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Assessment of Sensibility of Different Hydrological Models on Rainfall Spatial Variability: A Case Study

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Hydrological model has been proved to be an effective way in rainfall-runoff simulating. Currently, there exists a large number of hydrological models, covering from conceptual models to physically-based ones. However, it is really a problem to choose a model for a given basin and there has no general standard of that. Since rainfall is one of the most important input-variables for hydrological models, identifying the sensibility of different models on various spatial accuracy of precipitation observation could be quite helpful in model selecting. Traditionally, precipitation is measured by rain gauges and therefore the density of rain gauges could represent the distribution of rainfall data. In this study, 4 typical hydrological models, Easy Distributed Hydrological Model (EasyDHM), the Water and Energy Transfer between Soil, Plants and Atmosphere (WetSpa) model, the Xinanjiang model and HYdrological MODel (HYMOD), are applied to the Jinjiang River basin (with the area of 6215 km2), a sub-catchment of Ganjiang River in China. The subbasins are equally identified to minimize the impact of the spatial structure among the models. Several scenarios are used in which the number of rain gauges reduces from 20 to 5 representing the decrease of spatial resolution of precipitation. The performance of all 4 models in the scenarios are examined and indicators including relative bias (BIAS), root-mean-square error (RMSE), and Nash-Sutcliffe coefficient efficiency (NSCE) are used for the comparison purpose. The result shows that in the scenario of highest rainfall spatial resolution (20 gauges), HYMOD has the highest NSCE (0.869 in validation) with larger uncertainty in result. Generally, the Xinanjiang model is the most suitable model for the study area because it performs quite stable among all the scenarios and has the highest daily runoff estimation accuracy (NSCE reaches 0.818 in validation) in the scenario that has only 5 gauges in total. The conclusion is drawn that model with more detailed parameterization scheme may not be suitable for less gauged area because the information presented by precipitation are not enough to calibrate the parameters. Meanwhile, the conceptual model could lead to comparable estimation of rainfall-runoff response with physically-based ones under the condition of enough inputs. But it may get results with less stability after model calibration due to its conceptual structure.