

# Hydrological Drought

## Processes and Estimation Methods for Streamflow and Groundwater

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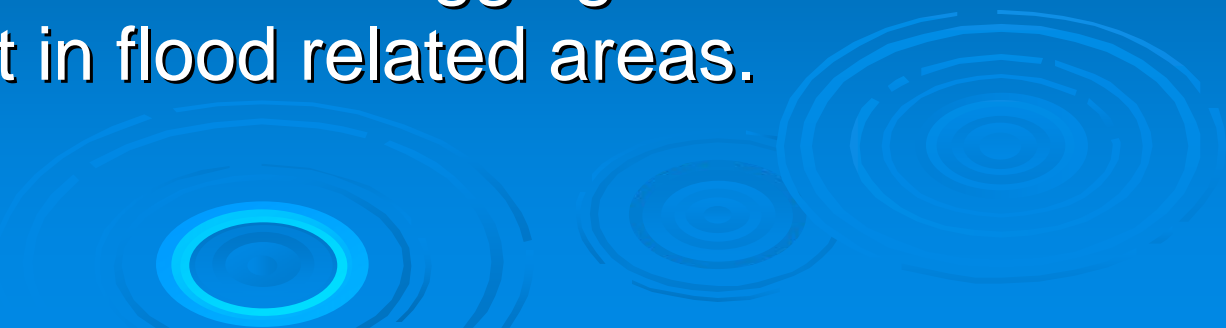
### ➤ Outline of presentation

- I. What is Drought?
- II. Drought processes and estimation
- III. Recent drought initiatives
- IV. Future needs

# What is Drought?

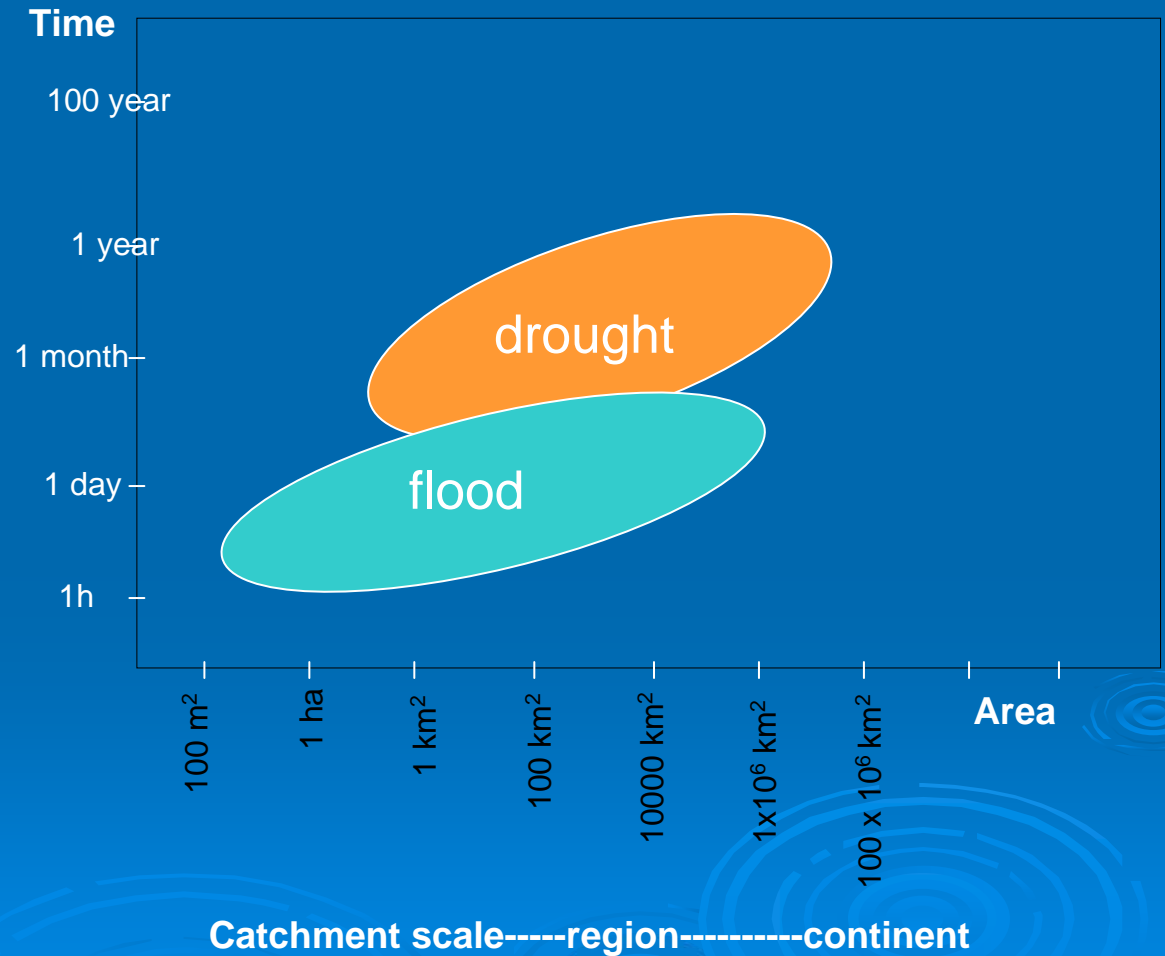


- Drought means lack of water that would normally be available in a region;
- Drought is a world wide phenomenon;
- Drought is a complex phenomenon with wide ranging social, environmental and economic impacts;
- Drought research and operational applications have been lagging behind the development in flood related areas.

