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Rainfall stochastic prediction based on its characteristic analysis of two typical regions in Yangtze River Delta, China

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Because of the impacts of both global climate changes and human activities, nonstationary variability are growing increasingly concerned in the worldwide hydrological processes in recent years, which has posed a challenge to the study on the hydrological processes and the hydrological extremes, such as droughts, rainstorms, floods and waterlogs, etc. With the development of the hydrological methods and technology, nonstationarity in hydrology has been becoming a hot topic in the hydrology research. In this study, methods of stochastic hydrology such as component analysis and stochastic models are used for the analysis of rainfall characteristic based on hydrological nonstationarity and applied to the rainfall prediction on different time scales of Xujiahui Station in Shanghai and Huxi hilly district of the Taihu Lake basin, both of which are typical regions in Yangtze River Delta, China. Shanghai has been greatly influenced by the urban waterlogs mainly caused by the flood season rainstorms, and there is no suitable rainfall prediction mode in Huxi hilly district. Thus, the study will make contributions to the local rainfall prediction, water resources management and flood control. The rainfall time series on different time scales, including day, year and flood season have been selected to analyze rainfall characteristic from time domain, space domain and frequency domain. In the time domain, the deterministic components including the trend, the mutation and the periodic components are identified and removed with component analysis. Specifically, we use Kendall rank correlation test and Spearman rank correlation test for the trend analysis, the cumulative curve method and rank sum test for the mutation analysis and the simple partial wave method for the periodic analysis. In the space domain, an animation is made in ArcGIS environment with spatial interpolation method, which shows how the variables including rainfall, climate and underlying surface evolve with a changing space. In the frequency domain, the characteristic of frequency distribution of the rainfall variables with different frequency ranges are analyzed. The correlation between the rainfall variables and other variables, such as climate and underlying surface is analyzed with the multiple correlation analysis. The results of the rainfall characteristic analysis reveal the nonstationary variability of the local rainfall processes, and can be a basis of rainfall prediction for the two regions. The flood season rainfall prediction at Xujiahui Station in Shanghai is implemented by separating the deterministic components and stochastic components from the series. The former can be predicted based on the results of the above-mentioned component analysis, and different models are established for the simulation of the latter, including the improved periodic mean superposition model, auto regressive model, threshold auto regressive model, gray model(1,1), BP neural network and RBF neural network. The linear superposition of the two parts is the final predicted results. As for the rainfall prediction of Huxi hilly district of the Taihu Lake basin, the rainfall-runoff pattern in this area is further studied, and the rainfall predicting model aimed at this area is finally established. Results have shown the feasibility and effectiveness of the rainfall prediction based on the analysis of rainfall characteristic with stochastic methods to deal with the hydrological nonstationarity.