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Assessing the Impact of Climate Change on Water and Sediment Discharges in the Dry-hot Valleys of Southwest China with Artificial Neural Network – an Example of Longchuanjiang

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The mechanism of the water and sediment discharge changes resulting from the climate change is a complex process. It is difficult to model this process, especially for the sediment transportation, with either traditional lumped or distributed model, due to both the complexity of the system and our inadequate scientific understanding about it. Artificial Neural Network was introduced into hydrological modeling in the 1990s and its ability to simulate the nonlinear system without any priori assumption of the processes involved makes it a potential tool for climate—water/sediment relationship modeling.

In this research, the application of ANNs for modeling the relationship between climate and water/sediment discharges and assessing the impact of climate change on the water/sediment discharges on monthly scale was investigated, with a case study in Longchuanjiang catchment in Upper Yangtze River, China. Climate data (precipitation, temperature, evaporation, relative humidity and day length at 5 weather stations in the catchment) and hydrological data (water and sediment discharge at Xiaohuangguayuan gauging station) from 1960 to 2001 were collected for this research. To do the simulation and assessment for water discharge, first, the average value of each climatic factor for the whole catchment was calculated with the Thiessen polygon method. The average values were then used as inputs to a standard multi-layer feedforward ANN with logistic sigmoid transfer function. The best performance ANN of this stage was constructed with the inputs which were lumped/averaged at catchment level. Second, spatial heterogeneity of climatic factors was introduced to improve the performance of ANN. Data of the dominant factors (identified by the best ANN of the first stage) at individual weather stations, without any averaging, were used as input to the ANN. At last, the optimized ANN of the second stage was run in the absence of climate change. The assessment of the impact of climate change was made by comparing the model outputs with the observed water/sediment discharges. The same method was applied for the sediment research, with water discharge at the current time as an extra input.

The results showed that the ANNs could provide satisfactory simulation for this study. The improvement of their performance could be made by introducing the spatial heterogeneity of the inputs, especially in the relative large catchment, in which the spatial distribution and difference the inputs play an important role.

Keywords: Water and sediment discharges, climate change, artificial neural network, spatial heterogeneity