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Statistical Modeling of Low Flow Conditions based on Climatic Indicators

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Regression-based approaches in climate change impact assessment may pose a practical alternative to the application of process-based hydrological models, especially with respect to low flow extremes. Extended durations and spatial dimensions allow for a quantitative assessment and exploitation of the interrelations between atmospheric driving forces and streamflow response during dry periods, and eventually for the prognosis of future low flow conditions based on climate model input. This study aims at using combinations of climatic indicators, quantifying a variety of meteorological drought characteristics, to model specific low flow indices, based solely on multiple linear regressions. The area under investigation is the federal state of Lower Saxony, Germany. Daily time series of climate and streamflow data pose the basis for calculation of a set of meteorological and hydrological indices, serving as regressors and regressands, respectively. Two approaches are being analyzed: a) a station-based approach, fitting a specific regression equation at each discharge gauge with sufficient record length, and b) a regional approach, enabling the estimation of low flow indices at ungauged sites and stations with minor record length. The station-based procedure is used for estimation of annual low flow index values from annual meteorological conditions. Subsequent fitting of distribution functions to the estimated values allows for the assessment of return periods of the low flow indices. The regionalization, on the other hand, is designed to directly estimate the shapes of the distribution functions by applying L-moment regressions, enabling a direct assessment of specific index values for the return periods in demand.