



LOW FLOW AND DROUGHT RESEARCH IN EUROPE: ACHIEVEMENTS AND FUTURE

Henny A.J. van Lanen ¹⁾ & Miriam Fendeková ²⁾

¹⁾ EURO-FRIEND Coordinator, Wageningen University, Wageningen, the Netherlands (henny.vanlanen@wur.nl)

²⁾ EURO-FRIEND Low Flow and Drought Coordinator, Comenius University, Bratislava, Slovakia (fendekova@fns.uniba.sk)

Introduction

A workshop on Low Flow and Drought was held at the Comenius University, Bratislava (Slovakia), 10-12 November 2008. The workshop was organized in the context of the FRIEND (Flow Regimes from International Experimental and Network Data) project. It is a contribution to the UNESCO International Hydrological Programme VII and to the Year of the Planet Earth.

Objectives of the meeting were:

1. to present recent research achievements on low flow and drought
2. to identify future challenges
3. to prepare joint research activities

Six topics were addressed:

- 1: Data – Drought Monitoring – Indicators
- 2: Drought generating processes and modeling
- 3: Drought patterns and characterization
- 4: Drought: large-scale drivers – teleconnections
- 5: Drought forecasting and prediction
- 6: Human impacts on drought – global change

About 40 scientists from 13 countries attended the workshop. Twenty-six papers were presented, which were followed by presentations of rapporteurs and a concluding general discussion. The outcome of the general discussion is summarized below. A comprehensive report, including the abstracts, will become available at the website of EURO-FRIEND (<http://ne-friend.bafg.de/servlet/is/7398/>) and the European Drought Centre (www.geo.uio.no/edc)

Conclusions and recommendations

1. Need for consolidated datasets

In all sessions the lack of data was addressed. In particular, observations at the regional scale (across national borders) are necessary to improve our knowledge of droughts, including the understanding of changing processes in the natural system (physical system). This is the most important way to reduce uncertainties in predictions and forecasts. Besides hydrological data, also other kinds of data are needed, e.g. climate data, land use and other catchment characteristics. Furthermore 'ground-truth' for the assessment of the impact of global change on drought is urgently required. Advancements are however, hampered by restricted data availability (access and quality of observations). All nations should be committed to contribute with observed data. Considerable effort is needed to collect transnational datasets with sufficient temporal and spatial resolution.

2. Drought indicators

Many drought indicators are available. Clearly, different indicators are needed to reflect the nature of the different types of drought and to accommodate the requirements of the different water-related sectors. In addition to management type indicators may differ from science-driven indicators, which are required particularly for the large-scale studies. Such Indicators should allow the comparison of droughts in different hydrological variables in the hydrological cycle and across different scales. Some drought indicators require imbedding of the drought area. The potential of other concepts than the threshold approach need to be explored, e.g. the cumulative deviation. However, new concepts need to provide a measure of duration and affected area.

3. Models and process understanding

Hydrological models are important to help us understanding processes, i.e. processes that are underlying drought development in different hydroclimatic regions and physical catchment structures. Models are not meant to fit the observed hydrograph, but to sharpen our research questions (Keith Beven & Bryson Bates). Lumped, two reservoir models using linear reservoirs are unable to simulate the extreme extremes. The research question is how to capture the special behavior of summer low flows (steeper than winter recessions). It is a challenge to find a (simple) model that is able to simulate the transient hydrological system with limited data for a wide range of hydroclimatic regions and physical catchment structures.

4. Detection of spatial and temporal patterns/trends in drought

Changes in climate and catchment processes, and anthropogenic interferences cause trends. Clearly, the statistical model should contain the trend that is present in the data, and if the trend is recent then data from recent years need to be available.

Long term Persistence (LTP) violates the assumption of trend tests and prevents us to provide the significance level of the trend. New methodologies need to be developed to come across this. This might be a new statistical test, but we should also reconsider at what we are aiming. We are searching for changes in hydrographs as a response on changes in climate. Climate is a large-scale phenomenon and its change will affect a large area. Hence, a change in climate drivers is expected to impact river flow in a certain climate region in a similar way. We should investigate regional consistencies. However, differences in physical catchment structure and associated hydrological processes likely blur this. We should explore a more holistic approach that aims at a more integrated framework that combines observation-driven and model-driven approaches. It may be useful to shift methodological focus from variation to co-variation, separate the climate and catchment signal, and consider human impacts. The development of the integrated approach would benefit from joint meeting of the Euro FRIEND group on "Low Flow and Drought", Project group 3 "Large-scale Hydrological Variation" and group 5 "Catchment Hydrological and Biochemical Processes in a Changing Environment" to compare drought across scales. Another option is at the EGU session on extremes, Vienna, 20-24 April 2009, which solicits presentations on both scales. Detailed catchment studies (e.g. Lange Bramke catchment, Dreisam catchment) also show that thresholds occur in the natural system that affect the aquifer-stream interaction and that may lead to droughts in groundwater and streamflow. Climate change also has an impact on land surface processes (e.g. tree line, timing and length of growing season), feedback processes.

5. Large-scale climate drivers and drought

The investigation of the correlation between weather types (WTs) and the regional drought index series shows potential to link large-scale climate drivers and drought. Some weather type classifications seem to link better with droughts than others. Clearly, local drivers (catchment processes) prevent strong links. The WTs have another time scale (short) than the drought (long).

Another way of studying coherent patterns is a Principal Component Analysis of the deciles of hundreds of time series of river flow across Europe. Based on the PCA coherent groups are identified, but the challenge is to find a physical meaning of the Principal Components and loadings.

6. Prediction of low flow characteristics at ungauged sites

Regionalization approaches enable prediction of low flow characteristics at ungauged sites. To date, linear regression models that predict a certain low flow index from a set of catchment characteristics perform better than physically-based hydrological models, although this depends on the availability of gauged streamflow records in similar areas. Including the regression model in a GIS enables the prediction of the low flow index at a selected

river point by an automatic determination of the upstream catchment boundary and area, and associated catchment characteristics. Weakness of the regionalization approaches is the lack of catchment characteristics, in particular subsurface properties (i.e. hydrogeological index). The prediction uncertainty needs to be communicated to the end user. While the uncertainty can be reduced by spot measurements, there is a trade-off between the costs of spot measurements and the width of the prediction range (operational aspect, how to deal with uncertainty). The prediction of indices at ungauged sites is strongly linked to the IAHS-PUB initiative, including the assessment of the uncertainty.

7. Impact of anthropogenic influence on drought

It is difficult to distinguish between natural variability and human influences that reduce or enhance a natural drought. Without detailed information it is therefore impossible to attribute changes in drought characteristics to certain causes. For example, in many regions the impacts of land use change, urbanization or abstraction for irrigation override the effect of climate change. An integrated observation-driven approach that confirms the dependencies with modeling seems to be a promising approach. We should focus on areas where it is likely to see changes in the near future (temperature), seasonal differences, transition zones. We should learn more about processes underlying the major recent events and address scaling issues (a theoretical approach using non-linear dynamics might be required).

Around the world, governments start to develop strategies to adapt to climate change. The time horizon is 2020-30. Near future scenarios pose several challenges, because projections based upon GCM and RCM simulation are uncertain on future drought. Alternatively, weather generators can be used to introduce stakeholders to the uncertainty of potential changes. Both long term (structural investments) and short-term operational management need to adapt to possible short term change.

8. Drought monitoring and forecasting

Development of drought monitoring and early warning systems for droughts with at least a seasonal lead time is in an important and also sustainable way forward to prepare for and manage drought.