Geophysical Research Abstracts
Vol. 18, EGU2016-5708, 2016
EGU General Assembly 2016

Regionalization of low flow indices in Lower Saxony

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For the purpose of finding an effective model to estimate low flow indices at ungauged sites within the Federal State of Lower Saxony in the north of Germany, several approaches for the regionalization of streamflow related variables are tested and evaluated. These include multiple linear regression (MLR), Ordinary Kriging (OK), External Drift Kriging (EDK) and Topological Kriging (TK).

In a first preliminary step mean low flow index values are calculated for the period from 1988 to 2009 at gauges with sufficient record length. Records of smaller lengths or temporal deviation from the main period are adjusted using a simple linear regression approach with neighboring long-record stations and are weighted according to model performance. In this way, a total of 238 observed mean index values are obtained throughout the study area that serve as the target variable for all regionalization approaches tested.

The first method applied to the data set is the MLR, were the target variable is modeled as a function of various physiographic catchment descriptors. Prediction performance is expected to improve through division of the study area into a set of homogeneous regions, using a k-means clustering approach and fitting an individual regression model for each region.

The second set of methods tested is of geostatistical nature. The OK approach is tested by treating catchment centers as points to which the theoretical variogram is fit. The OK is extended by including the catchment descriptors selected as regressors in the MLR model as external drift variables in the EDK. The final method to be applied is the TK, a block-Kriging method accounting for both areal extent and nesting of catchments.

Performances of all approaches are evaluated using a cross-validation procedure. The EDK proves as the most successful method when modeling the entire study area, but is outperformed by the MLR approach for homogeneous regions. The single MLR model for the entire study area still shows better performance than the TK. The OK approach turned out to be the least successful among the applied methods. The overall performance of the regionalization methods is rather poor compared to similar case studies, which can be potentially attributed to corrupted streamflow data through anthropogenic intervention.