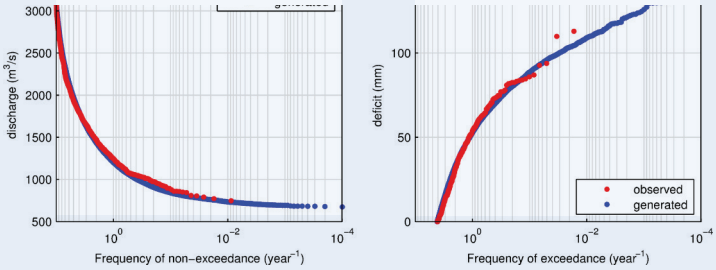
DROUGHT EVENT SIMULATION AND DROUGHT RISK ANALYSIS

Population growth and economic developments are leading to an increase in demand for water resources. Furthermore, many projections indicate that climate change will have a negative impact on the availability of water. Measures to reduce the risk of water shortages can be costly and they often require long-term planning strategies.



A thorough understanding of drought-related risks for the various water users is of crucial importance in the decision-making process. Risk is typically defined as the combination of hazard (the meteorological/hydrological event), exposure (assets and population) and vulnerability (the susceptibility of the exposed units to the hazard).

The Dutch government established the Delta Programme to protect the Netherlands from flooding and to secure freshwater supplies against the backdrop of climate change. A set of measures and regulations was defined to mitigate potential drought impacts in the Netherlands. However, extreme drought events were not taken into account at that point in the cost-benefit analysis that was used to select measures. A drought risk approach that includes a variety of drought events is therefore clearly needed. Since extreme events are, by definition, rare in historical records, valuable additional information can be obtained by using synthetic time series covering, for example, 1,000 or 10,000 years.

The objective of our research was to develop synthetic time series that are realistic and representative for current and future climate conditions. The Ministry of Infrastructure and Water Management is particularly interested in the formulation of a multitude of plausible drought events (synthetic or actual) that can be used as 'stress tests' for water availability in the Netherlands. The development of synthetic time series is by no means straightforward because multiple characteristics of the observed time series need to be reproduced simultaneously. These characteristics include exceedance probabilities of threshold values and mutual correlations between different time series. Techniques that focus on reproducing one of these characteristics often affect the reproduction of the other characteristics.

We developed a stochastic model framework for generating realistic time series of meteorological and hydrological variables that characterise drought events. The method combines an autoregressive modelling approach and a copula method for incorporating dependence between time series. The method is fully stochastic, which means that the relevant physical processes are not explicitly modelled. The method is generically structured and it can therefore be used in a range of locations and rivers. The main output of our research is a set of realistic synthetic time series of meteorological and hydrological variables and a model that can provide series of this kind. The model was applied to a case study in the Netherlands. Synthetic time series for discharges in the Rhine and rainfall in the Netherlands were generated. The characteristics of the synthetic time series closely matched the observed time series.

The framework was developed in the EU Horizon2020 research programme IMPREX - IMproving PRedictions and management of hydrological Extremes.

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Further reading:
http://www.imprex.eu/

▼ *Drought affecting the Rhine (source: beeldbank.rws.nl)*