XEROCHORE

SEVENTH FRAMEWORK PROGRAMME

Drought characterization/identification

Natural system (climate and hydrology)

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Extended Guidance Document

SEVENTH FRAMEWORK PROGRAMME

XEROCHORE

An exercise to assess research needs and policy choices in areas of drought

Extended Guidance Document on the Natural System & Drought (D.1.2)

part of
Work Package 1: Natural System

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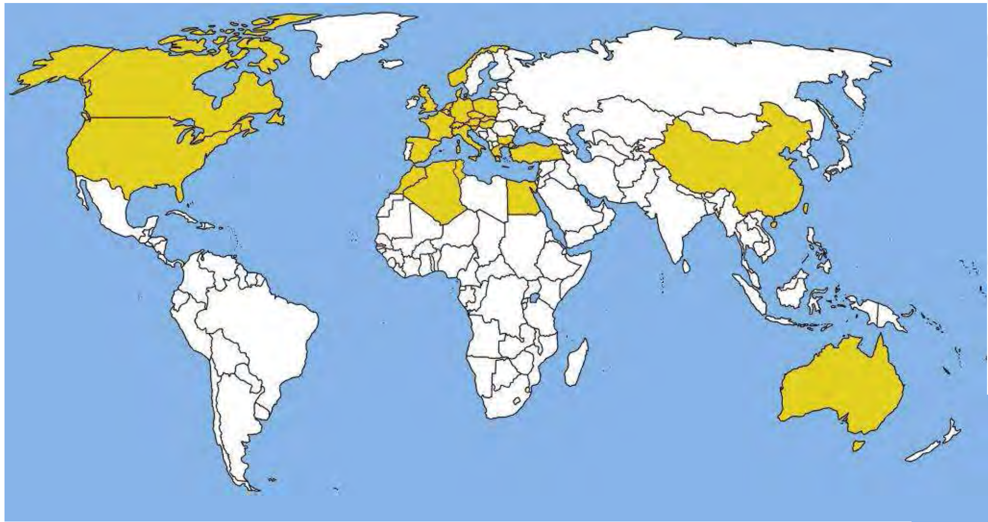
Contributors Extended Guidance Document on Natural System & Drought



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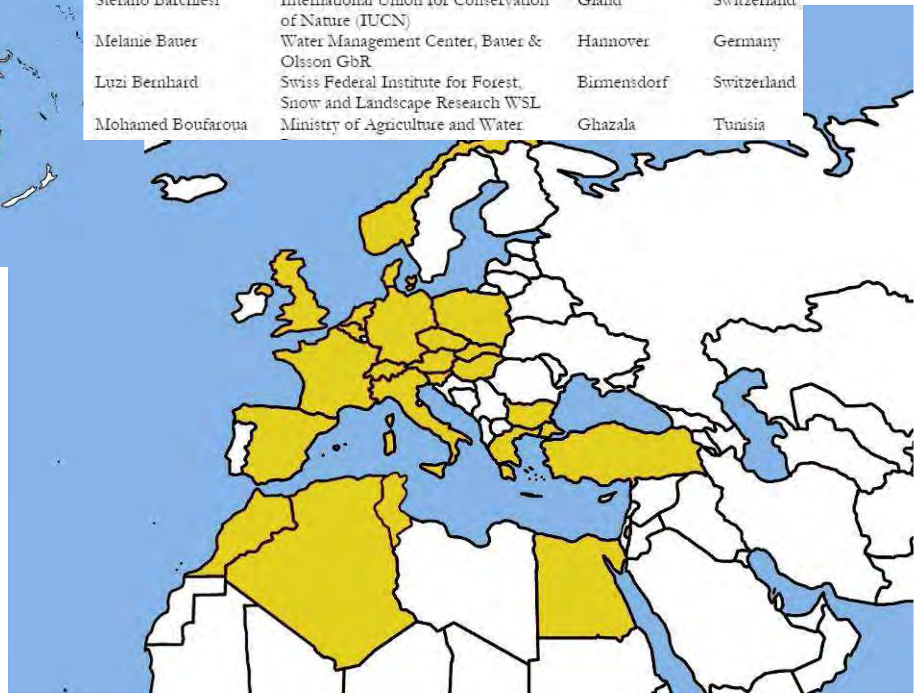


Drought experts from:

