IDENTIFYING TIDAL DIVIDES, TIDAL SUBBASINS AND TIDAL PRISMS IN AN EXPLORATORY MODEL OF MULTI-INLET TIDAL SYSTEMS

Multi-inlet tidal systems typically consist of several barrier islands, separated by tidal inlets that connect a back-barrier basin to a sea or ocean. Hydraulic tidal divides, forming the boundaries between tidal subbasins corresponding to the inlets, can be identified based on the flow patterns in the back-barrier basin. In this thesis, these tidal divides are identified in the exploratory model by Roos et al. (2013). Furthermore, the model results are compared to the empirical O'Brien-Jarrett Law, which relates tidal prisms to the cross-sectional area of inlets, and a sensitivity analysis is performed with respect to the ocean conditions. From this, a relation between the tidal subbasin area and the cross-sectional area of an inlet is derived.

The model combines Escoffier's stability concept for tidal inlets with a hydrodynamic model. The evolution and stability of each tidal inlet depends on the balance between waves, transporting sediment into the inlet, and tidal currents, transporting sediment out of the inlets. Two possible methods of identifying tidal divides in the model by Roos et al. (2013) are compared. It is concluded that a method based on identifying lines of minimum flow velocity amplitude in the basin gives accurate results and can be used to divide the back-barrier basin into tidal subbasins for each open inlet, whereas the results of a method based on large phase differences in alongshore flow velocity amplitude cannot be used to calculate these tidal subbasin areas directly.

The tidal prism is defined as the water volume entering a tidal (sub)basin during a characteristic tidal cycle. It is approximated by multiplying the tidal range with the tidal (sub)basin area. The actual tidal prism resulting from the model is calculated by integrating the flow discharge through the inlet over half a tidal cycle. The result is a linear relationship between the tidal prism and the inlet area in the model. Comparing this to the empirical tidal prism - inlet area relationship of the form $\Omega = kP^{\alpha}$ called the O'Brien-Jarrett Law, the coefficient α is always equal to 1 when the system is in equilibrium and k only depends on the tidal frequency and the flow velocities in the inlets. From the approximated tidal prisms, it follows that the relationship between the subbasin area and inlet area in equilibrium depends on the equilibrium velocity, tidal range and tidal frequency.

A sensitivity analysis is performed in which the response of the system to changes in basin and ocean water depth, tidal amplitude and littoral drift is analysed. The results suggest that instant sea level rise results in fewer open inlets in equilibrium, but also a slight increase in the tidal basin areas and the inlet areas. Both the inlet areas per inlet and the tidal prisms do not change significantly as the tidal amplitude changes, such that the tidal prism – inlet area relationship is maintained with the same coefficients. An increase in littoral drift decreases the number of inlets and the total inlet area in equilibrium since more sediment is available to close the inlets. However, the tidal prisms increase, such that the tidal prism - inlet area relationship changes, which is expected as that relationship depends on the (equilibrium) flow velocity amplitude in the inlets.

Figure 1: The Wadden Sea, an example of a multi-inlet tidal system. (copyright: Eurimage 2003, Common Wadden Sea Secretariat, Brockmann Consult)

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30 August 2019

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Roos, P.C., Schuttelaars, H.M., Brouwer, R.L. (2013). *Observations of barrier island length explained using an exploratory morphodynamic model*. Geophysical Research Letters, 40 (16), 1-6, doi:0.1002/grl.50843.