Modelling barrier coast dynamics

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Barrier coasts, covering about 10% of the world’s coastline, are often densely populated areas subject to potentially conflicting interests of economy, coastal safety and ecology. Barrier coasts typically display a chain of barrier islands, separated by tidal inlets that connect a back-barrier basin (lagoon) to a sea or ocean. These coasts are highly dynamic: the shapes of the islands, channels, ebb tidal deltas and tidal flats evolve continuously due to the complex interplay of tides, waves and sediment.

To study the long-term morphodynamics of such a multiple inlet system, we have developed an idealised morphodynamic model. In a schematised geometry, this model combines process-based formulations of tidal dynamics with empirical parameterisations of the tide- and wave-driven sediment transport in the inlet. Model simulations show the system’s nonlinear evolution to an equilibrium state. As shown by an extensive sensitivity analysis, the model is able to reproduce the widely observed relationships between inlet spacing (indication of island length) and other system parameters: importance of tides relative to waves, width of the back-barrier basin.

Example simulation with exploratory barrier coast model: (a) Top view of equilibrium state with back-barrier basin, connected by five inlets to a larger sea. To mimic a storm event, at t=0 two breaches are added to two of the barrier islands (stars). (c) Evolution, showing that one breach closes and the other stays open. (c) Top view of new equilibrium with six inlets. Basin length: 100 km, basin width: 2 km.
An exploratory model such as this one helps to understand the possible changes in the multiple-inlet configuration brought about by external factors, such as basin reduction, dredging activities, sea-level rise or storm-induced breaches (see figure). It stresses the interaction between basins and hence the need for an integral approach. This for example applies to the Wadden Sea. Wadden Sea management currently explores a policy shift allowing for more natural behaviour, by which the dynamics of the North Sea zone becomes part of the identity of the islands.

REFERENCES