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Nonstationary Modeling of Extreme Precipitation in the Wei River Basin, China

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Abstract : Under the impact of global warming together with the intensification of human activities, the hydrological regimes may be altered, and the traditional stationary assumption was no longer satisfied. However, most of the current design standards of water infrastructures were still based on the hypothesis of stationarity, which may inevitably result in severe biases. Many critical impacts of climate on ecosystems, society, and the economy are controlled by extreme events rather than mean values. Therefore, it is of great significance to identify the non-stationarity of precipitation extremes and model the precipitation extremes in a nonstationary framework. The Wei River Basin (WRB), located in a continental monsoon climate zone in China, is selected as a case study in this study. Six extreme precipitation indices were employed to investigate the changing patterns and stationarity of precipitation extremes in the WRB. To identify if precipitation extremes are stationary, the Mann-Kendall trend test and the Pettitt test, which is used to examine the occurrence of abrupt changes are adopted in this study. Extreme precipitation indices series are fitted with non-stationary distributions that selected from six widely used distribution functions: Gumbel, lognormal, Weibull, gamma, generalized gamma and exponential distributions by means of the time-varying moments model generalized additive models for location, scale and shape (GAMLSS), where the distribution parameters are defined as a function of time. The results indicate that: (1) the trends were not significant for the whole WRB, but significant positive/negative trends were still observed in some stations, abrupt changes for consecutive wet days (CWD) mainly occurred in 1985, and the assumption of stationarity is invalid for some stations; (2) for these nonstationary extreme precipitation indices series with significant positive/negative trends, the GAMLSS models are able to capture well the temporal variations of the indices, and perform better than the stationary model. Finally, the differences between the quantiles of nonstationary and stationary models are analyzed, which highlight the importance of nonstationary modeling of precipitation extremes in the WRB.

Keywords : extreme precipitation, GAMLSSS, non-stationary, Wei River Basin
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