Drought assessment in the Duero basin (Central Spain) by means of multivariate extreme value statistics

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Droughts cause important losses. On the Iberian Peninsula, for example, non-irrigated agriculture and the tourism sector are affected in regular intervals. The goal of this study is the description of droughts and their dependence in the Duero basin in Central Spain. To do so, daily or monthly precipitation data is used. Here cumulative precipitation deficits below a threshold define meteorological droughts. This drought indicator is similar to the commonly used standard precipitation index. However, here the focus lies on the modeling of severe droughts, which is done by applying multivariate extreme value theory (MEVT) to model extreme drought events. Data from several stations are assessed jointly, thus the uncertainty of the results is reduced. Droughts are a complex phenomenon, their severity, spatial extension and duration has to be taken into account. Our approach captures severity and spatial extension. In general we find a high correlation between deficit volumes and drought duration, thus the duration is not explicitly modeled. We apply a MEVT model with asymmetric logistic dependence function, which is capable to model asymptotic dependence and independence (cf. Ramos and Ledford, 2009). To summarize the information on the dependence in the joint tail of the extreme drought events, we utilise the fragility index (Geluk et al., 2007). Results show that droughts also occur frequently in winter. Moreover, it is very common for one site to suffer dry conditions, whilst neighboring areas experience normal or even humid conditions. Interpolation is thus difficult. Bivariate extremal dependence is present in the data. However, most stations are at least asymptotically independent. The according fragility indices are important information for risk calculations. The emerging spatial patterns for bivariate dependence are mostly influenced by topography. When looking at the dependence between more than two stations, it shows that joint extremes can occur more often than randomly for up to 6 stations, this depends on the distance between the stations.

References

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