- **Europe (50)**
- **Mediterranean (non-EU: 5)**
- **Overseas (4)**

28 countries

Natural/Physical System

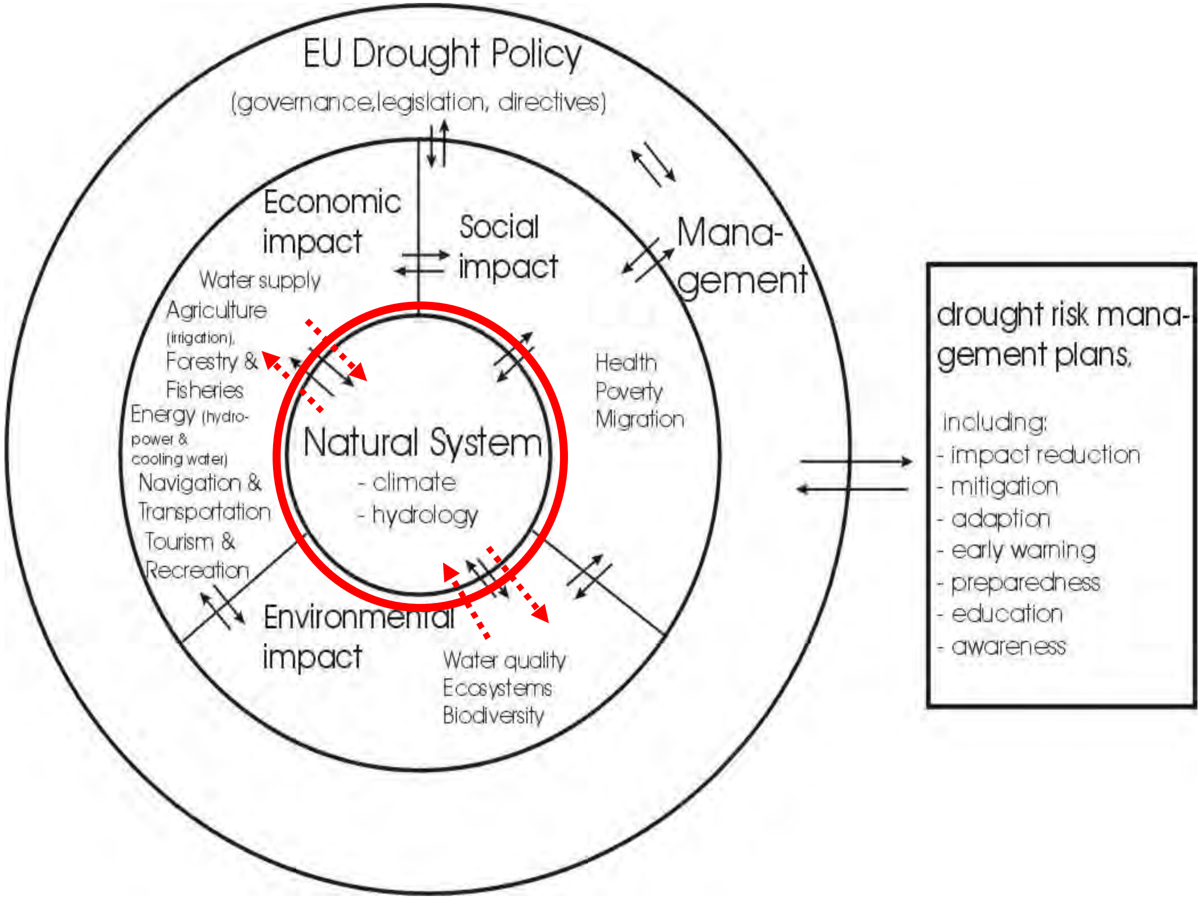
Natural System:

Physical system (hydrological system along with the climatological system) under natural conditions.

However, a pure natural system rarely exists, therefore:

- **focus is on drought under conditions without substantial human influences;**
- **some topics human influences are included (attribution, global change)**

Natural/Physical System in context



Terminology (glossary)

Deviation from normal conditions:

- occurrence of below average natural water availability due to climate variability; infrequent abnormal event
- naturally recurring feature; occurs in all hydroclimatic regions
- sustained
- widespread, transnational
- different types of drought

Do not confuse with:

