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Flood Forecasting With LSTM Networks: Enhancing the Input Data With Statistical Precipitation Information

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Reliable forecasts of water level and discharge are necessary for efficient disaster management in case of a flood event. The methods of flood forecasting are rapidly developing, part of this being artificial neural networks (ANN). These belong to the data-driven models and therefore are sensitive to the quality, quantity and relevance of their input and training data.

Previous studies at the Institute of Hydrology and Meteorology at the TU Dresden used both hourly discharge and precipitation time series to model the precipitation-runoff process with ANN, e.g. Deep Learning LSTM networks (Long Short-Term Memory – a subcategory of ANN). The precipitation data were derived of area averages of radar data, in which the spatial structure of the precipitation and thus important information for rainfall-runoff modelling is lost. This is a problem especially for small-scale convective rainfall events.

As part of the KIWA project, we carry out a study with the aim of improving the reliability of flood forecasts of our LSTM networks by supplementing the input data with statistical precipitation information. For this purpose, we are adding statistical information such as area maximum and minimum of precipitation intensity, as well as its standard deviation over the area, to the area mean values of precipitation from the hourly radar data.

As this information contains details on the precipitation intensity distribution over the area, we expect an improvement of the discharge prediction quality, as well as an improvement of the timing. In addition, we expect the LSTM network to learn from the statistical information to better assess the relevance and quality of the given precipitation values and to recognize the spatial uncertainties inherent to the area means. The resulting knowledge of the network should now enable it to forecast the discharge while communicating information on the uncertainty of the current discharge forecast.

We present the preliminary results of this investigation based on small pilot catchments in Saxony (Germany) with differing hydrological and geographical characteristics.