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Sensitivity of the Standardized Streamflow Index for drought to the choice of probability distribution, parameter estimation method and high-flow magnitude

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A pivotal step towards reducing the risk of streamflow drought impacts is the monitoring and analysis of the streamflow drought hazard. Traditionally, quantile-based approaches such as streamflow percentiles or the threshold level method have been used to characterize the drought hazard of ongoing and past streamflow drought events. More recently, the use of the Standardized Streamflow Index (SSI) has become more popular. However, there are various approaches to compute the SSI and up to now, no consensus has been reached on which procedure is preferable. In this study, we investigated the sensitivity of the SSI, and drought characteristics derived from SSI time series, to the choice of 1) probability distribution and 2) parameter estimation method. In addition, we tested the sensitivity of the SSI for drought to the magnitude of high flows. We computed 12 different SSI time series (six different probability distributions derived with two different parameter estimation methods) for a set of catchments (n=369) located across Europe. SSI time series derived from probability distributions that showed a poor fit with the empirical distribution were removed and the remaining SSI time series were compared among each other. Overall, the SSI for drought was found to be sensitive to the choice of probability distribution and parameter estimation method. This has implications for, e.g., drought research as the use of a different method results in different drought characteristics and consequently hinders a fair comparison between studies. Also, drought characteristics, such as the number of below threshold events, were often found to be not comparable over space and time which limits a fair comparison between stations and calendar months. In addition, the impact of high flow magnitude on the SSI for drought is unwanted as changes in drought characteristics are not anymore solely related to changes in low flow magnitude. Other implications are related to drought monitoring as the exceedance of a certain threshold or trigger-level depends on the used method. It is therefore debatable whether the use of the SSI should be preferred over the use of quantile-based approaches.