- aridity
- water scarcity

Extended Guidance Document: Content

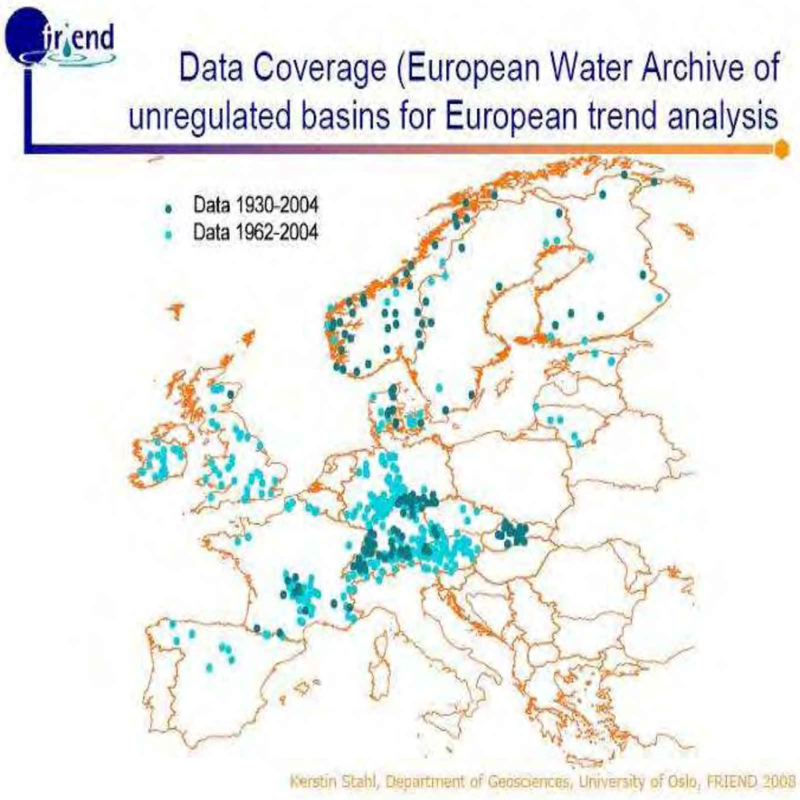
TOPICS of Natural system (climate and hydrology):

- Data required for drought research and management
- Atmosphere: climatic drivers of drought
- Land: hydrological/land surface responses
- Drought assessment framework: interactions and global change
- Methodologies for monitoring and forecasting

Natural/Physical System: Data

2. Data required for drought research and management: Key Challenges

- **a consistent, quality-controlled, extended and EU-harmonized database on drought that is easy-to-share and easy-to-access.**
- **in Europe, there is a special need for having access to hydrolological data across national boundaries to study drought, which by definition is a transnational phenomenon.**

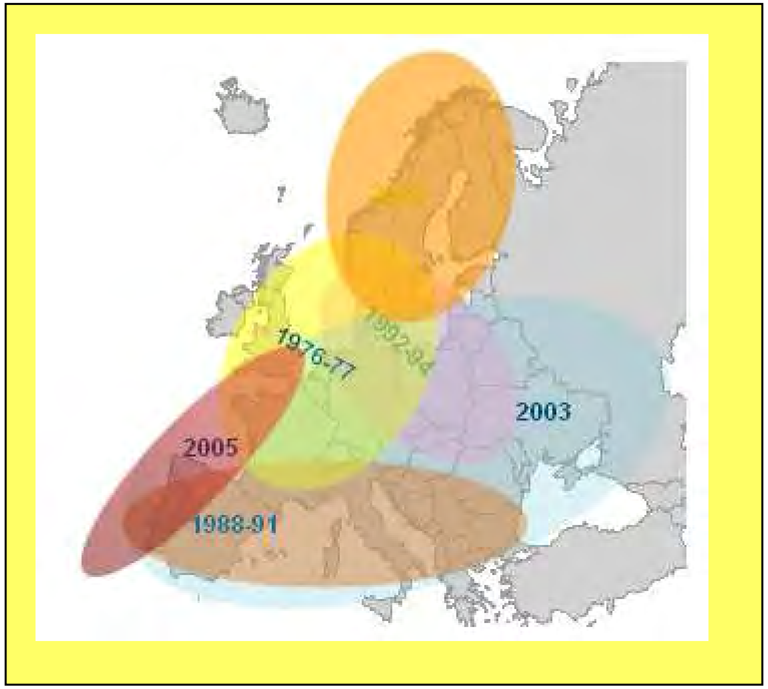


Stahl et al. (2008)

Natural/Physical System

3. Atmosphere: climatic drivers of drought

- drought hydro-climatology
- natural variability of current climate
- droughts and heat waves
- major historical events and climatological causes



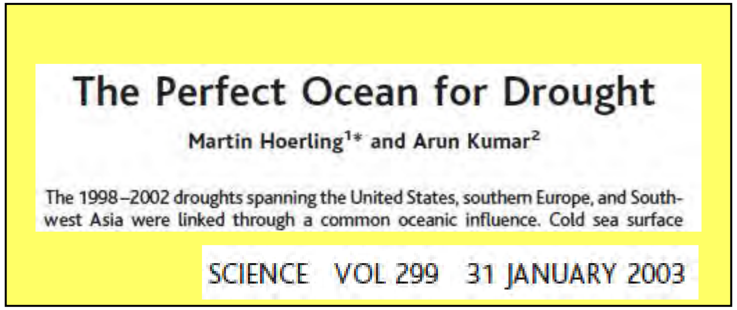
Major events:
- 2003
- 2005
- 2006
- 2007

Droughts happen often !

