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Testing the usefulness of hydrological models in simulating extreme streamflows for frequency analysis purpose

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Abstract:Recently, extreme flood events are becoming more uncertain and greater challenge in the world. Flood frequency analysis is a powerful tool to study and evaluate extreme flood events, and also a key step in design of water resources projects. Hydrological models have been used as an important tool for forecasting extreme flood event and design flood calculation. However, there are little studies on evaluation of the reasonability of flood frequency values obtained from runoff simulations of watershed hydrological models. In this study, the reasonability of the flood frequency analysis obtained from runoff simulations of different hydrological models is evaluated and analyzed by comparison with that from historical runoff observation. Xiangjiang basin, one of the most important economic belts in Hunan Province, is selected as the study region. Xiangjiang basin is always in a severe situation for flood control in summer and has also great influences on Dongting Lake's flood storage capacity. In this study Xiangjiang Basin was divided into 3 sub-basins and 1 downstream section, which have their outflow stations respectively. Each region has integrated and long observed historical runoff and rainfall series from 1961 to 2005. Three conceptual hydrological models, i.e. Xin-anjiang, HBV and WASMOD were established to simulate runoff in each sub-basins of Xiangjiang basin. To utilize the simulations from three hydrological models for frequency analysis, a transformation from deterministic rain-runoff models to stochastic models is needed by adding the model residuals to the simulated discharges using Monte-Carlo method. The commonly used Pearson type III distribution in China and L-moment were used to calculate the frequency. All three hydrological models perform well according to commonly used model evaluation criteria, i.e. Nash–Sutcliffe model efficiency coefficient and water balance error, etc. However, the frequency analysis results of annual maximum flow simulated by three models are rather different. The study provided a detailed explanation and evaluation in the possible usefulness of hydrological models in flood frequency studies.

Keywords: Climate change; Flood frequency analysis; hydrological models, Xiangjiang basin; China