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The effect of tidal basin connectivity and waves on sediment transport patterns in the Ameland Inlet

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Ameland Inlet has recently been studied intensively because of the mega nourishments (∼20 million m3) of its ebb-tidal deltas that are being considered. Therefore, to understand how such nourishment will behave, a good understanding of the sediment transport patterns and its spatial and temporal variability is needed. In a recent study (Lenstra et al., 2019) we showed that sediment transport patterns in Ameland Inlet not only depend on wave and tide conditions, but also strongly depend on the different phases of its cyclic evolution. However, we neglected the effect of wind and assumed the Ameland Inlet to be an isolated system where the tidal watersheds could not be flooded. The latter is realistic during calm weather conditions, but during storms the exchange of water over the tidal watersheds can be quite large. On the other hand, Sassi et al. (2015) did include these effects but only had a relatively simple wave module and focused on mud transport. In this study we present results on the effect of wind and flooding of tidal watersheds on estimated sediment transport patterns in Ameland Inlet based on a high resolution model and including the effect of winds, waves and flooding of tidal watersheds.

Therefore, we set up a model in Delft3D/SWAN with two-way coupling (domain decomposition) between a high-resolution Ameland Inlet grid and a medium coarse Wadden Sea grid. Boundary conditions for the tides and waves were based on a North Sea continental shelf model and wave buoy data, respectively. We included effects of wind growth because waves in the Wadden Sea are to a large extent determined by local wind growth. Wind and pressure input came from WRF and HiRLAM data.

Forcing was schematized by binning the wind and waves into 5 main directions and studying for each direction a mild, medium and extreme wind event and from the period between 2006 and 2016. Results show that adding winds and connectivity with adjacent basins has a strong effect on the estimated sediment transport rates. During large NW storms sediment transport across the watersheds can be quite large, about 30 – 40% of what is transported through the inlet. Especially when the storm surge enters, a large part of the water comes in via the watersheds (and not via the inlet), transporting sediment into the basin. When the surge declines also wind-direction has changed, causing prolonged net import of sediment over the watersheds. During the presentation we will also discuss the results of other wind directions and magnitudes and present the weighted mean sediment balance of Ameland Inlet and compare it with previous estimates. Furthermore, we will study the effect of the cyclic evolution of Ameland Inlet on the sediment transport patterns.