Tallaksen &van Lanen (2007)

Natural/Physical System: Climate drivers

Understanding interaction Ocean-Atmosphere-Land is essential for drought monitoring, forecasting and prediction

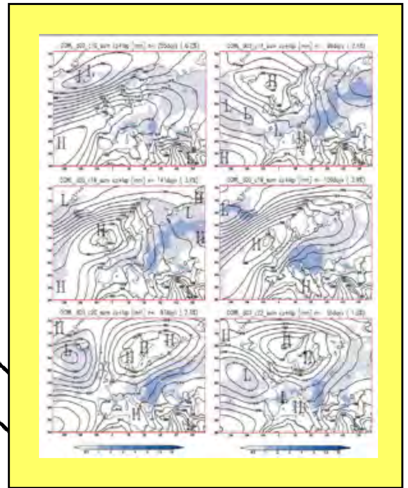

The Perfect Ocean for Drought

Martin Hoerling[1*] and Arun Kumar[2]

The 1998–2002 droughts spanning the United States, southern Europe, and Southwest Asia were linked through a common oceanic influence. Cold sea surface

SCIENCE VOL 299 31 JANUARY 2003

Fleig et al. (2010a; 2010b)



Atmosphere
- pressure fields
- temperature fields
- wind fields

Oceans
- SSTs
- salt concentration
- ….

Land
- soil moisture
- groundwater
- river flow

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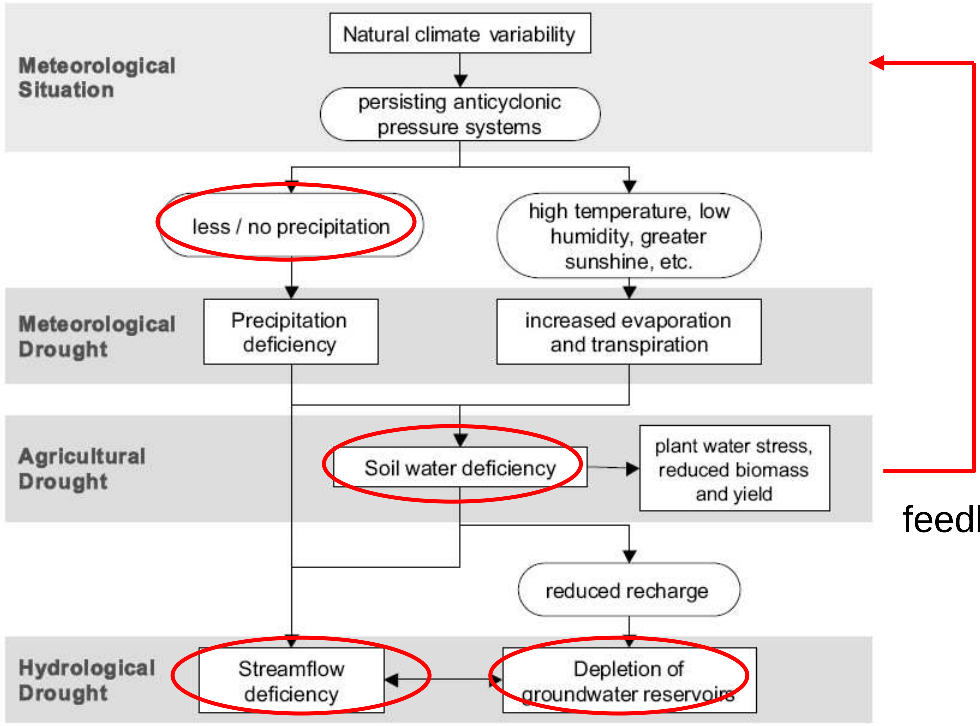
Natural/Physical System: Climate drivers

3. Atmosphere: climatic drivers of drought: Key Challenges

- **complex mechanisms involved in the formation and development of large- and regional scale droughts and associated heat waves in Europe (ocean-atmosphere and land surface response);**
- **whether regional droughts share a common global influence, i.e. are external forcings causing drought simultaneously across the world (synchronicity).**

