**VEGETATED DUNE AND SWALE FORMATION ON BARRIER ISLANDS**

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*Introduction*
Barrier islands in the Wadden Sea may temporarily experience large influxes of sand on their updrift side, related to sand banks merging to the shore. These form wide beaches, on which vegetation may establish and dunes and swales (primary dune slacks) may form. Whether or not such dune areas develop, has consequences for biodiversity, sediment exchange and coastal defence (buffer during storms) at these locations. However, relatively little is known about which factors are decisive for such dunes and swales to develop, and how stable such dune areas are through time.

*Methods*
We developed a model that simulates the formation of vegetated dunes and swales. It is the first model to that contains the full interaction between the three main forces in coastal dunes: the sea, dune formation by wind, and vegetation growth. Dune formation is simulated using a cellular automaton approach, where slabs of sand follow simple (nature-based) behavioural rules, leading to realistically-looking dunes. Sea action is simulated by letting topography, vegetation and a time-series of water levels determine which part of the topography is reworked by the sea into an equilibrium beach shape. The vegetation consists of two types: dune grass (e.g. *Ammophila arenaria*, Marram grass) and dune-slack vegetation (a mixture of several species that colonise primary dune slacks and green beaches). The vegetation types compete for nitrogen, and their growth is further affected by sand burial, proximity to the groundwater, and inundation and erosion by the sea. Simulations start with a bare beach and vegetated foredune, and various factors are investigated on their effect on dune formation.

*Results*
The simulations show that the full interaction between sand, sea, wind and vegetation needs to be taken into account, as these all shape the dunes. Not surprisingly, wide beaches (> 100 m dry beach width) are the main prerequisite for whether or not dunes and swales will develop, as beach width determines whether there is enough space. When they have established, only progressive beach erosion may erode the dunes again. The distribution of the vegetation types is determined by their preference and tolerance to the environmental forces. However, especially the dune grass exerts a strong influence on sand dynamics and, with that, dune shape, through its ecosystem engineering properties. The development of dunes, swales and their vegetation are further influenced by atmospheric nitrogen deposition, depth of the groundwater table, average wind strength and the frequency of storm surges. When comparing model results to real-world situations, it becomes apparent that the establishment threshold of vegetation is an important factor that was not included. As little is known about this yet, further studies are needed for quantification.

*Conclusion*
On the Wadden Sea islands, natural (bar welding) and human (beach nourishments) changes in beach width will be the most important factor for whether dunes and swales will develop. Next, opportunities for the establishment of vegetation are crucial. The model gives further insight into how young dunes and swales may develop under future global change. Additionally, the model can be used to design sand nourishments in such a way that they may lead to dune formation.