1. An adaptive middle and long-term runoff forecast model using EEMD-ANN hybrid approach

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**Abstract:** It remains a challenge to obtain an accurate middle and long-term runoff forecast, especially in flood seasons. The forecast performance can be improved using ensemble empirical mode decomposition (EEMD) to produce cleaner signals as model inputs. In many EEMD based forecast models, the entire time series are decomposed into several sub-series, and each sub-series is divided into calibration and validation datasets and forecasted by some common models, such as artificial neural network (ANN), and finally an ensemble forecast is obtained by summing the forecasted results of each sub-series. In such a decomposition-ensemble framework, some future information is used, and thus it is a hindcast experiment. Attempts have also been made to propose a real forecast experiment, which, however, often cannot be able to adapt to the non-stationary changes in runoff due to the lack of adaptive ability. Therefore, this study tries to improve the decomposition-ensemble framework and propose an adaptive middle and long-term runoff forecast model especially for flood seasons. Unlike a hindcast experiment, it does not use any future information; and unlike conventional forecast experiments, its decomposition and forecast models are adjusted adaptively as long as new runoff information is added. EEMD is used to decompose the original time series and ANN is used to forecast each sub-series, hence the name an adaptive EEMD-ANN (AEEMD-ANN) model. This model is applied to forecast the 1-month ahead streamflow of three stations in China, and the results show that the AEEMD-ANN model can improve forecast accuracy in flood seasons, but it is not as good as ANN, adaptive neuro-fuzzy inference system (ANFIS), support vector machine (SVM) and seasonal first-order autoregressive (SAR (1)) models in dry seasons. While the conventional forecast models, especially the SAR (1) models, are more suitable in dry season. Therefore, it is recommended to use SAR (1) model in dry season and AEEMD-ANN model in flood season to forecast the monthly runoff in Yangtze River Basin. © 2018 Elsevier B.V.

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