Types of drought

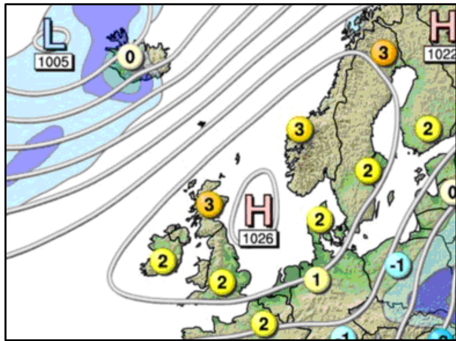
Propagation of Drought:
Atmosphere ⇔ Soil ⇨ Groundwater ⇨ River



feedback

Fig. 3.1 Propagation of drought through the hydrological cycle (modified after NDMC, 2001)

Tallaksen &van Lanen (2004)

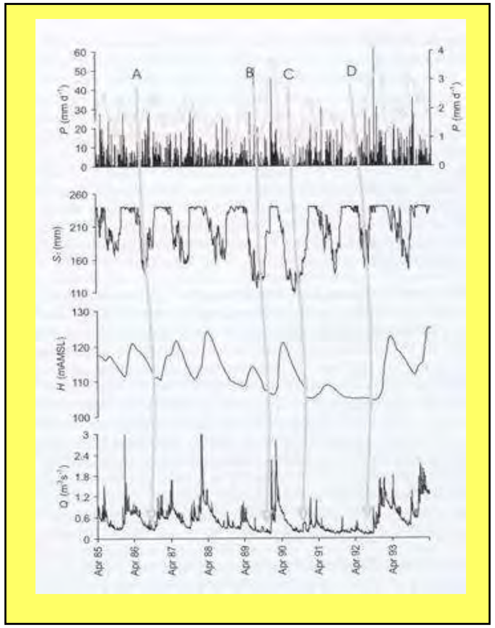


Natural/Physical System

4. Land: hydrological/land surface responses

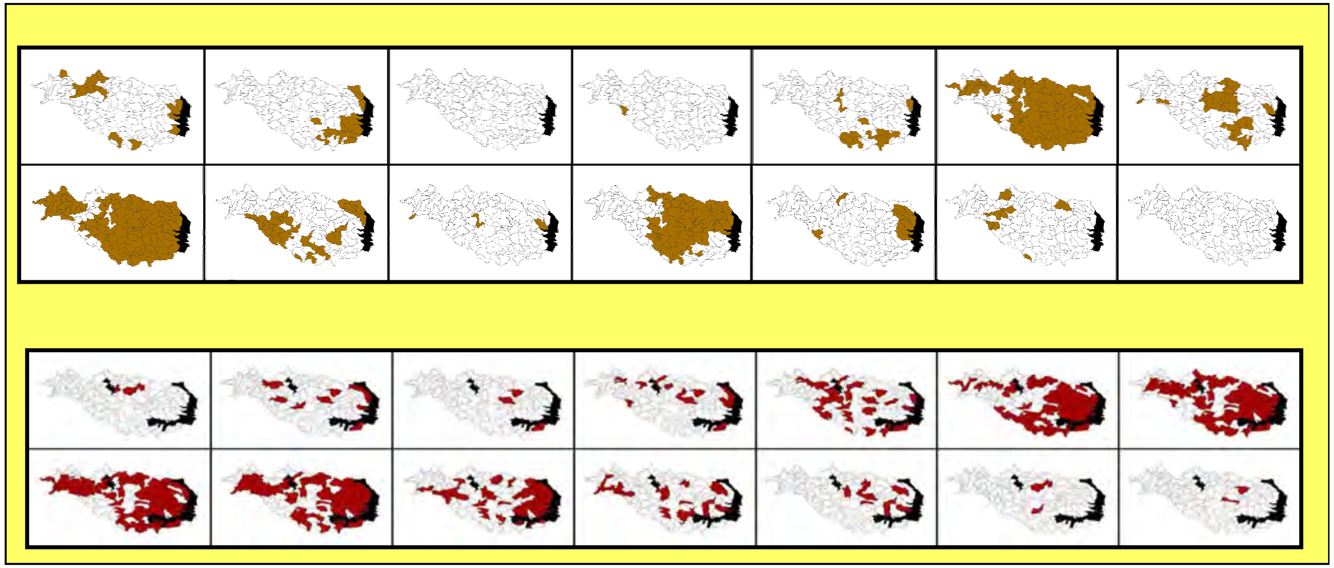
- propagation of drought
- temporal and spatial patterns of drought
- land surface feedbacks

Pang Basin, UK



Peters et al. (2003)

Danube River Basin



Natural/Physical System

4. Land: hydrological/land surface responses: Key challenges

- **a generic framework that translates meteorological drought into a hydrological drought based upon drought propagation across various spatial scales that considers the land surface characteristics and the hydro-climatic regime;**
- **feedbacks from (slowly varying) soil moisture and varying seasonal snow cover and snow accumulation to atmospheric variables**

