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Morphodynamic evolution and stability of multiple tidal inlets, a simple model

H.E. de Swart (1), H.M. Schuttelaars (2)

(1) Institute for Marine and Atmospheric Research, Utrecht University, The Netherlands, (2) Delft Institute of Applied Mathematics/Mathematical Physics, Delft, The Netherlands

The long-term evolution of cross-sectional areas of a tidal inlet is controlled by two competing mechanisms. First, littoral drift causes deposition of sand in the inlet, thereby attempting to close it. Second, the ebb-dominant tidal currents in the inlet erode and transport sand seaward, thus causing the cross-sectional areas to increase. Theoretical analysis has demonstrated that multiple inlets, if being forced by the same tide at sea and if draining the same back-barrier basin, are always unstable, i.e., ultimately at most one inlet remains open. However, recent work by Van de Kreeke and co-workers has demonstrated that stable multiple inlet configurations can exist if the sub-domains that are being drained by the different inlets are weakly coupled or/and if tidal conditions at sea are not identical for different inlets.

In this presentation a new model will be discussed that focuses not only on equilibria and stability, but also simulates the full morphodynamic evolution of cross-sectional areas of a multiple tidal inlet system. The model computes the evolution of the wetted volume of the inlets due to imposed in situ deposition of sand by littoral drift and due to erosion and removal of sand from the inlets by local tidal currents. Erosion and deposition are assumed to occur uniformly over the length of the inlets and these lengths are kept constant. Tidal currents are modelled by the shallow water equations for an inlet-bay system.

Model results reveal the domains of attraction of the different stable equilibria of the model in phase space and show that the boundaries of these domains are quite sensitive to the formulation of sand erosion that is chosen. Results are also shown of the

response of the system to sudden interventions in the system (e.g., dredging, or construction of a dyke). In particular the case of reducing the basin area of the Frisian Inlet (Western Wadden Sea), due to closure of the Lauwerszee, will be discussed. Model results appear to be in fair agreement with available field data.