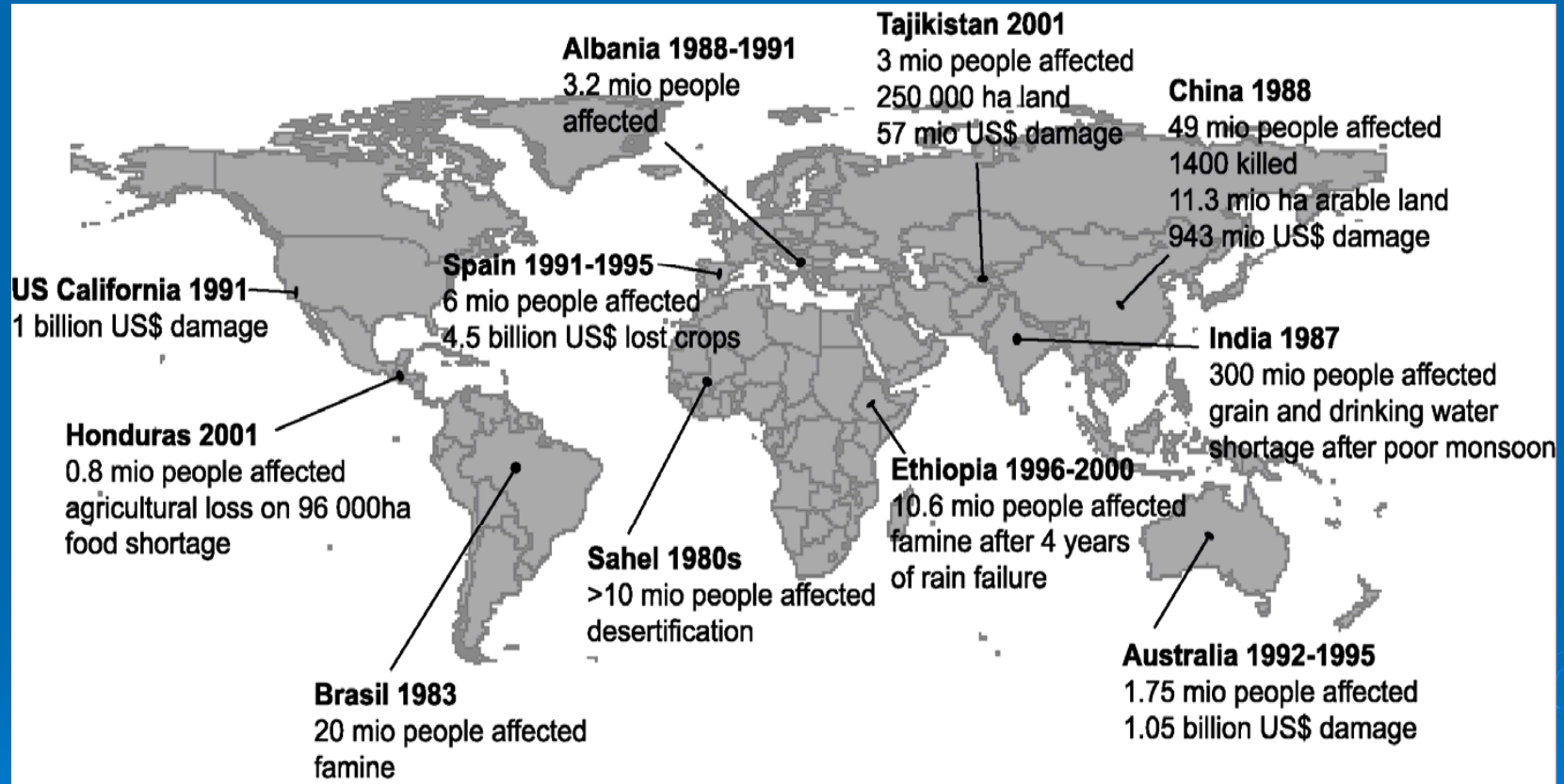


# Drought as compared to Flood

- Drought is a non-event;
- Drought develops slowly in time and space;
- Drought can not be forecasted based on a preceding precipitation event;
- Drought must be described in terms of several variables to assess the impacts of drought.



# The Drought Hazard



Recent severe droughts

The OFDA/CRED International Disaster Database, 2001

# Drought Definition

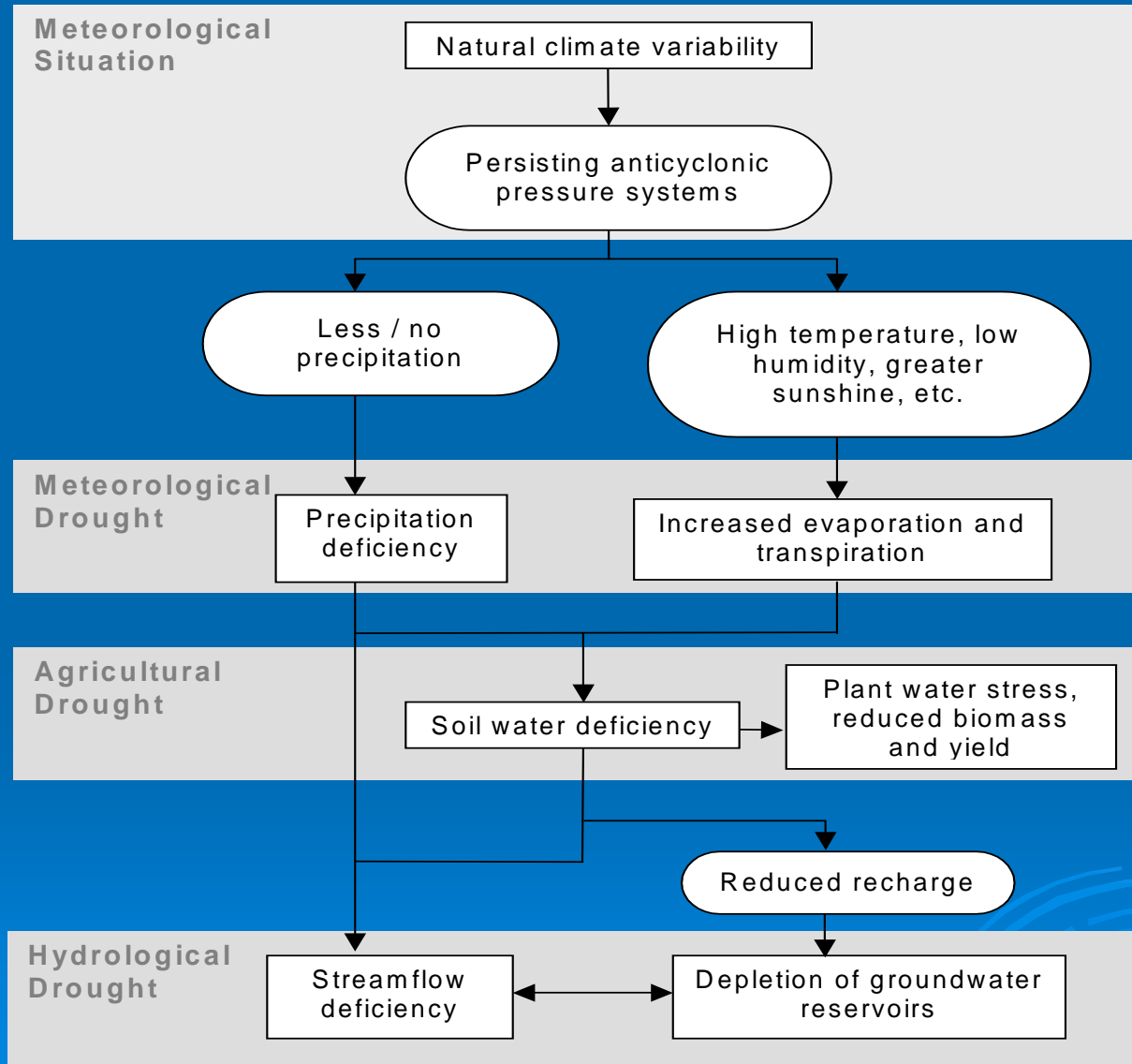
- Drought is a sustained and regionally extensive occurrence of below average natural water availability



