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Online flood forecasting using artificial neural network

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Inspired by the functioning of the brain and biological nervous systems artificial neural networks (ANNs) provides a quick and flexible means of creating flood forecasting models. However, these models perform poorly when encountering extreme events containing previously unobserved values and thereby fail to generalize.

The present methodology for online flood forecasting combines the reliability of physically based, sophisticated modeling with the operational advantages of ANN. These operational advantages are not only extremely low in computation times, but also absolute robust and straightforward operation, which form the basic requirement for flash flood forecasting. WaSiM-ETH (Water Balance Simulation Model), a physically based hydrologic model was subsequently used for simulating all meaningful and flood relevant storm scenarios which are obtained from a catchment specific meteorological data analysis. This provides a database of corresponding input/output vectors which was then completed by generally available hydrological and meteorological data for characterizing the catchment situation prior to each storm event. This database subsequently serves for training of an ANN for portraying the rainfall runoff process. The proposed method takes advantages of both Levenberg–Marquardt Backpropagation algorithm (LMBP) and cross-validation technique to avoid underfitting or overfitting on ANN training and enhances generalization performance. Trained network architectures were tested using “unseen” simulated storm events, i.e., one which did not feature in the training process and also with real flood event of year 2002 for different lead time ranging from 6h to 48h.

The proposed methodology was applied to the Zschopau catchment (1757 km^2) of Friberger Mulde which is an East German mountainous catchment. Several ANN topologies had been tested and compared for incremental flow forecast. Three-layer

feed forward networks capable of modelling a complex rainfall runoff relationship had been observed for different prediction ranges. Demonstrated computational efficiency and the prediction reliability underline the potential of the new methodology for online flood forecasting. The results of present study also shows the improved generalization ability of ANN in predicting one of the real extreme event (year 2002 flood event) when trained with simulated events for short term flood forecasting.