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Reduction of model structure bias in the prediction of critical source areas

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Effective mitigation strategies to reduce the contamination of surface waters by agrochemicals rely on an accurate identification of critical source areas (CSA). We used a spatially distributed hydrological model to identify CSA in a small agricultural catchment in Switzerland. Since the knowledge about model parameters is coarse, prior predictions of CSA involve large uncertainties. We investigated to which degree river discharge data can constrain parameter values and improve the prediction. Thereby, we combined the prior knowledge used for the prior prediction with additional river discharge data within a Bayesian inference approach. In order to consider the effect of uncertainty in input data and in the model structure we formulated the likelihood function with an autoregressive error model additive to the river discharge calculated by the deterministic hydrological model. The additional information gained from river discharge data slightly reduced the width of some of the marginal parameter distributions and the prediction uncertainty for high or low-risk areas. However, the analysis of the statistical assumptions of the inference process revealed deficits in the model structure. Thus the base flow during dry periods tended to be overestimated. By making the percolation process water table dependent the base flow prediction could be improved. These improvements in model structure significantly reduced the model structure bias and thus improved the statistical basis of the probabilistic CSA prediction. Furthermore, the improved model structure led to a large constraint of the CSA prediction uncertainty.