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Bayesian uncertainty assessment of rainfall-runoff models for small urban basins – the influence of the rating curve

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In hydrological flood forecasting, the problem of quantitative assessment of predictive uncertainties has been widely recognized. Despite several important findings in recent years, which helped to distinguish uncertainty contribution from input uncertainty (e.g., due to poor rainfall data), model structure deficits, parameter uncertainties and measurement errors, uncertainty analysis still remains a challenging task. This is especially true for small urbanized basins, where monitoring data are often poor. Among other things, measurement errors have been generally assumed to be significantly smaller than the other sources of uncertainty. It has been also shown that input error and model structure deficits are contributing more to the predictive uncertainties than uncertainties regarding the model parameters (Sikorska et al., 2011). These assumptions, however, are only correct when the modeled output is directly measurable in the system. Unfortunately, river discharge usually cannot be directly measured but is converted from the measured water stage with a rating curve method.

The uncertainty introduced by the rating curve was shown in resent studies (Di Baldassarre et al., 2011) to be potentially significant in flood forecasting. This is especially true when extrapolating a rating curve above the measured level, which is often the case in (urban) flooding. In this work, we therefore investigated how flood predictions for small urban basins are affected by the uncertainties associated with the rating curve. To this aim, we augmented the model structure of a conceptual rainfall-runoff model to include the applied rating curve. This enabled us not only to directly modeled measurable water levels instead of discharges, but also to propagate the uncertainty of the rating curve through the model. To compare the importance of the rating curve to the other sources of uncertainty we estimated them along with other model parameters from available water level measurements using a Bayesian framework.

The approach was tested on the Sluzew creek catchment in Poland (Warsaw), where a dedicated monitoring campaign was performed from 2007 to 2009. The rating curve parameters were informed from a few reference measurements, which were performed for the monitoring cross section. The results of our case study indicate that the uncertainty contribution from the rating curve was found to be higher than those of the model parameters and, consequently, the rating curve method can introduce a significant error into the model. Treating the rating curve independently may lead to overconfident predictions. To provide decision makers with reliable measures of predictive uncertainties we therefore recommend to integrate the rating curve within the model for uncertainty analysis.

References:
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