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Reduction of uncertainty of hydrological modelling using different precipitation inputs

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Precipitation is one of the main sources of uncertainty in hydrological modelling, due to its high temporal and spatial variability. A dense network of rain gauge stations or a combination with, e.g., radar data is needed to account for the - in comparison to other climatic elements - pronounced variability. The density of existing station-networks is low in many countries worldwide. Alternative approaches that use additional information should be applied to improve the estimation of areal precipitation.

Within the project „International Research Alliance Saxony" (http://www.iwas-sachsen.ufz.de/), one subproject aims at a system analysis of a meso-scale catchment of the Western Bug in Ukraine. Effective and sustainable measures have to be identified to improve the water quality of the Western Bug under the premise of upcoming changes of climate, land use and socio economy. An exact quantification of the water balance is needed as a pre-requisite for a matter balance. This contribution demonstrates possibilities to reduce the uncertainties of water balance modelling of the catchment Kamianka-Buzka/ Western Bug (2560 km^2) by applying and combining alternative precipitation inputs.

Available precipitation data were undergone an extensive quality check and were bias corrected. The Soil and Water Assessment Tool (SWAT, http://swatmodel.tamu.edu/) was used for water balance modelling. By default, meteorological observations are incorporated into SWAT using the *station* that is nearest to the centroid of each sub-catchment. Two alternative precipitation inputs were applied: 1) Data of 20 stations were *regionalized* using kriging methods. 2) The output of the Regional Climate Model *CCLM* that was set up for the region was used. After a pre-calibration of the model, three models - having different precipitation inputs - were set up and calibrated independently applying the auto-calibration procedure Sequential Uncertainty Fitting (Abbaspour et al. 2004). The performance of the models was evaluated with the Nash-Sutcliff-Efficiency coefficient (NSE) and the R^2 between observed and modelled runoff.

The model *Stations* performed better (R^2/NSE: 0.66/0.61) than *CCLM* and *Regionalized* (0.54/0.54 and 0.57/0.53). Uncertainty of the hydrologic modelling (POC and d-factor) could not be reduced applying the alternative models. A promising method to improve the model performance and reduce the uncertainty is model averaging. Two model averaging methods were tested: arithmetic mean of the ensemble and a weighted mean (depending on NSE). The results show that the model performance could be improved (R^2/NSE: 0.67/0.67) and the uncertainty reduced. Differences between the applied model averaging methods were marginal. Although not all observations could be reproduced, neither by the single models nor the ensemble averages, it was illustrated that combining different precipitation inputs improved the hydrologic predictions. Further calibration runs as well as the application of Bayesian Model Averaging are envisaged as next steps.

Reference:

Abbaspour, K. C., Johnson, C., & van Genuchten, M. T. (2004). Estimating uncertain flow and transport parameters using a sequential uncertainty fitting procedure. Vadose Zone Journal, (3), 1340-1352.