5. Drought assessment framework: interactions and global change

- detection of changes in historical drought frequency and severity

- drought modeling: new model developments and evaluation
- attribution of changes in historical drought frequency and severity
- assessment of future changes: linking and coupling of climate and hydrological models
- quantification of uncertainty

River Danube at Bratislava, Slovakia

$Q_{330,}$; high flow measure

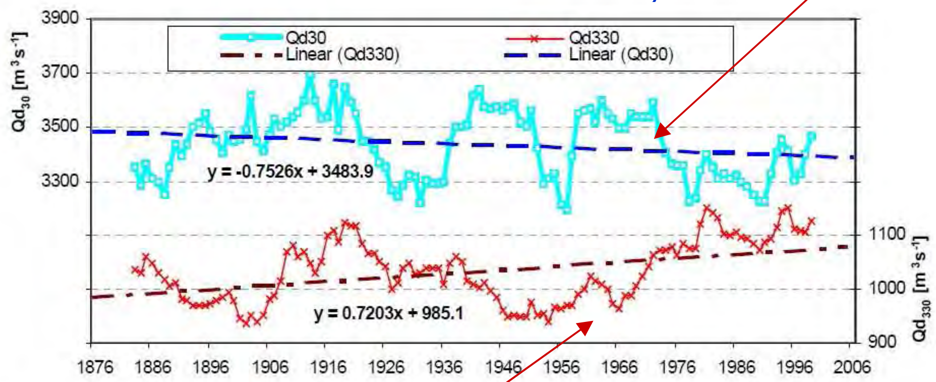


Fig. 1-14 Trends of the 15-year moving averages of 30-day and 330-day discharge of Danube in Bratislava.

$Q_{30,}$; low flow measure

Pekarová et al. (2008)

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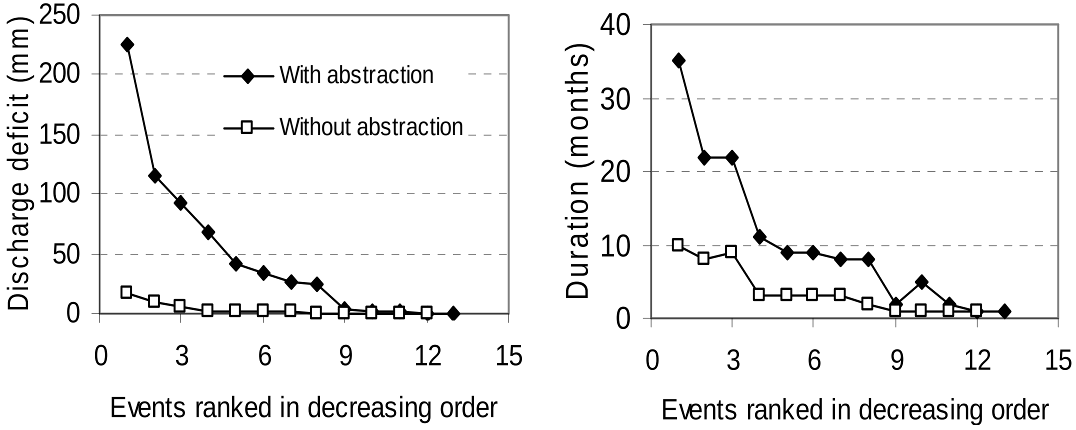


River Svitava, Czech Republic

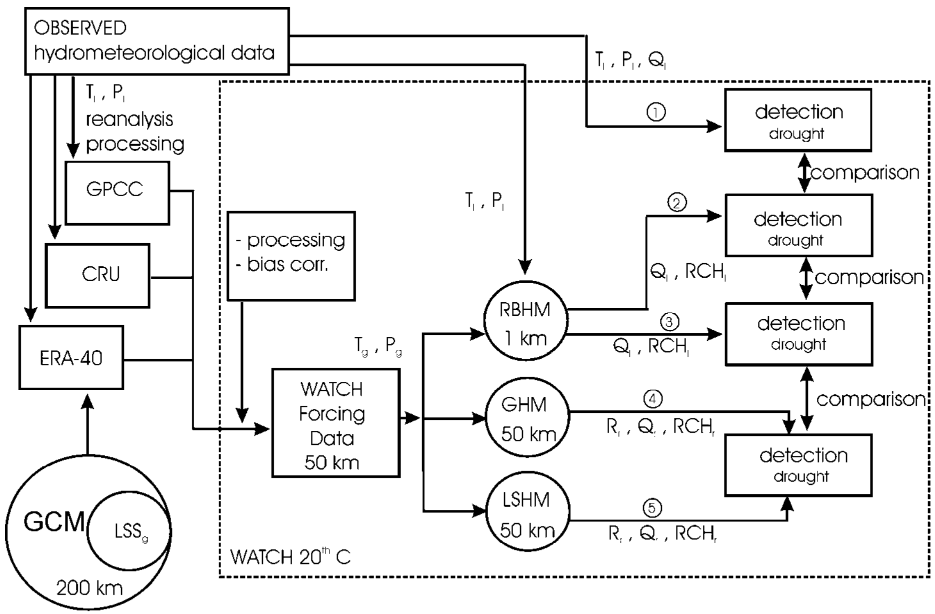
Impact of groundwater abstraction on drought

van Lanen et al. (2004)

