil moisture	RS, in situ	"	d, <30d
Ground water	In situ, modelling	Point, gridded	d, <30d
discharge	In situ	Point	H, d, <30d
Lake/Reservoir level	In situ, RS	Point, gridded (1-25 km)	d, <30d
Water /ground water abstraction	In situ, information	Point	d, <30d

What observational data are used

Variables	Types	Spatial resolutions	Temporal resolutions
Water quantity (see previous)	In situ, remote sensing	m, km, basin scale (outlet)	H, days
Water temperature	In situ, remote sensing	m, m-km,	days
Suspended sediments	Load, concentration	m, km, basin scale (outlet)	days
Chlorophyll	Load, concentration	"	days
Soil organic carbon		"	days
Atmospheric aerosol	Concentration Particle size distribution, load,	M, km	days

Use of data



- 100% of all data are needed for monitoring and model input
- More than half of the data are also used for model validation
  - Meteorological data are not used for validation <u>except</u> evapotranspiration
  - Water abstraction is not used for validation

Requirements

What are the gaps, and what is needed for further development?

- Long-term continuous data sets in digital format (in situ, remote sensing, re-analysis)
- Station density for in situ data very heterogeneous. Reliable/robust remote sensing data and methods for gap filling and blending needed
- Data access
  - Missing data hubs for different data with extraction tools for different applications in OGC standards including easily available remote sensing product time series, e.g. in NetCDF time series or similar
  - License conditions for research and operations

Requirements

What could/should be the role of Copernicus in facilitating/ harmonising/ stimulating this development?

- Negotiate open data access for hydrological and meteorological data with providers for the COPERNICUS services
- Produce long-term consistent in situ data sets in particular for stations with RT data as well as continuous (HR) satellite data sets easily accessible
- Data hub with relevant expertise for extraction/post processing of data for different applications
- Facilitate cross-links between different COPERNICUS services regarding data, e.g. EMS, AMS,

Conclusions - water resource management

- High density real-time data **with** coherent long-term historic data for hydro-meteorological variables are essential
- Flow and concentration of nutrients and chemicals are important for water quality modelling
- Seamless forecasting and climate products are essential for planning
- Robust methodologies for blending data sets, bias corrections needed
- A "knowledgeable" data hub with expertise for hydrologists would provide added value