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A comparative study of data-driven approaches for flood early warning in small catchments

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Flood early warning for small catchments is a challenging task: As the basin response is fast, proper warning lead times strongly depend on precipitation forecasts which are subject to quantitative and spatial uncertainties. In addition, gauge data in small catchments is often sparse and therefore, the hydrological regime is hardly known. In presence of these uncertainties, the benefit of different model approaches in terms of their predictive quality and their transferability to ungauged catchments is in question. For investigating this issue, two data-driven model approaches of different complexity were developed and comparatively tested. The first model is an artificial neural network for flood forecasting, in particular a two-layer perceptron feedforward network. Precipitation and discharge here serve as forcing data. The second approach is a flood potential assessment procedure. Precipitation history and precipitation forecasts are classified based on threshold values from a precipitation analysis. From this, a score of flood potential is derived. For the model evaluation a quantile-based mapping procedure is used to assign the resulting scores to catchment-specific discharge values. The two model approaches have been tested on 50 catchments in Saxony, Germany, with areas ranging from 5 to 1000 km^2. Two datasets of quantitative precipitation estimates – one from rain gauge measurements, one from radar measurements (RADOLAN) – and two datasets of quantitative precipitation forecasts – a probabilistic forecast based on expert knowledge (Quantile Forecast) and a numerical weather forecast (COSMO-DE) – are used as input data. Update cycles as well as lead times are varied within the tests. The model performance is evaluated using different statistical quality criteria. Based on a Leave-one-out cross-validation, the potential of model parameter transfer to ungauged catchments is examined. The large number and the wide range of considered catchments provide a comprehensive analysis of the potentials and limits of data-driven models for flood early warning in small catchments.