Natural/Physical Systems

5. Drought assessment framework: interactions and global change

- Required data to advance research on drought
- Detection of changes in historical drought frequency and severity
- Attribution of changes in historical drought frequency and severity
- **Assessment of future changes: linking and coupling of climate and hydrological models**
- Uncertainty quantification of uncertainty



FP6 WATCH data and Modelling scheme for drought assessment

van Lanen & Tallaksen (2009)

Natural/Physical System

5. Drought assessment framework: interactions and global change:

Key Challenges

- combined at-site and regional analyses for consistency in trend detection;
- more consistent approach to attribute most likely causes for the detected change in drought;
- development of global, high resolution, integrated climate-hydrological models (Earth System models);
- joint effort by the climate and hydrological communities at short term to improve the offline approach;
- consistent approach that quantifies the propagation of uncertainties in the chain climate models, hydrological models and subsequent drought analysis tools.

Natural/Physical System

6. Methodologies for monitoring and forecasting

- Identification of drought indices

- Monthly and (multi-)seasonal drought forecasting
- Drought monitoring and early warning systems

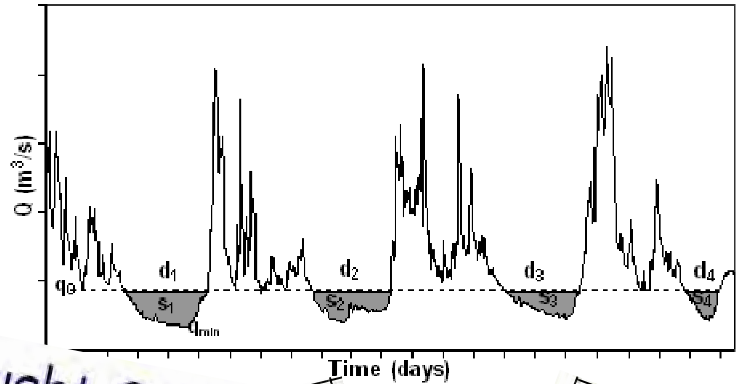
- Single index or parameter
- Multiple indices or parameters
- Composite index

Key Indicators For Monitoring Drought

- climate data (precipitation, temperature)
- soil moisture
- stream flow
- ground water
- reservoir and lake levels
- snow pack
- short, medium, and long range forecasts
- vegetation health/stress and fire danger

Martonne aridity inde

Threshold approach



Standardized Precipitation Inc

Palmer Drought Severity Index, PDSI

Surface Water Supply Index, SWSI

Natural/Physical System

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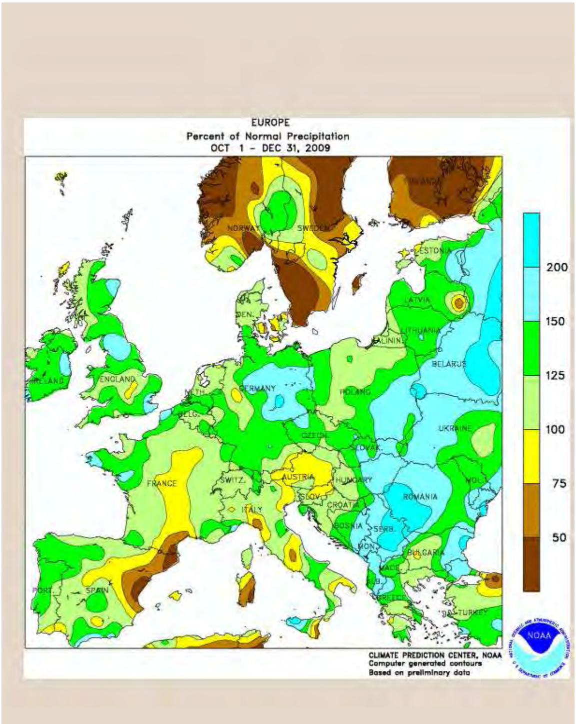


How should a EU water manager respond this?