*En indonesisk gutt leker på uttorret flodbunn på Java.*

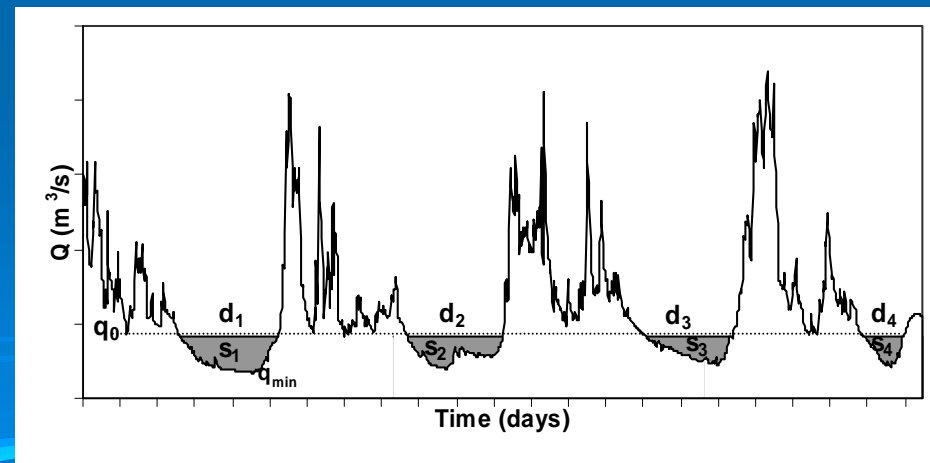
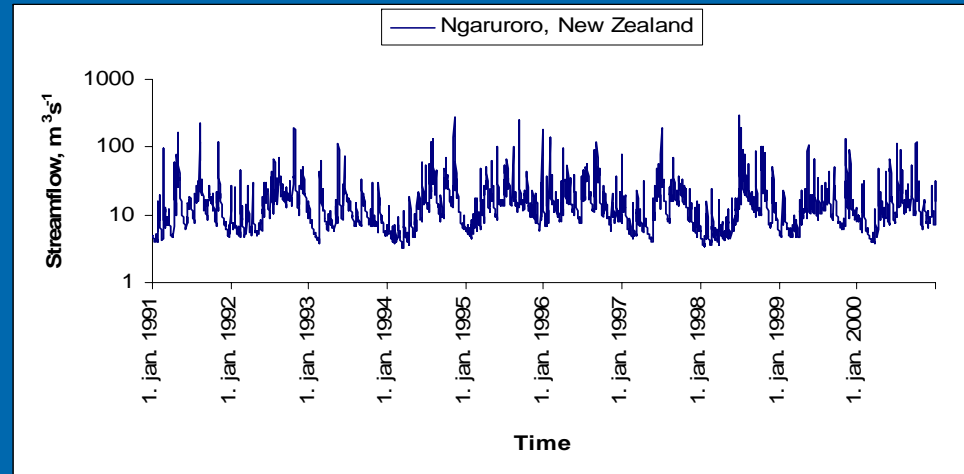


# Hydrological Drought



# Streamflow drought

- Time series of
  - Low flow characteristics
  - Deficit characteristics



# Groundwater drought

## ➤ Fluxes

- recharge
- groundwater discharge (base flow)

