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Towards risk-based drought management in the Netherlands: comparing two methods to generate synthetic drought events

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It is widely acknowledged that drought management should move from a crisis to a risk-based approach. A risk-based approach to managing water resources requires quantifying the probability and impacts of water shortage due to droughts. Impacts of droughts are for example crop yield losses, hydropower production losses, and water shortage for municipal and industrial use. The challenge here is that in the past only a limited number of droughts have occurred, which makes it difficult to accurately predict characteristics of possible future (extreme) droughts. In order to better cope with potential extreme drought events, more insight in the occurrence and characteristics of these events is essential. To overcome the limitations of the short observational records with limited drought events, substantial effort in the European IMPREX project was put in deriving lengthy synthetic time series. Two approaches were implemented; a purely statistical approach based on autoregressive (ARMA) model and an approach using the climate model RACMO.

Both methods were applied to a case study in the Netherlands. Synthetic time series of precipitation deficit and Rhine river discharge were generated. Of both synthetic models (RACMO and ARMA), the ARMA model provides the most promising results. The developed stochastic model ARMA satisfies all requirements on the monthly time scale. This means autocorrelations and correlations between different time series were well reproduced as well as monthly frequencies of (non-)exceedance and seasonal variations. This is very promising, also because this stochastic model is still at a relatively early stage of development. Only for extreme dry summers, the temporal patterns of river discharge and rainfall deficits appear to have a lower persistence/autocorrelation than the observed events. It is unclear whether this is caused by an underlying meteorological process. This will be further investigated in a follow-up study. The synthetic series of the ARMA model are expected to be of added value for the characterization of future drought periods since it offers a wealth of realistic drought events that can be used as input of a socio-hydrological model to carry out a comprehensive drought risk analysis.