Prec anamoly
(NOAA)

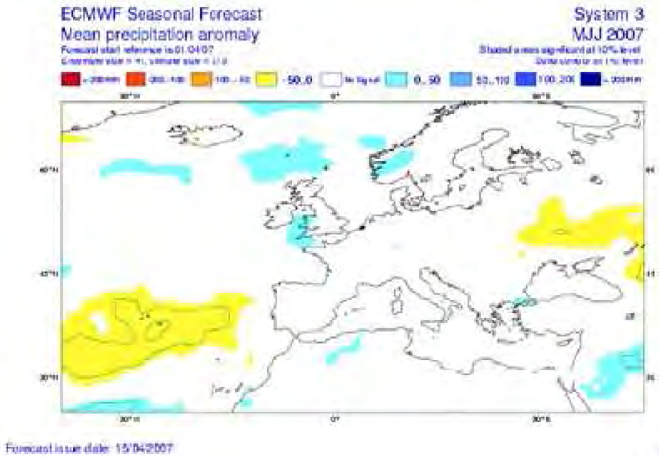
Natural/Physical System

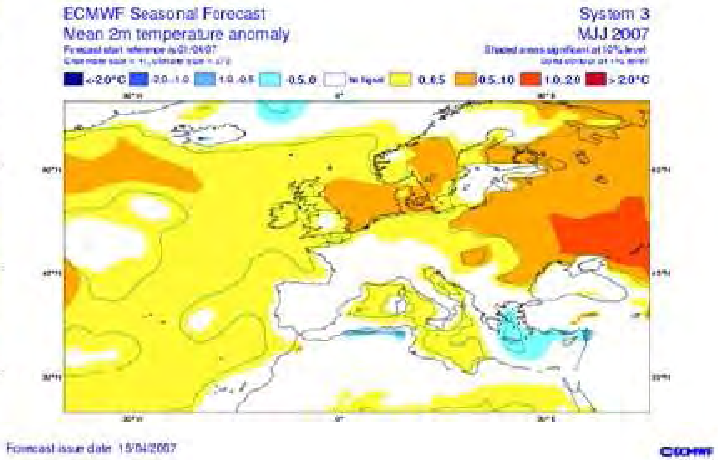
6. Methodologies for monitoring and forecasting

- Identification of drought indices
- **Monthly and (multi-)seasonal drought forecasting**
- Drought monitoring and early warning systems

ECMWF anomalies:

- **precipitation**
- **temperature 2m**
- **lead time 3 months (MJJ)**





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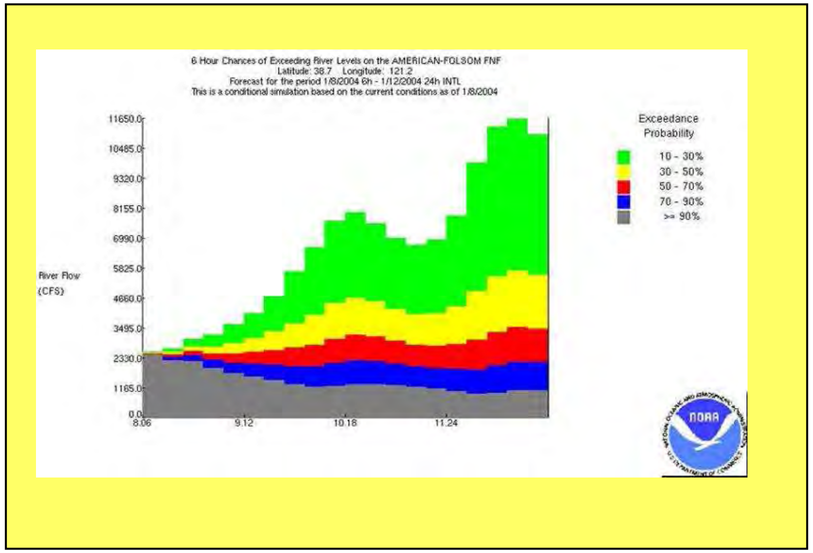

→ DROUGHT ?

climate and hydrological ensembles forecasting system (EFS)

01.08.04 - 01.12.04

Schaake (2006)

Natural/Physical System

KEY CHALLENGES:

- **detection of historic droughts and attribution to causes;**
- **building a concise drought reference database;**
- **influence of climate drivers and feedback processes on drought development;**
- **drought propagation (meteorological to hydrological droughts);**
- **improved modeling of the climate-hydrological systems, incl. quantifications of uncertainty;**
- **development of a European early warning system (incl. multi-monthly, seasonal forecasting system).**

Acknowledgements

Participants 1st XEROCHORE workshop, Noordwijkerhout, NL, 15-17 June 2009