## ➤ State variables

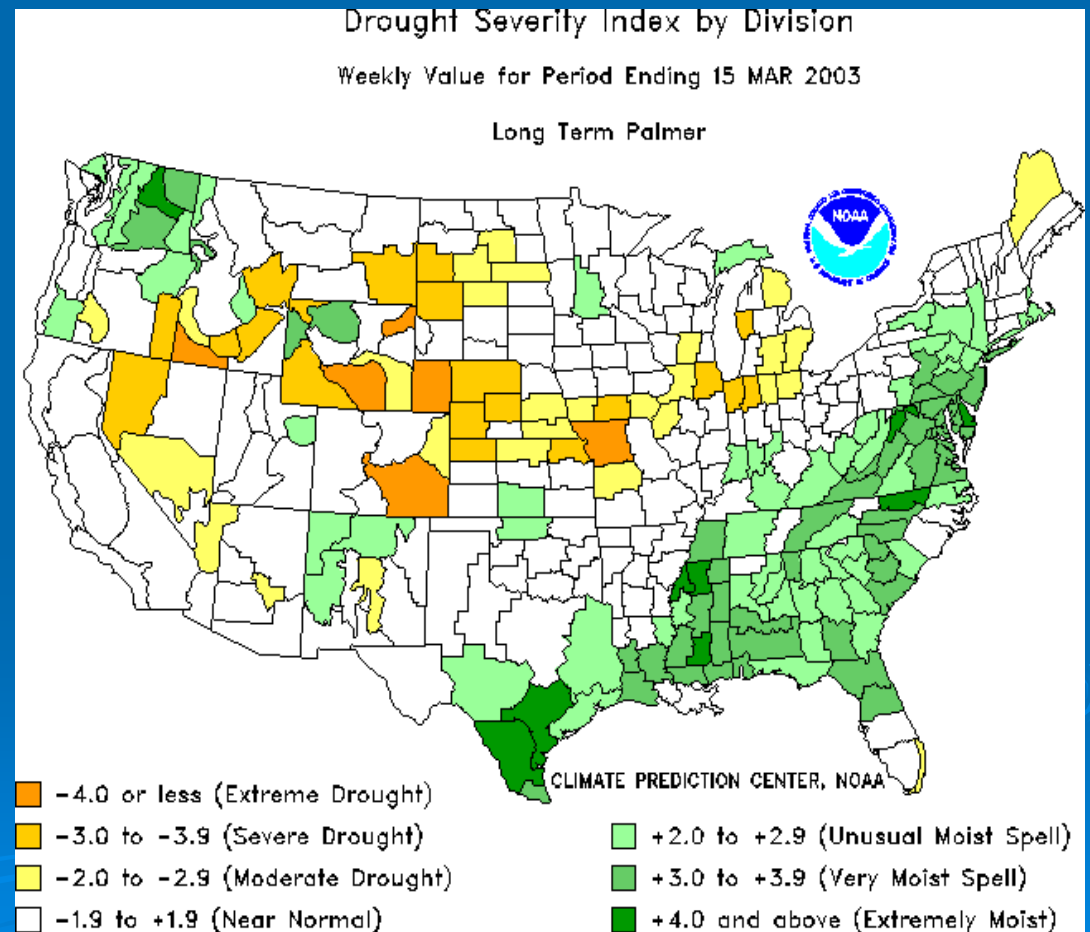
- groundwater heads or levels
- storage





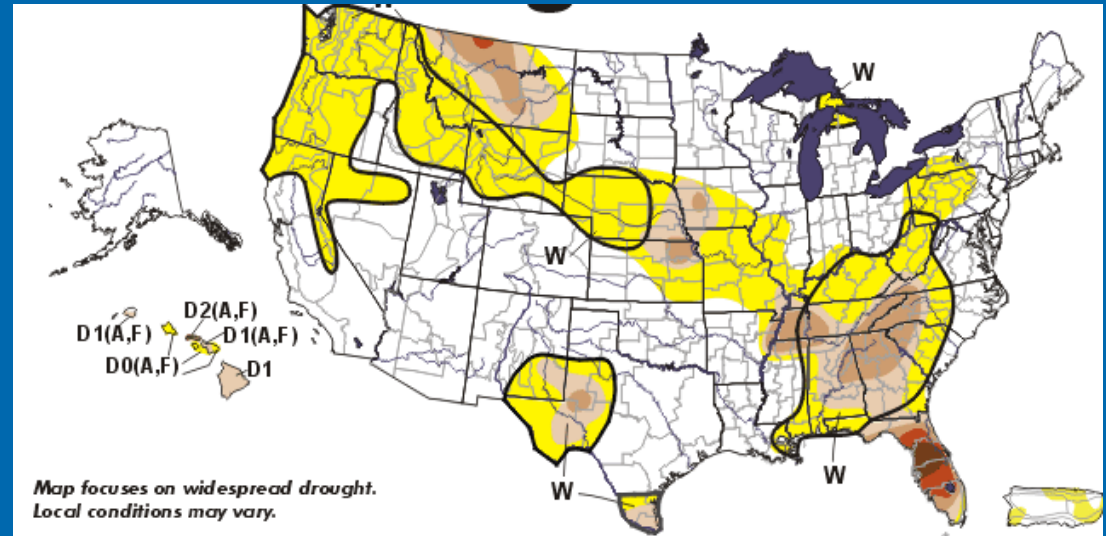
# Multivariable indices, e.g. PDSI, SWSI

- Based on several variables
- Often include water balance calculations
- SWSI: Includes snow, precipitation, reservoir storage, streamflow
- PDSI: Meteorological drought index, snow not included



# Spatial variability

Droughts are regional events, it is thus important to assess:



- the spatial extent of the events
- the variability within the affected area
- the dynamics of an event
- possible recurrent patterns in space

# Drought indicators

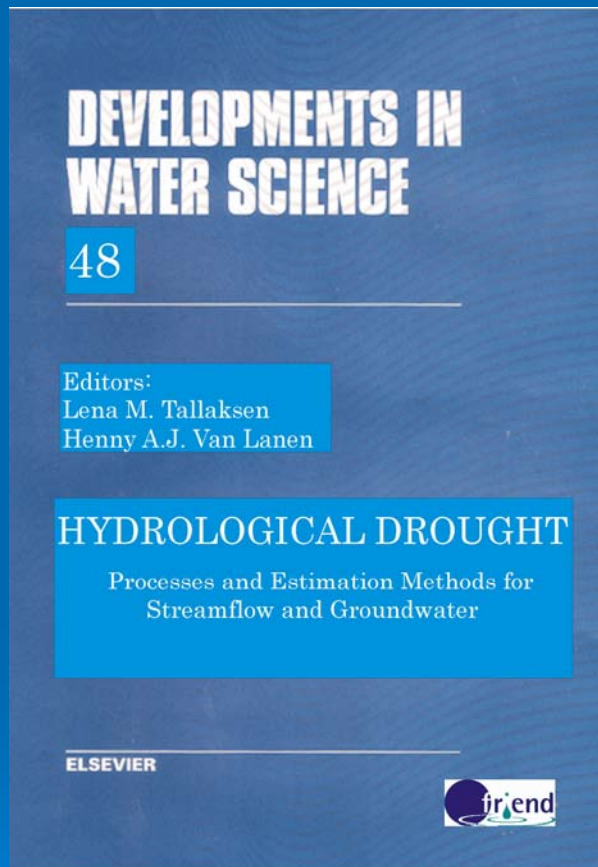
- The choice of drought indicator and relief measures depends on:
  - The purpose of the study
  - The hydrological regime under study
  - The data availability



