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Geo-logic in coastal and shelf research: a matter of multi-disciplinarity

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LONG-TERM MORPHOLOGICAL BEHAVIOR OF BARRIER COASTS: INFLUENCE OF STORM-INDUCED BREACHES USING STOCHASTIC MODELLING

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Many barrier coasts are characterized by an interrupted coastline with a chain of barrier islands that are separated by tidal inlets, through which water and sediment flow between the open sea and the tidal basin. They are found around the world (e.g. the Long Island coast, USA and the Wadden Sea, the Netherlands, Germany, Denmark) and they are important for coastal safety, ecology, and economy.

Previous work on the long-term (decades to centuries) behavior of barrier coasts has focused on the evolution of single (Escoffier 1940), double (e.g. van de Kreeke 1990; Brouwer et al. 2012), and multiple inlet systems (Roos *et al.* 2013). This earlier research revealed the existence of equilibria and interaction among adjacent inlets. However, how randomly appearing storm-induced breaches influence these dynamics is unclear.

The effect of storms on barrier coasts can be significant, ranging from increased sediment transport to the creation of new tidal inlets through storm-induced breaches (e.g. as happened during Hurricane Sandy at Long Island near New York in 2012).

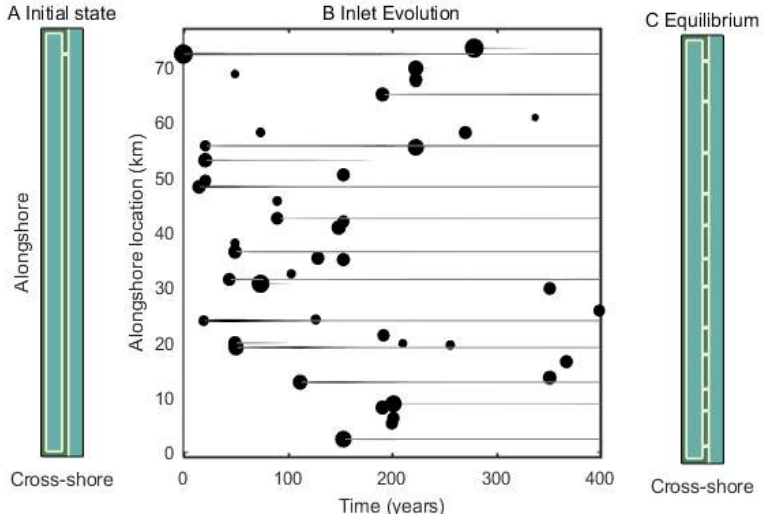

Figure 1. Example of a model run showing:

A, initial configuration with a single inlet.
B, evolution of the barrier coast with storm-induced breaches as black dots (dot size is proportional to initial breach size, line thickness proportional to inlet width over time).
C, the final configuration in which the inlets are in equilibrium.

Here we present our work on how storm-induced breaches influence the long-term behavior of barrier coasts, using a morphodynamic model based on Escoffier's (1940) concept for inlet evolution (whilst neglecting inlet migration), combined with an idealized hydrodynamic model. Herein, storm-induced breaches are included as a stochastic forcing. As part of the WADSnext! Project, aimed at understanding the long-term behavior of barrier coasts to support sustainable management, we conducted Monte-Carlo simulations (n = 10,000) with duration of 400 years for each simulation to investigate the effect of randomly appearing storm-induced breaches on the long-term behavior of barrier coasts.

Results, as depicted in Figure 1, show that breach evolution (closing or staying open), is governed by the breach characteristics (i.e. initial width and distance to the nearest inlet) in combination with the state of the full system (proximity to contemporary equilibrium, which, in our model, is related to the total inlet area and number of inlets). Furthermore, we found that when a breach remains open, the nearby pre-existing inlets decrease in size, confirming field observations.

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Van de Kreeke, J. (1990). Can multiple tidal inlets be stable?. *Estuarine, Coastal and Shelf Science*, 30(3), 261-273.