

Drought in Europe: hazard, impacts, management and science-policy interfacing

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Abstract

Europe's water resources are heavily exploited leading to water scarcity in several regions. Global change (climate change, population growth, land use change) likely will worsen water scarcity and not only in the dryer Mediterranean region, but it will even develop in currently not water-stressed regions (e.g. temperate humid north western Europe). This is particularly felt during drought, such as the large-scale 2003 drought or the 2012 drought in the UK. The European Environmental Agency has estimated the losses due to drought to be as high as 4940 billion Euro over the period 1998-2009. The high socio-economic and environmental impacts of drought urge drought to be explicitly addressed in water management and planning. This requires advanced monitoring, forecasting and prediction of drought, which adequately addresses impacted sectors and requires to be accomplished as dialogue between policy-makers, stakeholders, water managers and scientists. In this context, examples of pan-European drought monitoring will be presented using different drought indicators. It will be discussed that a distinction needs to be made between awareness indicators, which are used to provide large-scale information, to do predictions, and operational indicators that are common at the river basin scale to manage an ongoing drought.

Past droughts in Europe, which are essential to understand impacts, will be presented using the European Drought Reference Database (EDR). We will show that it is important to distinguish between different drought types (e.g. meteorological, hydrological drought). We argue that, for water management, hydrological drought needs to be investigated in addition to the frequently used meteorological or soil water droughts (e.g. SPI, SPEI, PDSI). This implies that drought propagation (i.e. drought-generating processes) should be considered, incl. non-linearities due to temperature and storage-related processes resulting in different hydrological drought types, which have different impacts on water resources. Influence of climate and catchment characteristics on drought propagation is illustrated for different geo-climatic conditions in Europe. We investigated trends in observed low flows for several hundreds of European catchments and trends in hydrological drought characteristics, which were obtained from multi-model simulated runoff. We will show that observed low flows have decreased and drought intensities have increased in multiple regions in Europe. Uncertainty in trends will be addressed through model intercomparison and comparison against observed characteristics. We also will illustrate that trends should carefully be interpreted because of climate variability. Data beyond the instrumental record demonstrate that severe drought have occurred in Europe since Mediaeval times.

Reported impacts of drought across Europe will be shown that have been collated and stored in the European Drought Impact report Inventory (EDII). Impacts on agriculture, water supply and energy production are the most reported with slightly different importance across European regions. It appears that there is need to elaborate impact-specific indicators for drought monitoring and management.

Future drought will be presented that are based upon various hydrological modeling and drought identification approaches. The contemporary reliability of these approaches is one of the reasons for the rather large spread in drought projections, which hampers identification of drought-sensitive regions and sectors in Europe, and potential responses for drought risk reduction.

The trend to more severe hydrological drought in many European regions and the projected increase in duration and severity of drought urges policy makers to better fine-tune existing land and water policies, and water managers and stakeholders to take pro-active measures to combat water scarcity and to adapt to future drought, which would reduce society's vulnerability. We will present experiences from EU, UNESCO, WMO-GWP funded international projects. We also will address the important role of the European Drought Centre (web-based centre of hundreds of drought experts) in integrating

different drought science fields (e.g. natural hazard, impacts) and bridging the gaps between scientists, policy-makers, water managers and stakeholders.