# Textbook on Hydrological Drought

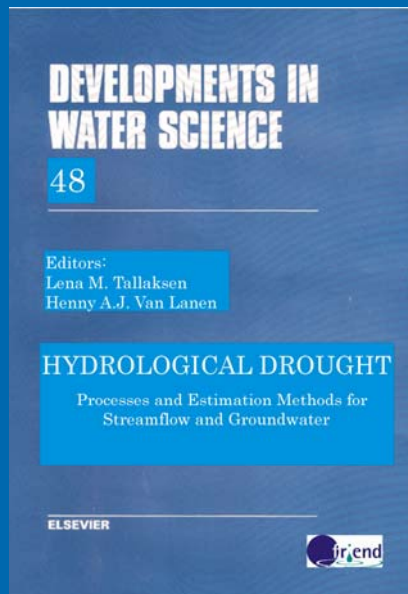
## CHAPTERS

1. Introduction
2. Hydroclimatology
3. Flow Generating Processes
4. Hydrological Data
5. Hydrological Drought Characteristics
6. Frequency Analysis
7. Time Series Modelling
8. Regionalization Procedures
9. Human Influences
10. Stream Ecology and Flow Management
11. Operational Hydrology
12. Outlook



**Publication date: October 2004**

# CD to accompanying the Textbook



## ● CD to the Textbook: ●

Hydrological Drought -  
Processes and Estimation Methods for Streamflow and Groundwater

### Contents

#### Worked Examples



#### Selfguided Tours



#### Case Studies



#### Data



#### Software



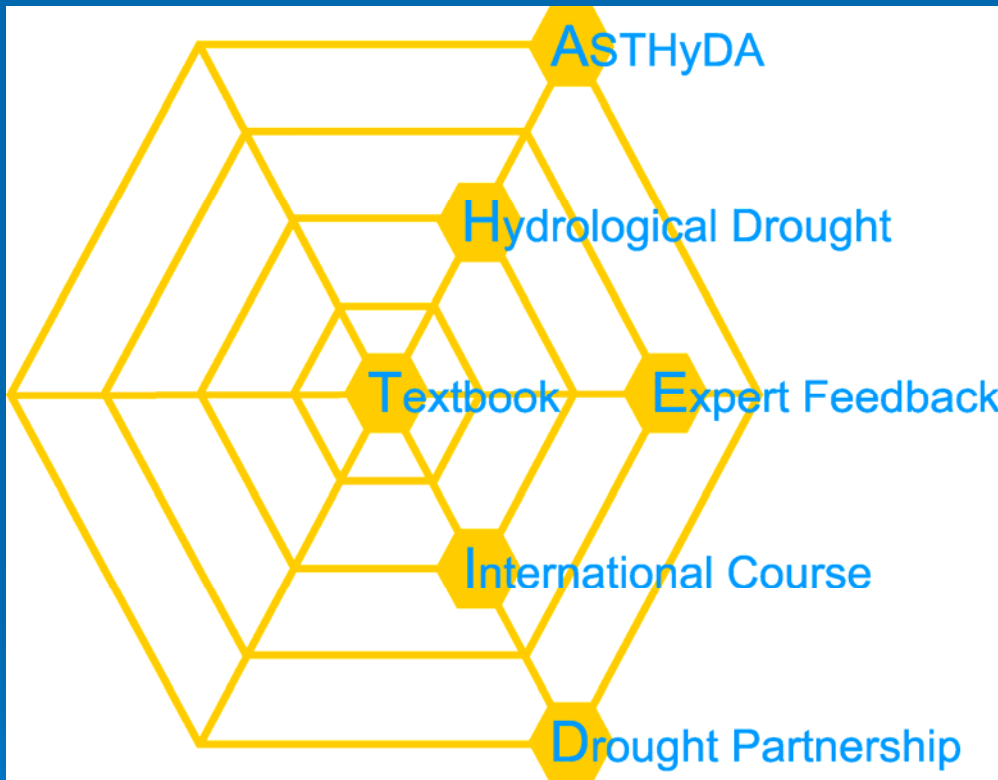
#### Supporting Documents



#### How to use this CD

# The ASTHyDA project

Analysis, Synthesis and Transfer of Knowledge and Tools on  
Hydrological Drought through a European Network



