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Linear and non-linear regional low-flow frequency analysis

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Generalized Additive Models (GAMs) are introduced in this study for the regional estimation of low flow characteristics at ungauged basins. GAMs add more flexibility in the shapes of the relationships between the response and the explanatory variables in comparison to the more commonly used linear models. A comparison of GAM with a number of approaches adopted for the regionalization of low flows is presented. Regional low-flow frequency analysis approaches are based on the transfer of low-flow information from homogeneous regions using a set of measurable physiographical and meteorological catchment attributes. In the present work, the identification of homogeneous regions is performed using three commonly used methods: hierarchical cluster analysis (HCA), canonical correlation analysis (CCA) and region of influence (ROI). CCA and ROI are based on the definition of a neighborhood for each target basin separately. On the other hand, HCA defines a set of fixed geographically non-contiguous groups of basins. In the present study, regional estimation of low flow characteristics at the target site is carried out using multiple linear regression (MLR) and GAM. Different combinations of methods for the delineation of groups of basins and methods of regional estimation are hence defined. GAM is also applied to the whole study area without the use of a delineation technique to access its robustness. The method of spatial interpolation (SI) is also tested in the present work and compared to the other techniques. The case study is represented by seasonal low flow quantiles for a set of 190 stations in the province of Quebec, Canada. Results indicate that the GAM approach leads to improvements in the estimation of summer and winter low flow quantiles, especially if it is combined to a homogeneous region delineation method. Future work should focus on the use of other non-linear estimation methods for the regional estimation of low-flow characteristics.