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Nonstationary frequency analysis for annual runoff and sediment load of the Wujiang River

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The hydrological series can no longer meet the stationarity hypothesis due to the influence of climate variability and human activities. The process of runoff and sediment load changed significantly under a changing environment. Analyzing the variations of runoff and sediment load and exploring the main influencing causes leading to their changes will be of great help to understand the dynamic process of water and sediment in river basin. Many studies have considered the effects of rainfall and reservoir on the downstream runoff or sediment: the impact of rainfall on runoff or sediment load is normally performed by comparing the statistical characteristics before and after an extreme weather event (e.g. heavy rain of the Yangtze river in 1998); the effect of reservoirs is usually determined by comparing the pre-dam and post-dam frequencies of runoff or sediment load. In this study, the major influencing factors of annual runoff and sediment load in Wujiang River basin were identified firstly based on the results of trend analysis and change-point diagnosis for runoff and sediment load. Then, Generalized Addictive Models in Location, Scale, and Shape (GAMLSS) is used to describe the rainfall and reservoir impacts on nonstationarity of runoff and sediment load, in which, distribution parameters (including the location, scale and shape parameter) are expressed as a function of the explanatory variables. The results show that: (1) runoff and sediment load of Wujiang River decrease with the intensification of climate change and human activities; (2) runoff is mainly affected by rainfall, the operation of cascade reservoirs has critical effect on the sediment load; (3) the correlation between runoff and sediment closely related to the nonstationarity of sediment load, namely, the sediment load change can directly lead to the alteration of dependence between runoff and sediment.