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Assessing the impacts of climate variability and human activities on runoff with a nonlinear hybrid model

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Understanding the contributions of potential drivers on runoff is of great importance for the sustainable management of water resources. In this study, we develop a nonlinear hybrid model, which integrates extreme-point symmetric mode decomposition (ESMD), back propagation artificial neural networks (BPANN) and weights connection method, to represent the relationships between different drivers and runoff. ESMD allows to decompose the times series of drivers and runoff into different components. BPANN is then employed to simulate the relationship between the drivers and runoff at each time scale separately. The performance of this model is compared with multiple linear regression (MLR). We select the mountainous area of the Hotan River Basin as case study area. The results indicated that runoff exhibits oscillation periods of 2, 9 and 14 years. Climate variability strongly affects runoff and accounts for 81% of the runoff variation, while human activities play a minor role, accounting for 8%. In all performance measures, the proposed model substantially outperforms MLR. The proposed model can represent nonlinear relations and simulate the association between drivers and runoff at different time scales (even opposite associations), which is the improvement of this study.