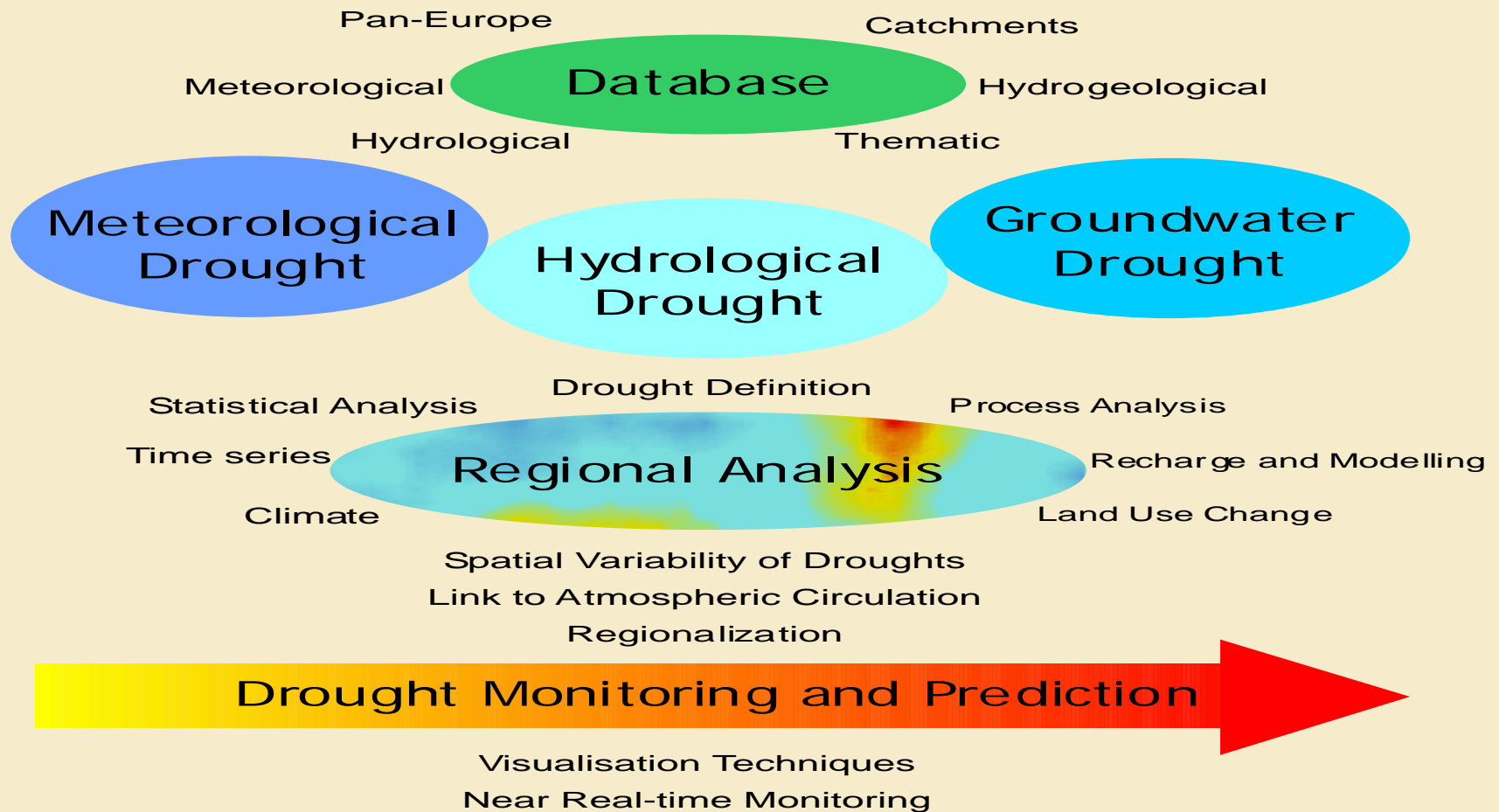
<http://drought.uio.no>

An Accompanying Measure in the EC's 5<sup>th</sup> Framework Programme



**ARIDE**

**Assessment of the Regional Impact of Droughts in Europe**  
 European Community Framework Programme for Research and Technical Development  
 Climate change and impact on natural resources:  
 1.1.4.1 European Water Resources



**University of Freiburg, Germany (Co-ordination)**

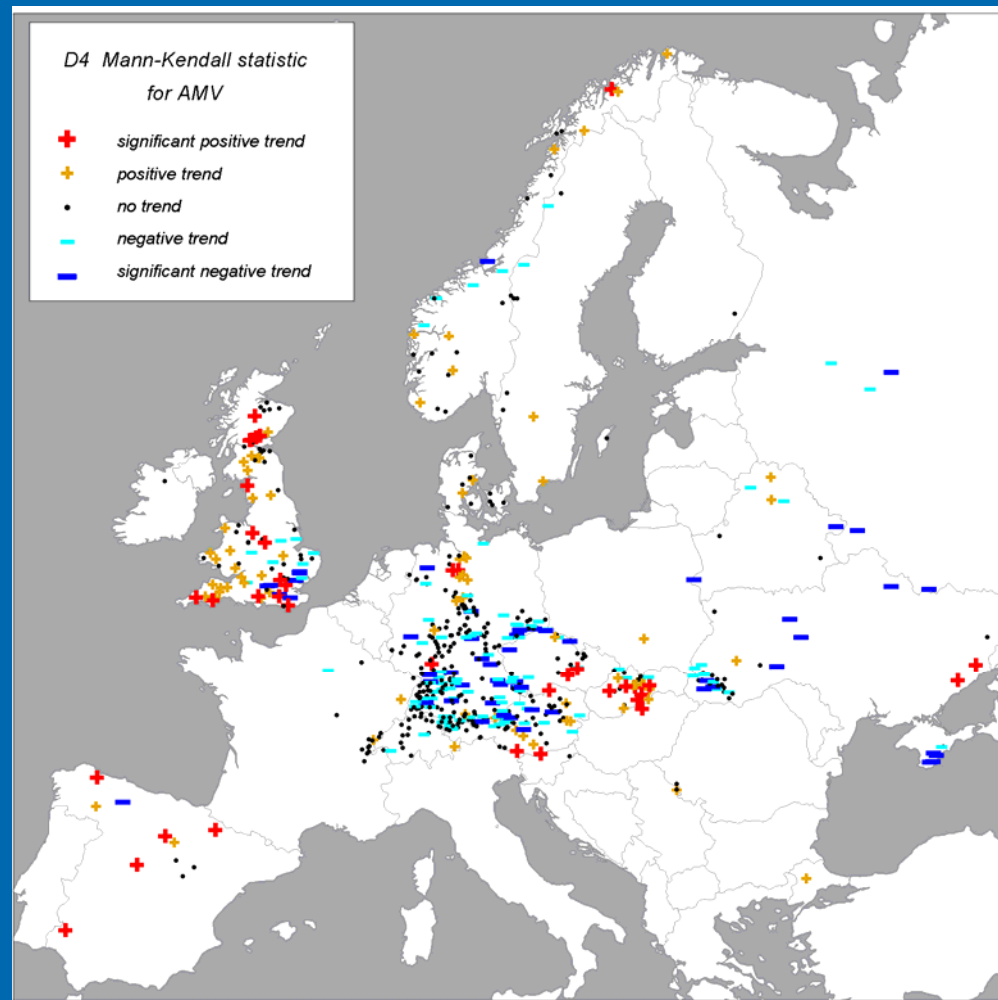
# Examples of pan-European drought studies within the ARIDE project

- Trends in streamflow drought
- Streamflow drought monitoring
- Streamflow drought forecasting

