Geophysical Research Abstracts
Vol. 16, EGU2014-2620, 2014
EGU General Assembly 2014

Effect of human interventions on sand volume of deltas and tidal prism

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Ebb-tidal deltas are bodies of sand that are located seaward of tidal inlets. They play an important role in the net exchange of sediment between the coastal area adjacent to the inlets and the back-barrier basin. Earlier studies have demonstrated that size and spatial structure of ebb-tidal deltas depend on the tidal prism and on wave conditions. Thus, interventions in the back-barrier basin (e.g., construction of dams) will change the characteristics of the tides and thereby affect the deltas.

Most field data and model studies indicate that a larger tidal prism leads to a larger ebb-tidal delta. In contrast, the delta of the Texel inlet (Western Wadden Sea) has shrinked after the closure of the Zuiderzee (backbarrier basin reduced from 120 km to 30 km), whereas the tidal prism of the inlet increased.

In order to understand these observations, results will be presented of two models. The first is a numerical morphodynamic model (Delft 3D), which will be used to simulate the evolution of ebb-tidal deltas for different lengths of the back-barrier basin. The results of these experiments reveal that there is no monotonic relation between the volume of sand stored in the delta and the tidal prism and that a reduction of the length of the back-barrier basin may result in a larger tidal prism and smaller delta.

An explanation of this behaviour is given by discussing the results of a 1D analytical morphodynamic model are discussed, which describes the dynamics of tides and net sand transport in a tidal inlet system. It will be shown that the length of a tidal basin affects the asymmetry of the tidal currents, and thereby the direction of net sediment transport. Important agents for net sediment transport are the tidal flats, nonlinear friction and Stokes return flow.