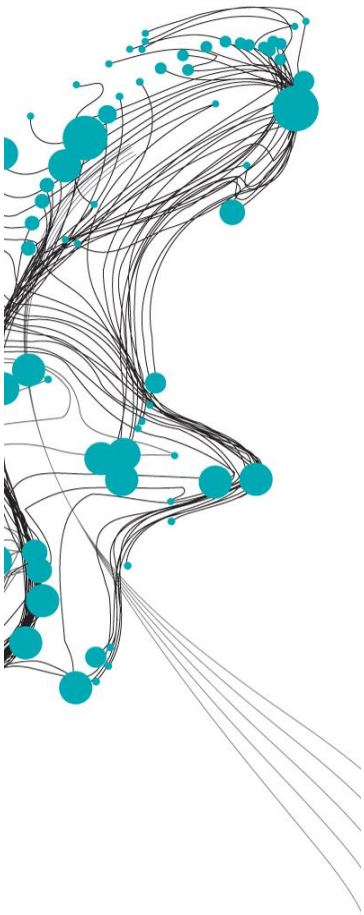
RAPID GENERATION OF PROBABILISTIC INUNDATION FORECASTS BY UTILIZING CLOUD COMPUTING AND DEEP LEARNING



Heavy rainfall events are occurring more frequently due to climate change, and can lead to inundation which poses risks for society. Inundation forecasts are crucial to alleviate these risks. The most important variable for predicting inundation is rainfall, however the uncertainty in rainfall forecasts is usually high. To include the uncertainty of the rainfall forecasts in the inundation predictions, probabilistic inundation forecasts are made. These forecasts consider an ensemble of rainfall forecasts, and predict the inundation for each ensemble member.

Conventional hydraulic models are too slow to generate probabilistic inundation forecasts, with total computation times generally exceeding one hour. This is because inundation for each of the ensemble members of the rainfall forecast has to be simulated. This study applies and analyses two methods of making probabilistic inundation forecasts fast enough to be used operationally.

The first method utilises cloud computing such that many simulations can be executed simultaneously. This significantly reduces the computational time required for making probabilistic inundation forecasts, since simulations for multiple ensemble members can be executed in parallel. In this study, cloud computing has proven to be a feasible solution, reducing the time required for probabilistic inundation forecasts to the computation time of a single hydraulic simulation.

The second method is utilising deep learning by training a neural network to make inundation predictions. The neural network trained for this study can predict inundation depths at a 10 meter resolution, and for 12 time steps. The network is trained on 1600 hydraulic simulations, and can accurately predict inundation depth progression over time. The network also performs very well in generating probabilistic inundation forecasts: For 99.6 % of the predictions the neural network inundation probability is within 2 % of the probability predicted by the hydraulic model. The neural network can generate a probabilistic inundation forecast within seconds.

Both methods of providing probabilistic inundation forecasts within an operational time frame have proven to be successful. Which method is preferred depends on the application. The neural network can make forecasts much faster, and at a negligible cost. However to do so a large number of training simulations have to be performed beforehand, and this has to be re-done when changes in the hydraulic model are required. Utilising cloud computing is more expensive and slower, but the hydraulic model used to make the inundation predictions can be changed whenever required.

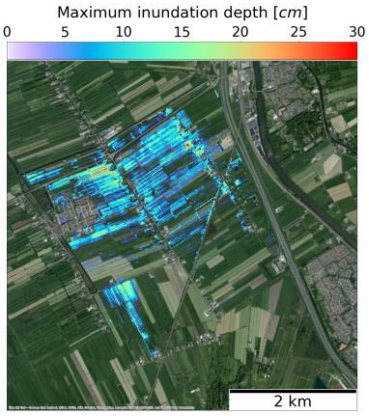


Figure 1: Example of an inundation prediction that can be made by both the hydraulic model and neural network.

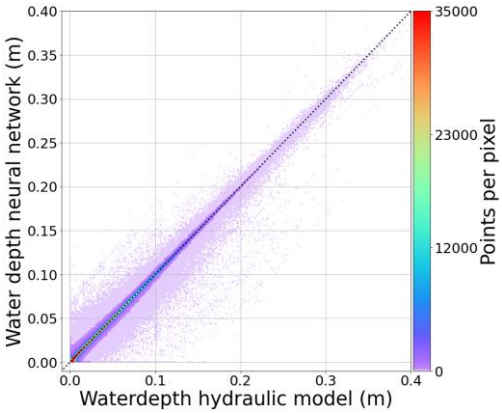


Figure 2: 2D density plot of the predictions of the hydraulic model and those of the neural network.

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