EGU23-13714, updated on 14 Sep 2023
https://doi.org/10.5194/egusphere-egu23-13714
EGU General Assembly 2023

Development of a flood prediction model for heavy rainfall based on spatially and temporally distributed precipitation using machine learning techniques

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Convective rainfall cells have a maximum prediction time of 30 to 120 minutes, which means that physically based models are usually too slow to calculate the expected flooding depths within the available time. For this reason, novel models for short-term flood and flash flood prediction are needed.

The work is being carried out as part of the WaX program and its aim is to develop a fast flood prediction model for temporal and spatial precipitation data (for example high-resolution radar forecast) and runoff-relevant soil parameters with machine learning methods for catchments with strong topography.

The developed AI model aims to predict maximum flood depths for an urban catchment (Emmendingen in Baden-Württemberg, Germany) and temporally resolved flood depths in predefined neuralgic areas. It is based on supervised learning and therefore requires a database of input and associated output for training and validation.

The effective rainfall, which is based on spatially and temporally distributed rainfall (from radar hindcast) and runoff-relevant parameters such as land use, slope, soil type and especially soil moisture, serves as the training input. The associated results for training and validation are the spatially distributed flood depth within the catchment. To build up the database both, the flood depths and effective rainfall rates, were precalculated using established hydrological respectively hydrodynamic models. To predict flood depths during real heavy rainfall events, a number of different high-resolution radar forecasts are used and combined with a range of soil moisture assumptions.

The model is a combined method, in which the hydrological processes are done by a fast and calibrated physically based model, while the time-consuming hydrodynamic calculation is replaced by machine learning methods. This leads to a utilization of the low calculation time in the range of seconds with promising accuracy compared to the results from hydrodynamic simulations. Due to the fast prognosis time it is possible to calculate a series of ensembles for different soil moisture

conditions and precipitation loads as a result of the uncertain soil moisture conditions and the uncertain radar forecast. The contribution will compare preliminary AI model predictions to the physically based model results to assess the potential and limitations of the model.