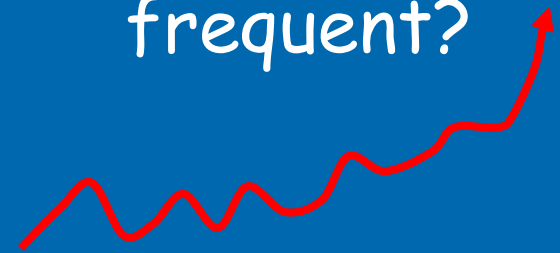




# 1. Pan-European Trend study

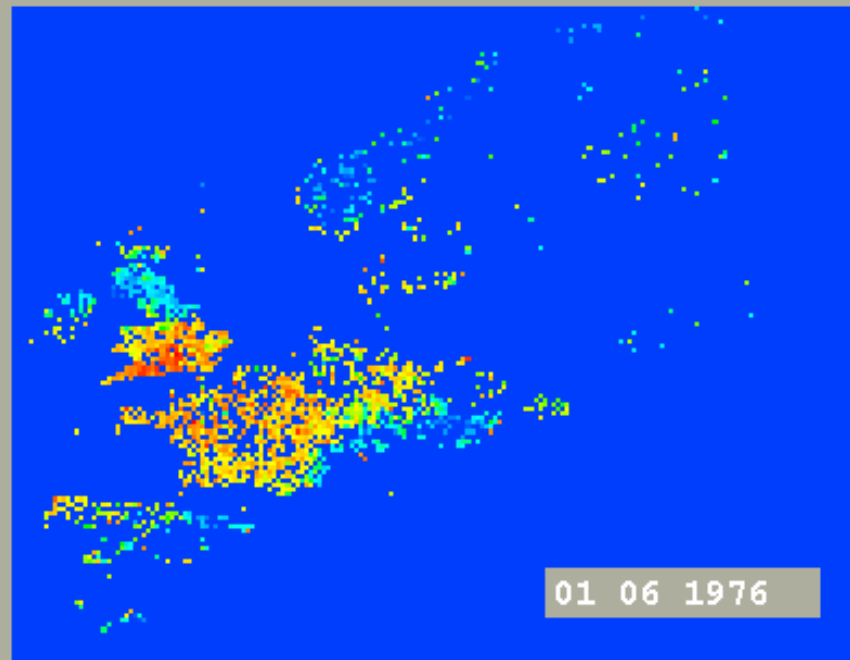


Have streamflow droughts in Europe become more severe or frequent?



## 2. Hydrological drought Monitoring, Pan-European scale

Variation in River Flow Conditions - Europe



% Exceedance

CEH, 2001

# 3. Links with the climate system

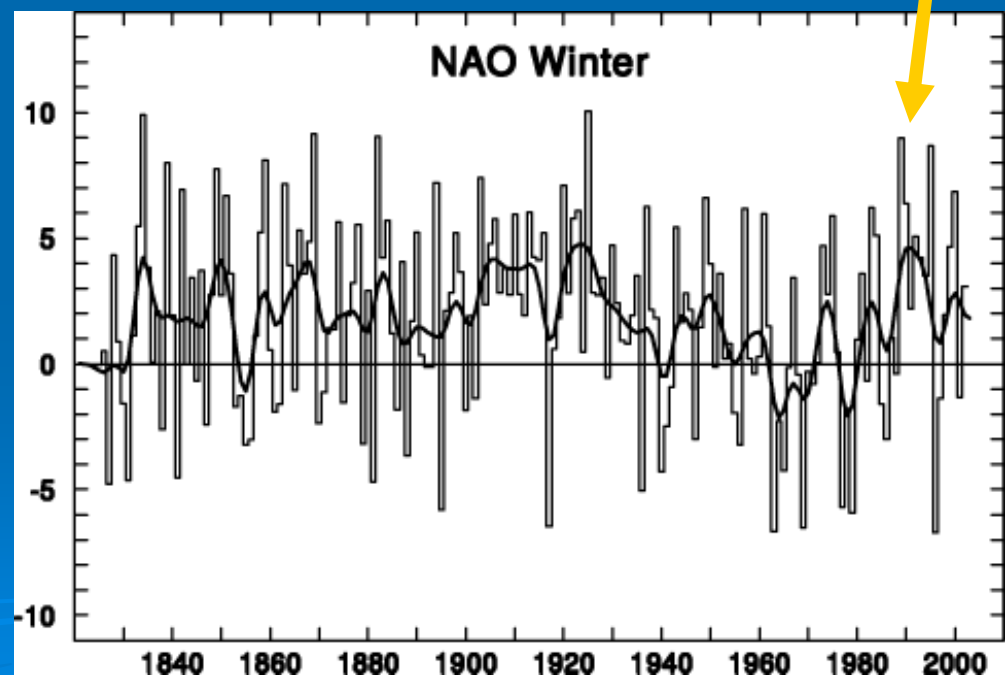
NAO Index: pressure difference between Iceland and the Azores/Gibraltar/Lisbon

High winter Index:

- Storm tracks shifted northwards, sparing southern Europe, where anticyclone persists

➤ Reduced winter rain

➤ Drought



(from CRU)

# Joint FRIEND and ASTHyDA meeting

Bratislava, 12-15 May 2004

## Research needs:

- Drought monitoring and forecasting
- Development of drought indicators
- Drought patterns in time and space
- Impact of land use and climate change
- Propagation of drought through the hydrological cycle
- Links between drought and stream ecology
- Methods for assessing the severity of drought
- Estimation at the ungauged site
- Need for good quality, long-term data (easy assess)

