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Approaches to handle data of low quality in hydrological modelling

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Hydrological modelling is an important tool for many applications in water resources engineering. It is widely used for designing storage reservoirs, flood protection measures or for prediction purposes. Therefore the quality of the required input data and the used hydrological model have a significant influence on the quality of the results and, consequently, on the reliability for the mentioned objectives above.

Many factors affect the usefulness of data and models. In the first place, the number and spatial distribution of observation points build the base for all subsequent processes. Secondly, the quality of the input data, e.g. discharge, precipitation, has to be checked. It is known that rain gauge measurements underlie a high uncertainty, especially during periods with high rain intensities or snowfall. Last, the choice of the model according to the objective of its usage is the determining factor. Under such conditions a reliable assessment of the uncertainty is required.

This contribution will focus on the described items and try to provide approaches on how to handle the presented problems. A hydrological model usually needs areal information of specific input data. The density and distribution of gauging stations lead to uncertainty if a spatial interpolation of the measures is applied. In the case of a high topographic variability within a catchment, uncertainties through the underestimation of rainfall amounts at exposed stations can occur. Drifts of rain or snow by wind are a central issue at this point.

Common interpolation methods of precipitation are different forms of kriging which provide only the best estimate at the ungauged locations. However, these methods cannot correctly quantify the associated uncertainty of the estimation. Thus, this contribution applies a new method of random mixing of spatial random fields with the ability to incorporate equality and inequality constraints. Such conditions are applied to exposed gauging stations on different elevation levels. Instead of an interpolated kriging field, a number of simulated realizations of precipitation are passed to a hydrological model. This approach allows a better assessment of the uncertainty induced by the lack of spatial information at ungauged locations as well as the measurement inaccuracy under certain meteorological conditions at certain conditional points.

The applied hydrological model has a lumped configuration and requires as input data just discharge, precipitation, temperature and evapotranspiration. Based on the comparatively simple model set-up it is checked if a distributed external pre-processing of the input data on a high spatial resolution yields a gain of information and an improved model performance. This is shown by using the example of temporal and spatial snow distributions. Hereby it is investigated if a simple model approach combined with an elaborated pre-processing is sufficient or even improving, for instance, the prediction of snowmelt caused flood events.

The results are presented on the basis of a catchment in south-eastern Bavaria, Germany. The catchment is characterized by its high topographic variability. In addition, the measuring network is very unbalanced within the catchment and contains regions with very rare coverage of gauging stations. There, measured data of low quality can have an essential impact on spatial interpolations, model results and, finally, on the predictions.