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A comparison of Top-kriging and regional regression for low flow regionalisation

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Two different stochastic low flow regionalisation techniques are compared. Top-kriging, the first technique, is based on the spatial correlation of low flows. Specific low flows are considered as realisations of a spatial variable which is defined only in points along the river network, and whose support is the catchment area. Top-kriging, as opposed to Ordinary-kriging, uses a regularised variogram to describe spatial correlation between measured data with different support (catchment area). This approach is also appropriate for nested catchments. As a consequence, Top-kriging takes the area and nested nature of catchments into account. Regional regression, the second technique, is based on a linear relationship between low flows and multiple catchment descriptors. For hydrological heterogeneous regions, the regional regression model consists of separate component regressions for homogeneous sub-regions. A model is used here which distinguishes eight regions of similar low flow seasonality which have been determined by seasonality analysis. Ordinary least square regression requires non-nested catchment structure. In order to exploit the information of nested catchments, we disaggregated them into residual catchments.

The assessment of regionalisation techniques is based on an Austrian dataset consisting of q95specific low flows and 31 catchment characteristics for 320 gauged catchments. Predictive performance of both techniques was assessed by cross-validation. Results indicate that both regionalisation techniques perform well for the Austrian setting. On average over the study area, regional regression leads to slightly lower prediction errors, and therefore yields somewhat better low flow estimates. Top-kriging, however, is easier to apply since no catchment descriptors need to be determined. This

is a clear advantage for regions where geographical information is scarce. The success of Top-kriging mainly depends on the (intrinsic) homogeneity and the density of the gauging network in the region. Top-kriging is therefore best suitable for larger catchments along with a dense gauging network. Regional regression, however, is better suitable for smaller catchments or headwater catchments, where gauging network is typically scarce. Also local heterogeneity, if apparent in catchment characteristics, is better handled by regional regression, because the intrinsic variogram does not capture local heterogeneity.

A merit of both techniques is the specification of estimation uncertainty. This is notably important for the main purpose of regionalisation, i.e. predicting at ungauged sites. The uncertainty of Top-kriging is given by the Kriging variance, the uncertainty of regional regression is the prediction error of regression for a single data point. Hence both techniques are fully in line with the main goals of the IAHS Decade on Predictions at Ungauged Basins (PUB), optimal prediction and predictive uncertainty of hydrological variables.