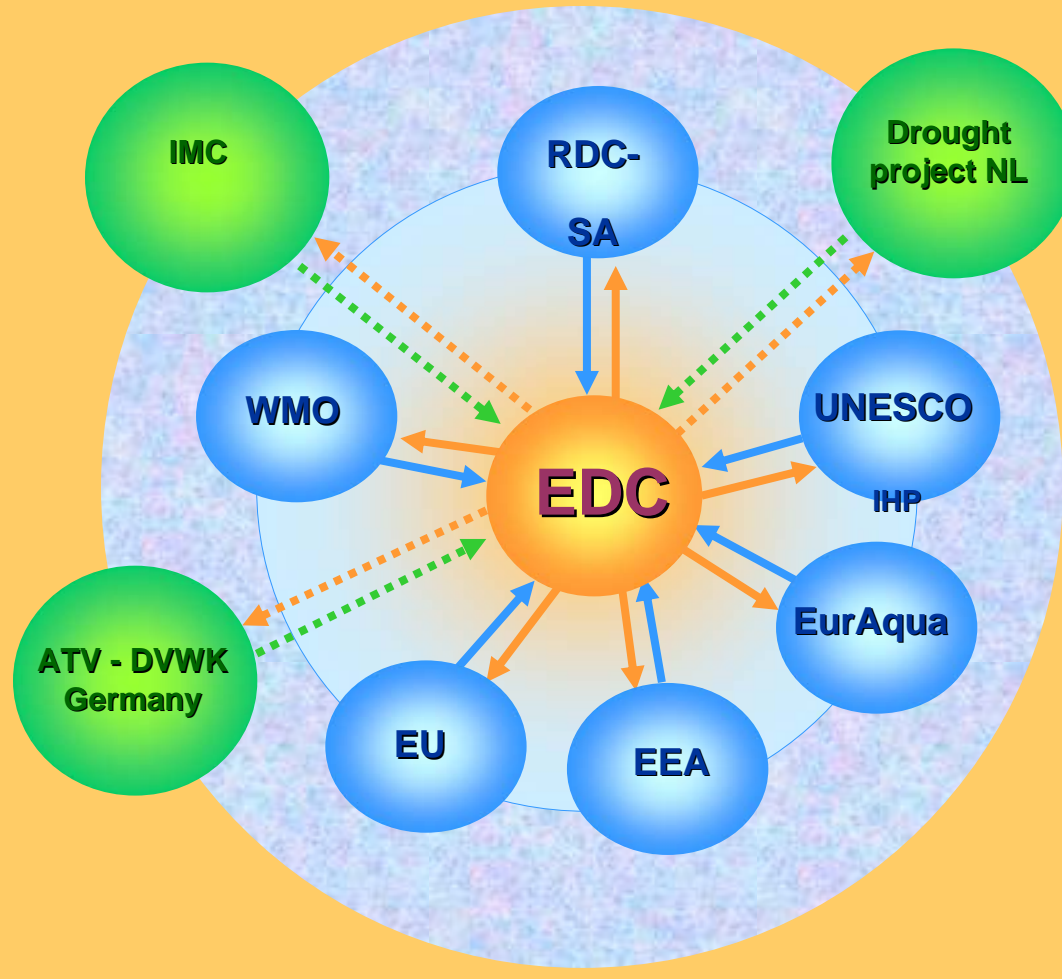
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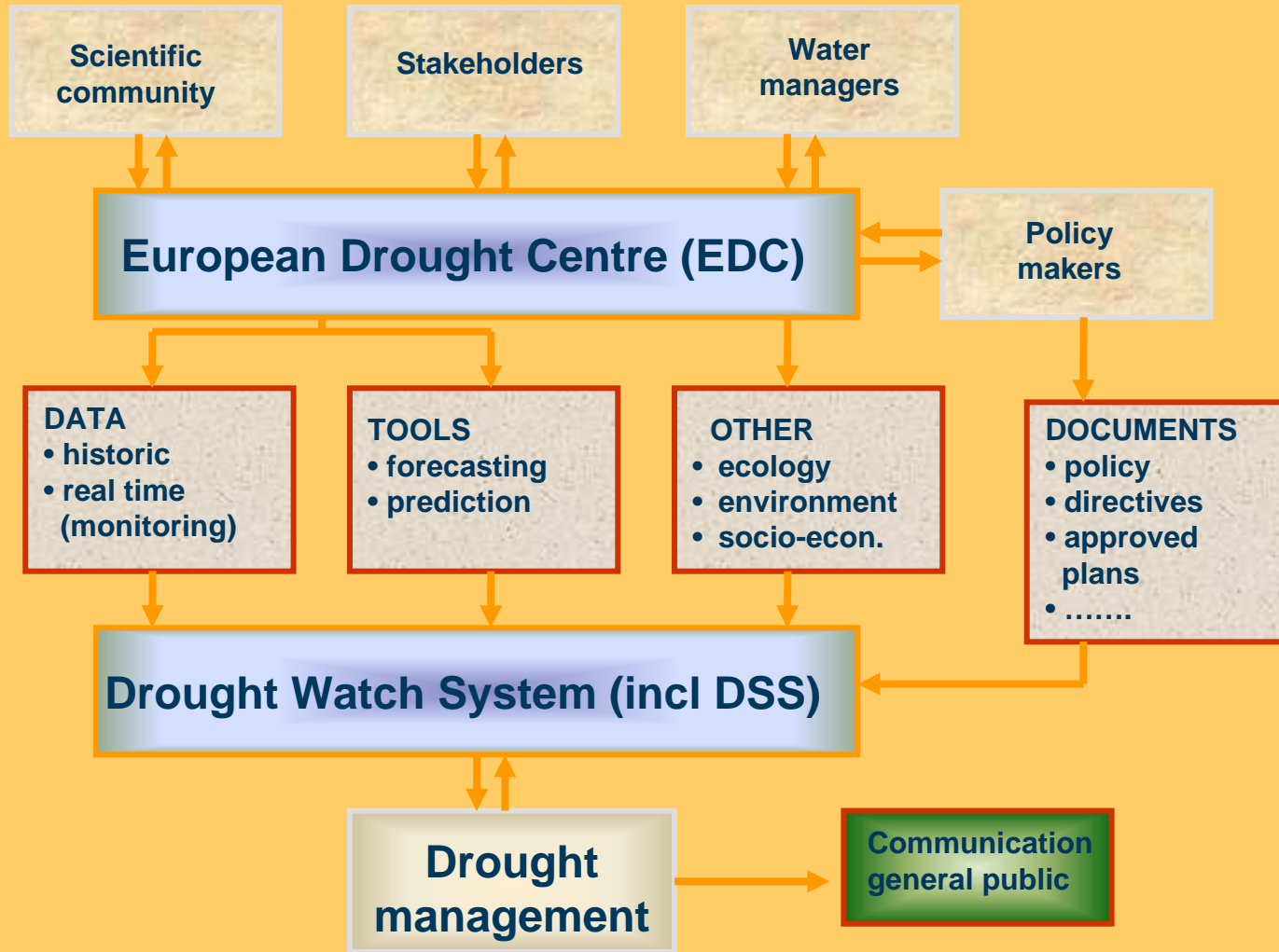
## Other aspects:

- Assess the operational needs for drought monitoring and forecasting
- Arrange workshops and joint research projects
- Transfer of knowledge through International study courses and workshops (Training)
- Communication to policy makers and the public
- Establish a European Drought Centre as a framework for future cooperation and improved coordination of research and operational activities

# European Drought Centre (EDC)



# Conceptual Diagram EDC



# Concluding remarks

- Drought is a natural hazard that cannot be prevented
- But, its impacts can be reduced through mitigation, i.e. knowledge, preparedness and good management practice

