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Climate-informed bivariate flood frequency analysis based on Bayesian theory and Copula function

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Traditional flood frequency analysis is performed under the stationary assumption that flood characteristics fluctuate within an unchanging envelope of variability. However, with global climate change and intensified human activities, stationary approaches can no longer capture the fast changing characteristics of flood events. Thus, this study aims to provide a bivariate nonstationary flood frequency analysis model of the peak and volume from 1953 to 2013 in the Three Gorges Dam (TGD). Three types of models were established and rigorously compared to evaluate the usefulness and weakness of the proposed models, including: (1) stationary model; (2) time-informed model and (3) climate-informed models with two covariates and three covariates. The result showed that the flood peak and flood volume of the TGD have a close relation and both represented a decreasing trend in 1953-2013 by M-K test. When fitting the flood distributions, the climate-informed model with three covariates exhibited the smallest uncertainty, best performance of fitting and the most complex. Time-informed model is relatively simple and the performance is the next. The stationary model exhibited the worst and traditional stationary flood frequency analysis of single variable may be no longer sufficient for the TGD. For prediction, climate-informed models performed the best after cross-validation, which can provide the basis for dynamic management strategies of floods before flood seasons and we can prepare in advance for the coming extreme floods. Time-informed model predicted badly and just equal to the observed even though the floods have a notable down trend.