Uncertainty analysis of a conceptual hydrological model by the Metropolis Hasting algorithm and GLUE method

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Uncertainty assessment of hydrological models is one of the most important and difficult topics in hydrology research now. Many studies using different methods have been carried out and different results are reported in the literature. Uncertainty assessment methods can be broadly classified into two groups, i.e. the Bayesian method and the Generalized Likelihood Uncertainty Estimation methodology (GLUE). Previously published results have shown that the determination of the likelihood function is the key point in the Bayesian method which determines the successfulness of the method. While the threshold values and ranges of parameters are the important factors influencing the results of the GLUE method.

This study makes a comprehensive evaluation about the parameter and predictive uncertainty estimated by the GLUE and the Metropolis Hasting (MH) algorithm, which is based on Bayesian inference, for a well-tested conceptual hydrological model (WASMOD) in an arid basin of North China. For deriving the likelihood function for the MH algorithm, it is convenient to have the simulation errors (1) normally distributed with zero mean and constant variance, and (2) time independent. In this study the Normal Quantile transform (NQT) is used to transform variable into a Gaussian distribution and the AR (1) Gaussian error model is used to remove the time dependence of residuals. As for the GLUE method, the dependence of the results on the threshold values and the ranges of the parameters are investigated.

The results show that: (1) the parameter posterior distributions estimated by the Metropolis Hasting algorithm are sharper and narrower than those by the GLUE method; (2) the best Nash-Sutcliffe efficiency of the estimated discharges derived by Metropolis Hasting algorithm and GLUE are nearly the same; and (3) however the posterior distribution of parameters and the 95% confidence intervals of the simulated discharge by GLUE are significantly impacted by the threshold values and the ranges of parameters.

Key words: Metropolis Hasting, Bayesian method, GLUE, hydrological model, Normal Quantile Transform, autoregressive, likelihood function