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Case studies of extended model-based flood forecasting: prediction of dike strength and flood impacts

Dana Stuparu, Daniel Bachmann, Tom Bogaard, Daniel Twigt, Jan Verkade, Karin de Bruijn, and Annemargreet de Leeuw

Deltares, Delft,Netherlands (dana.stuparu@deltares.nl)

Flood forecasts, warning and emergency response are important components in flood risk management. Most flood forecasting systems use models to translate weather predictions to forecasted discharges or water levels. However, this information is often not sufficient for real time decisions. A sound understanding of the reliability of embankments and flood dynamics is needed to react timely and reduce the negative effects of the flood. Where are the weak points in the dike system? When, how much and where the water will flow? When and where is the greatest impact expected? Model-based flood impact forecasting tries to answer these questions by adding new dimensions to the existing forecasting systems by providing forecasted information about: (a) the dike strength during the event (reliability), (b) the flood extent in case of an overflow or a dike failure (flood spread) and (c) the assets at risk (impacts).

This work presents three study-cases in which such a set-up is applied. Special features are highlighted.

Forecasting of dike strength. The first study-case focusses on the forecast of dike strength in the Netherlands for the river Rhine branches Waal, Nederrijn and IJssel. A so-called reliability transformation is used to translate the predicted water levels at selected dike sections into failure probabilities during a flood event. The reliability of a dike section is defined by fragility curves – a summary of the dike strength conditional to the water level. The reliability information enhances the emergency management and inspections of embankments.

Ensemble forecasting. The second study-case shows the setup of a flood impact forecasting system in Dumfries, Scotland. The existing forecasting system is extended with a 2D flood spreading model in combination with the Delft-FIAT impact model. Ensemble forecasts are used to make use of the uncertainty in the precipitation forecasts, which is useful to quantify the certainty of a forecasted flood event.

From global to local forecasting. The third case explores the use of global models for local flood forecasting in Manila Bay (Philippines). The forecasting chain combines global forecasted data on storm surges, a local hydrodynamic model of the bay and the hinterland and a quantitative impact model.

All three study-cases prove the added value of extended flood impact forecasting systems: timely identification of the weak spots in the flood defence lines, expected flood spread and extent as well as expected impacts and consequences of a flood event.