Vici project Turning the tides

dynamics of channels and shoals in estuaries with sands and mud

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Project summary

Tidal systems such as the Scheldt, Humber and Columbia estuaries and Wadden seas in Florida and the North Sea, have perpetually changing and interacting channels and shoals formed by ebb and flood currents. Current models fail to forecast these natural dynamics. Yet main channels are economically important shipping fairways, whilst shoal areas that emerge and submerge daily are ecologically valuable habitats under threat of dredging, dumping and sea level rise. Our aim is to investigate and forecast how channel-shoal dynamics in estuaries result from geomorphological processes and human interference.



Hypotheses

- Channel- and shoal-margin collapses and current-driven sand transport on sloping channel beds cause the dynamics of channels and shoals,
- whilst break-down of shoals is balanced by resistant cohesive mud layers.
- bifurcating channel network propagates and possibly amplifies small-scale disturbances by collapses and dredging through the system into neighbouring reaches.



Figure 1. Aerial photograph Dovey (Dyfi) estuary



Figure 2. Local-scale processes: 1) Bed slope effect on sediment transport by currents, modified by waves, and effect on channel bifurcations. 2) Mud deposition on shoals, mud flats and marsh. 3) Channel margin collapse by bank failure, liquefaction of loose sand, or dense sand breaching. Large-scale channel-shoal interactions: 4) Formation of mutually evasive ebb- or flood-dominated channels in the network. 5) Large local perturbations propagate to adjacent reaches.



Figure 3. Annular flume at TU Delft

Figure 4. Placing of the 'Metronome', a novel experimental tilting flume to create dynamic tidal systems



Figure 5. Delft3D model of a straightened Oer-IJ estuary. a) bathymetry, model without mud, b) bathymetry, model with mud influx, c) mud fraction top layer, model with mud influx



Figure 6. Pilot experiment in small tilting flume

Figure 7. Arrival of the Metronome

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Collaboration

Deltares, Netherlands Center for Coastal Research (NCK), Rijkswaterstaat Zeeland, NOIZ (Yerseke), Bureau of Economic Geology, University of Texas (USA) TU Delft University of Technology, University of Genova (Italy), University of Cantabria (Spain), University of Antwerp (Belgium) Wetenschapsknooppunt for elementary school children (Science Hub), www.uu.nl/wetenschapsknooppunt

