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Observations and analysis of fluid mud dynamics at Holwerd, the Netherlands

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Abstract

Holwerd is a small harbour at the Wadden Sea coast (the Netherlands) where the ferry to the barrier island Ameland departs (Figure 1). Over the past decade, siltation of the navigation channel and, as a consequence, dredging volume have rapidly increased (Figure 2). Notwithstanding dredging on a nearly daily basis, the ferry link experiences frequent delays during low water, notably during spring tide and wind set-down conditions. Increasing maintenance costs and decreasing time-table reliability have resulted into a study to investigate the causes for this adverse trend.

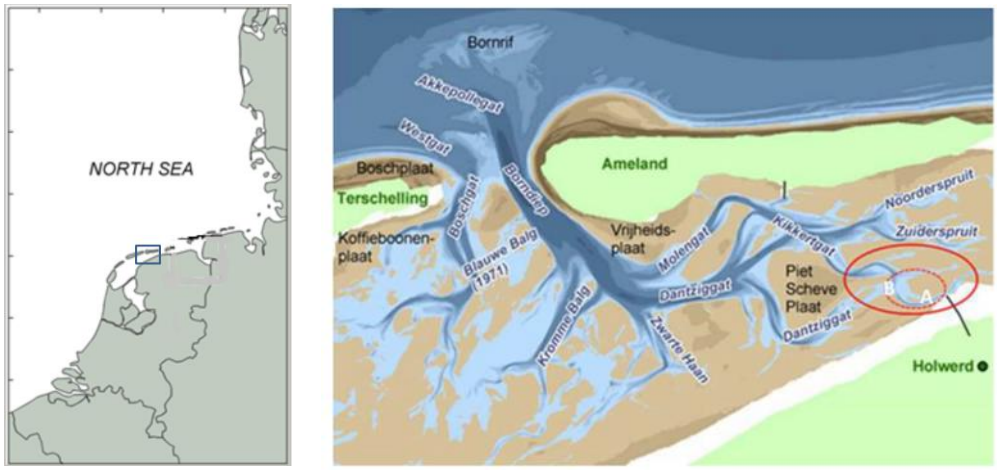

Figure 1: Navigation channel Holwerd – Ameland with Kikkertgat and areas with most maintenance dredging (red oval). Within the dotted red oval dredging is most intense and fluid mud has been observed.

As a first step in this study, the local morphological development of the Wadden Sea around Holwerd has been analysed (e.g. Elias et al., 2012; Wang et al., 2013), including the effects on currents using a local 2DH hydrodynamic model. From this exercise it becomes clear that the tidal volume of the channel has gradually diminished caused by a bed level increase of the surrounding mud flats and salt marshes. As a result, the ebb and flood peak velocities in the channel have reduced markedly and hardly exceed 0.4 m/s at present. Gradually the contribution of mud to the dredging volume has grown. A preliminary analysis with a schematised 1DV model reveals that the conditions for mud deposition and the formation of fluid mud layers are much more favourable at present than in the past. This may partly explain the strong increase in dredging volume.

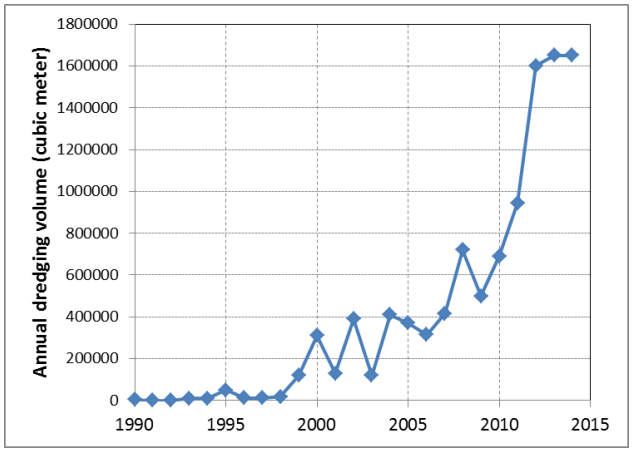

Figure 2: Development of maintenance dredging volume of navigation channel Holwerd – Ameland.

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However, to be able to draw well-founded conclusions on causes and mitigations, local field observation on hydrodynamics and sediment dynamics are essential. Therefore a field survey was carried out in April and May 2016. During these 13h ship-based surveys, velocity, sediment concentration and bed level were observed using ADCP, OBS and dual-frequency echo sounding along the thalweg of the channel and at a number of cross-sections. Vertical sediment concentration profiles were observed with a combination of backscatter (range 0 – 1000 mg/l) and transmission (range 0 – 50 g/l) sensors. Also a number of bed samples were retrieved with a Van Veen grab and a soft sediment sampler for subsequent lab analysis on grain size and cohesive properties. Results from this survey are still pending, but will be available for presentation during the PECS conference.

The analysis of the field surveys will focus on the identification of dominant sediment transport and siltation mechanisms. As a next step, it will be investigated which viable options exist to reduce siltation. These could include a different cross-section or orientation of the navigation channel, a different dredging or dumping strategy or a modification of the exchange of water and sediment between the channel and the nearby mud flats and salt marshes.

References

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