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Influence of rainfall observation network on model calibration and application

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Hydrological modeling and forecasting require precipitation data as one of the most important input. Precipitation often varies significantly over space and time within a basin and it is generally interpolated from the available point raingauges over the investigated area. Uncertainty in precipitation is due to the result of variability in time and space and measurement errors.

The objective of this study is to investigate the influence of the spatial resolution of the rainfall input on the calibration of the conceptual rainfall-runoff HBV-IWS model. The analysis is carried out by varying the distribution of the raingauge network and by considering different validation period.

Firstly, the HBV-IWS model is calibrated with the precipitation interpolated from the available observed rainfall of varying raingauge networks. An automatic calibration method based on the combinatorial optimization algorithm simulated annealing is applied. For this optimization, aggregated Nash-Sutcliffe coefficients at different time scales are used as objective function. The calibrated model is then validated using the same precipitation used for the calibration as well as interpolated precipitation based on networks of reduced and increased raingauge density.

In a second set of experiments, a new spatial representation of the rainfall input is considered: the precipitation is generated using multiple linear regression technique at specific locations (treated as missing measurements) of a selected raingauge network; the observed precipitation is considered at the remaining locations of the raingauge network. The model, calibrated with the complete set of observed data, is then run in the validation period using the above described precipitation field.

The simulated hydrographs obtained in the two sets of experiments are analyzed through the comparisons of the computed Nash-Sutcliffe coefficient and several goodness-of-fit indexes. The results show that the model using different raingauge networks might need recalibration of the model parameters: model calibrated on sparse information might perform well on dense information and model calibrated on dense information fails on sparse information. Also, the model calibrated with complete set of observed precipitation and runs with incomplete observed data in associated with the data generated using multiple linear regression technique, at the locations treated as missing measurements, perform well.

A meso scale catchment located in the southwest of Germany has been selected for this case study.