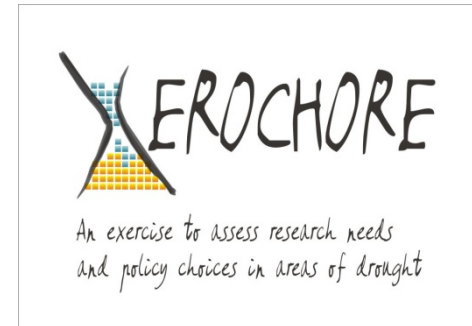




**Water Management Center – WMC
Bauer & Olsson GbR - Engineers -**



Environmental Impacts: Key Challenges

XEROCHORE Final Conference

Session 2: Drought assessment - Environmental impacts

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Involved Partner



Partner	Name	Short Name	
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2	Wageningen Universiteit	WU	
3	Water Management Center GbR	WMC	
10	Centre National du Machinisme Agricole, du Genie Rural, des eaux et des Forets	CEMAGREF	
11	The International Union for Conservation of Nature and Natural Resources	IUCN	

Environmental impacts of droughts

- The **aim** of was to provide
 - a review of existing background and knowledge on environmental impacts related to drought, and
 - to identify research gaps and key challenges

- Main **focus** was
 - on impacts and their relevance for drought management plans in the frame of the EU Water Framework Directive (EU WFD)
 - to support the integration of such plans within the implementation of the WFD as a result of a (possible) European Drought Policy

Environmental Impacts of droughts

- 1) Introduction
- 2) Impacts of droughts on the physical environment (quantity and quality)
- 3) Impacts on ecosystems
- 4) Impacts of droughts across different climatic conditions in Europe and worldwide
- 5) Strategies for reducing ecological and related socio-economic vulnerabilities to drought
- 6) Relevance to WFD

State of the art “direct and indirect impacts ”

- There is a wide range of different types of environmental impacts
- Direct impacts - identified acc. to three mechanisms of drought:
 - low precipitation,
 - increased air temperature,
 - increasing wind speed and/or frequency.
- Indirect impacts - assessed in two stages:
 - Indirect Impacts (1) may not always be a direct result of drought, although drought can contribute to these impacts where there are other contributing factors:
such as poor land management practices, pollution of watercourses, over-extraction of water.
 - Indirect Impacts (2) are a result of direct or indirect initial impacts of drought.

State of the art “Impact Matrix”

- State of the art review is summarised amongst others in an “**Impact Matrix**” identifying direct and indirect impacts on the environment

Drought ‘mechanism’	Direct Impacts	Indirect Impacts (1)	Indirect Impacts (2)
Reduced precipitation	<ul style="list-style-type: none"> • Reduced volumes of water available in rivers, streams, lakes and standing water bodies • Reduction in groundwater recharge from surface waters 	<ul style="list-style-type: none"> • Reduced volumes available for water supply • Possible reduced volumes of freshwater available for wastewater and industrial water treatment 	<ul style="list-style-type: none"> • Increase in particulate and organic matter in water courses and bodies • Increased energy and chemical costs for drinking water treatment • Salts and suspended solid concentrations increase in water • Dissolved oxygen decreases in water
Increasing air temperature	<ul style="list-style-type: none"> • Higher water temperatures in water courses and bodies (consequence of lower flows and possible higher temperatures)* 	<ul style="list-style-type: none"> • Soil structural changes - breakdown of topsoil into small particles • Possible stratification of water in lakes and water bodies 	<ul style="list-style-type: none"> • Flash flooding due to soil instability and landslides (mud slides in alpine areas) and higher surface run-off due to poor infiltration into soils • Possible impact on fresh, estuarine and marine water qualities (increase in algal blooms, and possibly human health)

Impacts of droughts on the physical environment (water quantity and quality)

- To quantify the influence of land use on runoff and water quality, especially over the long term and at large scale (e.g. wetlands).
- To extend the knowledge on the combined effects of:
 - droughts on both water and soil quality,
 - simultaneous drought and high temperatures on all important water quality parameters
- To clarify the contribution of each energy flux influencing stream temperature dynamics in the past and for the future

Impacts of droughts on the physical environment (water quantity and quality)

- General use of existing indices is difficult as different hydrological indices characterise low flow regimes as “environmental flows”.

- Better understanding of:
 - ecosystem sensitivity,
 - required flow conditions and
 - how future climate change will worsen the water quality deterioration in the Mediterranean.

Impacts on ecosystems

- Better understanding of how drought alters ecological functions and how these effects are influenced by species composition.
- More information required on the effects of long-term droughts on fish and at the spatial scale of river basins to subcontinents.
- Knowledge of how vegetation responds is even more limited
- As early warning indicators, further and sustained monitoring of headwater streams macroinvertebrates is needed.
- Further research is required on the role that drought refuges play in fish population dynamics.

Impacts on ecosystems

- In agroecosystems, research priorities should focus on the prospects for crop and soil management and plant breeding and biotechnology that are needed to achieve high stable yield under drought.
 - Forestry research should focus on the simultaneous effects of drought and other factors, such as forest management, air pollution and global warming.
- General tendency in conservation to shift from site prioritisation to landscape-scale or basin-wide ecosystem management.

Impacts of droughts across different climatic conditions in Europe and worldwide

- To develop effective indicators and indices to detect and assess drought situations throughout Europe.
- To develop vulnerability assessment methodologies under different environmental conditions, including the predicted climate change in Europe.
- To share experiences and to encourage database development (e.g. GIS platform and reliable database) at European level.
- Knowledge and expertise from Australia
 - Several changes in water policy have been formulated in recent times with the objective of striking a balance between the consumptive and environmental components of flows in Australian catchments.

Strategies for reducing ecological and related socio-economic vulnerabilities to drought

- Appropriate drought impact-reduction measures are required based on sound and agreed data that is regionally, nationally, and basin-wide applicable.
- Indicators are required for key habitat management and restoration
- River science and management need to be multi-disciplinary
- Economic valuations that include ecosystem services considerations
- Recognition of natural or green infrastructure in portfolios of water storage options through e.g. river restoration
- The role of environmental flows for river basin allocation to improve the resilience of ecosystems to drought should be further investigated
- Further research may also be required on the cost of droughts and the negative impacts on ecosystems in relation to tourism revenue

Outcomes of Xerochore

- Water Framework Directive weakness: hydrological modification and flow regime change not considered.
- Minimum Environmental Flow should be integrated part of WFD (River Basin Plans).
 - A minimum flow should be maintained in river basins as a practical means to maintain water quality throughout the river basin and prevent further deterioration of high ecological value areas such as Natura 2000 sites
- Environmental Flows will need to be nationally determined based on the WFD requirement to maintain good ecological status.

Outcomes of Xerochore

- Need to differentiate between arid, semi-arid, humid and mountainous regions as effects of Droughts differ per region
 - Need to provide tools for water resource managers to evaluate the overall impacts at the river basin level
- → Drought Plans must be integrated into River Basin Plans, to allow for characterization of **exceptional droughts** including appropriate **indicators and thresholds** of ecological impacts and vulnerabilities together with **measures** to be adopted for **recovery** towards Good Ecological Status

Thank you!

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