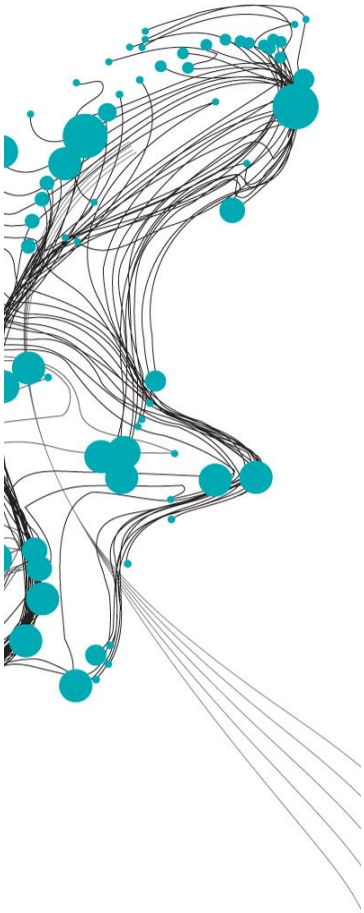
SURROGATE MODELS: A SOLUTION FOR REAL-TIME INUNDATION FORECASTING?

SURROGATE MODELLING FOR THREE CASE STUDIES IN THE NETHERLANDS.



The Netherlands is facing an increased risk of pluvial flooding due to the expected rise in the frequency and intensity of extreme rainfall events caused by climate change. Hydrological inundation models are crucial in flood mitigation as they support water managers by predicting the flooding, allowing for the implementation of appropriate measures. Hydrological inundation models must meet certain criteria to ensure the operational usability. Detailed hydrological inundation models have long computational times and are therefore impractical for the operational context. Surrogate models approximate the detailed hydrological inundation model, resulting in a reduced computational load.

Alternatively, conceptual hydrological models like the 'Waarschuwing voor Wateroverlast' (W2O) model, could be useful. This conceptual bucket model covers the entire area of the Netherlands at a spatial resolution of 1 km x 1 km and has a computational time of only a couple of minutes. In this study, the added value of surrogate models in an operational setting compared to the W2O model is investigated. Three cases studies are selected to evaluate the hydrological inundation models' compliance with the end-users' requirements.

Semi-structured interviews with the end-users took place to specify the modelling goal, perspectives for action, relevant output variables, and the required accuracy. For each case study, a surrogate model is created. For the first case study (Municipality of Amersfoort), a machine-learning model is used that predicts flood volume timeseries for all manholes in the sewage system based on rainfall timeseries as input. The machine-learning model created for the second case study (Municipality of Tilburg), predicts the maximum inundation depth using the rainfall timeseries as input. For the third case study (Hoogheemraadschap van Rijnland), a surrogate model is created based on a detailed hydrological inundation model by applying simplifications to the model schematisation. The quality of these surrogate models is assessed using the requirements from the end-user. Besides, also the quality of the W2O model is assessed using the requirements from the end-users.

Overall, it can be concluded that the W2O model provides sufficient information for municipalities in an operational setting. It is advised to further research the accuracy of the W2O model to ensure that the W2O model also meets this requirement. The machine-learning model used in the second case study has high potential. If the accuracy of this machine-learning model is improved, it has an added value to the W2O model as it is able to rapidly predict inundation depths at a high spatial resolution. For waterboards, the W2O model suffices in the information provision on the 2D grid, but additional models are needed to provide information regarding water levels in waterways. The surrogate model created for the third case study meets this need. Using the W2O model to get a general overview of the predicted inundation and combining this with a surrogate model for the most vulnerable areas, results in all information needed for end-users to make informed decisions on flood mitigation.

Figure 1: Output of the W2O model for Udenhout (Municipality of Tilburg). Probability of exceedance is defined as percentage of ensemble members that predict an inundation depth of more than 10 mm.

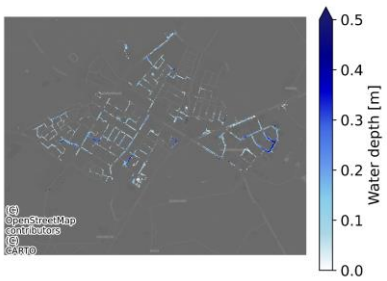


Figure 2: Output of the surrogate model created for Udenhout (Municipality of Tilburg). This machine learning model predicts the maximum water depth on surface level based on a probabilistic rainfall forecast. The figure shows the 90th percentile of all ensemble members.

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