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Regional frequency analysis of streamflow drought duration and deficit volume

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A regional model for drought frequency analysis is presented. The model is based on the threshold level approach for defining drought duration and deficit volume from time series of streamflow data. The widely applied regional index-flood method in flood frequency analysis is extended to drought analysis considering both annual maximum and partial duration series of drought characteristics. To evaluate and quantify the regional heterogeneity of the drought series L-moment analysis and generalized least squares (GLS) regression are applied. In the case of significant regional variability the potential of dividing the region into more homogeneous sub-regions according to catchment descriptors is analysed using a split-sample regionalisation procedure. To allow drought estimation at ungauged sites the index parameter is regionalised using GLS regression with catchment descriptors. L-moment analysis is applied for determination of a proper regional distribution.

The regional estimation procedure is applied to a regional data set from Baden-Württemberg, Germany that includes data from 46 stations. The analysis shows that the sample of all sites comprises a significantly heterogeneous region. Division of the sites into wet and dry catchments according to mean annual precipitation and a further division of the wet catchments with respect to the average hydraulic conductivity provide three acceptably homogeneous regions. For estimation of the index parameter regression models that relate the mean value of the drought characteristics to land use, morphometry, soil characteristics and mean annual precipitation are derived. The L-moment analysis reveals that the Gamma distribution is adequate for describing both duration and deficit volume. The resulting regional models allow estimation of the T-year drought duration and deficit volume and associated uncertainties at an arbitrary location (gauged as well as ungauged) in the region.