Modelling erosion of pre-embankment breaches in coversand ridges in the IJssel floodplain due to major flood events in medieval times

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Abstract: Coversand ridges are natural elevated areas that formed in the last part of the glacial period due to wind transport. Some coversand ridges created a watershed between the Rhine and IJssel floodplain. Erosion of these coversand ridges was of major influence for the formation of the river IJssel as a Rhine delta distributary. A coupled hydrodynamic-erosion model is set up to simulate potential coversand ridge breach scenarios at different locations along the coversand ridges during flood events. The first results imply that breaches in the coversand ridges located at the current location of the river IJssel are the most favourable for a breach to expand.

Keywords: Coversand ridge, Erosion model, Flood events, River formation, River IJssel.

Objective

- Obtain insight into the erosion process of developing breaches in coversand ridges in the IJssel floodplain.
  - Of archeological-historical interest (Cohen, 2010).
  - Of interest for future designing projects (Cohen et Lodder, 2007).

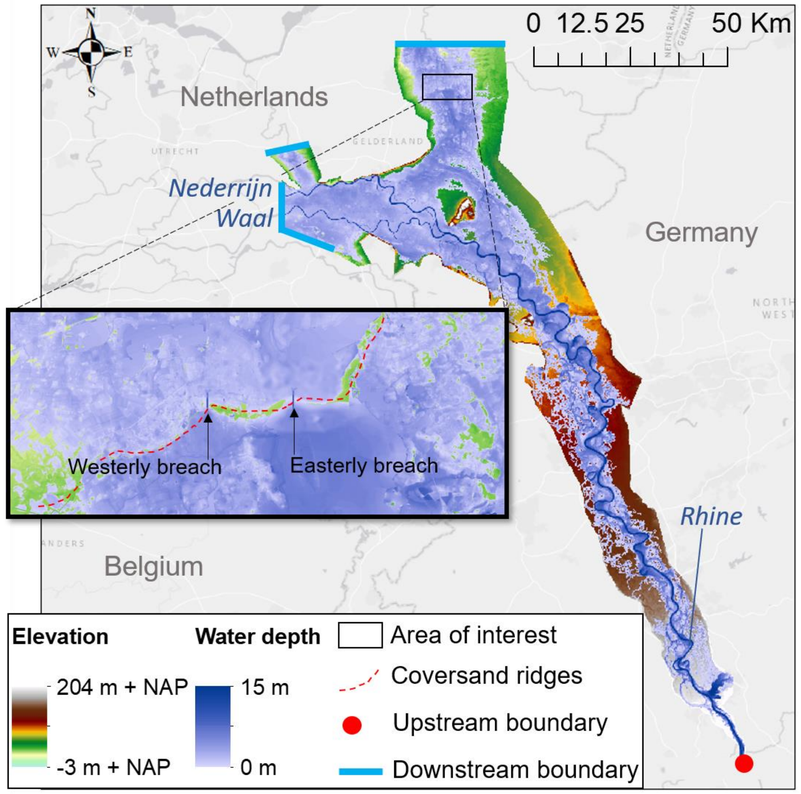

Figure 1: Representation of the flood wave extent of an extreme flood wave on the Lower Rhine floodplain before the existence of the river IJssel and the flow through the breaches in the coversand ridges

Method

- Implementation of breaches with various depths (1, 2 and 4 meters) and widths (50 and 100 meters) in a Digital Elevation Model (DEM) of the medieval times of the Rhine and IJssel floodplain set up by Van der Meulen et al. (2020).
- Set up of a hydrodynamic model analogous to Bomers (2019)
- Simulate flood waves (peak discharges of 10,000 and 14,000 m^3/s as the upstream boundary condition) over the DEM for the various breach depths and widths
- Use the output of the hydrodynamic model for erosional and sediment transport capacity computations in the breaches

Results

- Easterly breach suffers higher erosion velocities perpendicular to the bed than the westerly breach (Figure 2).
- The easterly has a larger sediment transport capacity than the westerly breach (Figure 2).
- The easterly breach discharges more water and at an earlier moment in time than the westerly breach (Figure 2).
- The statements above are true for each scenario

Conclusions

From the results can be concluded that in the easterly breach larger erosion velocities occur during a flood induced overflow and that these flow velocities occur earlier during the flood wave. The hydrodynamic conditions at that location are more favourable for a breach to expand. The results from this study substantiate why the river IJssel formed at the locations where it still flows today, the easterly location.

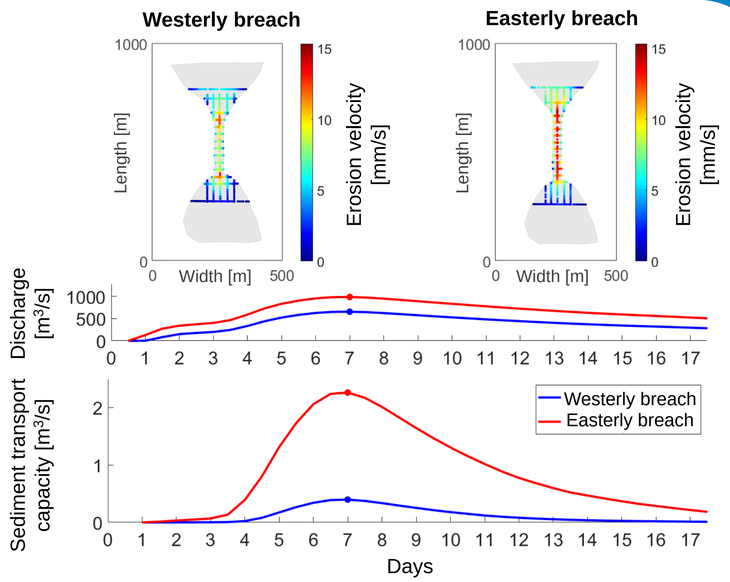

Figure 2: Erosion velocity perpendicular to the bed locally in the breaches at the peak of the flood wave and the discharge and sediment transport capacity through the breaches with a width and depth of respectively 50 and 4 meters in time for a 14,000 m^3/s flood wave

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