ABSTRACT

Accurate and reliable river flow forecasts are necessary for water resources planning and management. In this study, four neural network (NN) models are developed, namely NN, bootstrap based NN (BNN), wavelet based NN (WNN) and wavelet-bootstrap based NN (WBNN). Initially, a NN model is developed. To increase the generalisation capability of NN model, BNN model is developed as an ensemble of several NNs built using bootstrap resamples of input dataset. The significant wavelet sub-time series of a particular gauging station are added to construct new time series and used as input for development of WNN model. WBNN model is developed as an ensemble of several NNs built using bootstrap resamples of newly constructed time series using discrete wavelet transformation (DWT) instead of raw dataset. In this way, the WBNN model uses the capabilities of both wavelet transformation and bootstrap resampling techniques. All the models are used for daily discharge and hourly water level forecasting for 1-5 day and 1-10 h lead times, respectively at Naraj gauging station in Mahanadi river basin, India. BNN and WBNN models are also used to assess the predictive uncertainty associated with daily discharge and hourly water level forecasts. Higher order neural network (HONN) model is found to perform better than NN model, though it requires high computational time.. The performance of the four developed NN models is compared with each other as well as with multiple linear regression (MLR) and simple naive persistence models. Performance of WBNN model is found to be the best for daily discharge as well as hourly water level forecasting. Also, the performance of WBNN model is found to be significantly better than MLR and simple naive persistence models. The WBNN model also satisfies the Central Water Commission (CWC) performance evaluation criterion reasonably well. The WBNN model forecasts along with confidence bands are found to improve the reliability of forecasts to make them useful in river flow forecasting. Overall, the WBNN model emerges as a very useful tool for uncertainty assessment and ensemble forecasting. Higher order neural networks have been used for the first time in river flow forecasting and the results are promising. A new approach is proposed for selection of appropriate models for river flow forecasting using SOM which improves the prediction performance. Finally, a user friendly software is developed using Visual Basic 6.0 for daily discharge and hourly water level forecasting at Naraj gauging station in Mahanadi river basin using the developed WBNN model.

Keywords*: River flow forecasting, NNs, bootstrap, wavelet transformation, ensemble, uncertainty.*