

Ecological optimization of dynamic coastal defence

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Worldwide, coastal sand dunes are important for safety against flooding. At the same time, they are valuable for recreation and nature conservation. The latter is reflected in the designation of many coastal dunes as Natura 2000 sites under the European Birds and Habitats Directive (BHD).

Before the 1990's, the Dutch coastal dunes were managed by fixing the position and hence their dynamics. This led to a static landscape, with very few young phases of vegetation succession and a low degree of geomorphological diversity. Since the 1990's, management of the Dutch sandy coast has shifted its focus to the preservation of location of the coastline. As long as the coastline remains seaward of the assigned 'basal coastline', and other uses (e.g. drinking water supply, tourism, recreation, habitation) are not compromised, natural processes are allowed to shape the landscape. An important component of this so-called dynamic coastal defence is the combat of coastal erosion by 'soft' measures, mainly by sand nourishments. The large-scale application of sand nourishments has led in some places to the development of new dunes (Figure 1). These are considered valuable for nature conservation and recreation, but may also have ecological effects on and strengthen the already existing dunes. Recently, there is even a trend towards applying overdimensioned quantities of sand to stimulate dune growth. It is, however, still hard to predict how and where dunes will develop as a result of nourishments.

A comparable process takes place at other sites along the Dutch coast. As a result of their characteristic natural dynamics, barrier islands generally experience periodic large sand influxes. These traditionally lead to the formation of new dunes and related valuable habitats. Again, it is difficult to predict quantitatively how such dunes and the associated vegetation will develop, and how stable these will be under changing environmental conditions.

In this project, we study the effect of sand supply and climate change on the formation of young dunes and their associated vegetation development. The main focus lies on the Wadden Sea area. Findings from this area with natural large sand influxes can then be applied to areas with artificial nourishments. This should lead to recommendations for managers on how to combine coastal safety and nature development.

We will build a spatially explicit model that integrates young dune formation and vegetation succession, and parameterize and validate it with field data. The dynamics of the vegetation and soil development will be described by adapting the existing model NUCOM (developed by the NCP group). It has been developed to model competition between grasses and ericaceous species in dry heathland systems. The model will be modified to include species or plant functional types relevant for the dune ecosystem. It will be extended with specific processes observed in coastal settings, such as salt spray, burial by sand and the abrasive forces of blowing sand (Figure 2).

The dune formation module will be based on the DECAL model developed by Andreas Baas et al. in the UK. It is a cellular automata model that is capable of simulating realistic dune landscapes by including a limited set of behavioural rules. The model already includes the effect of vegetation, but in a simplistic way. Coupling the two models will yield more insight in the interaction between vegetation and dune formation on the coast and the model will be used to simulate various scenarios of sand input (either natural or by nourishments) and climatic change.

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Figure 1. Young dune formation.

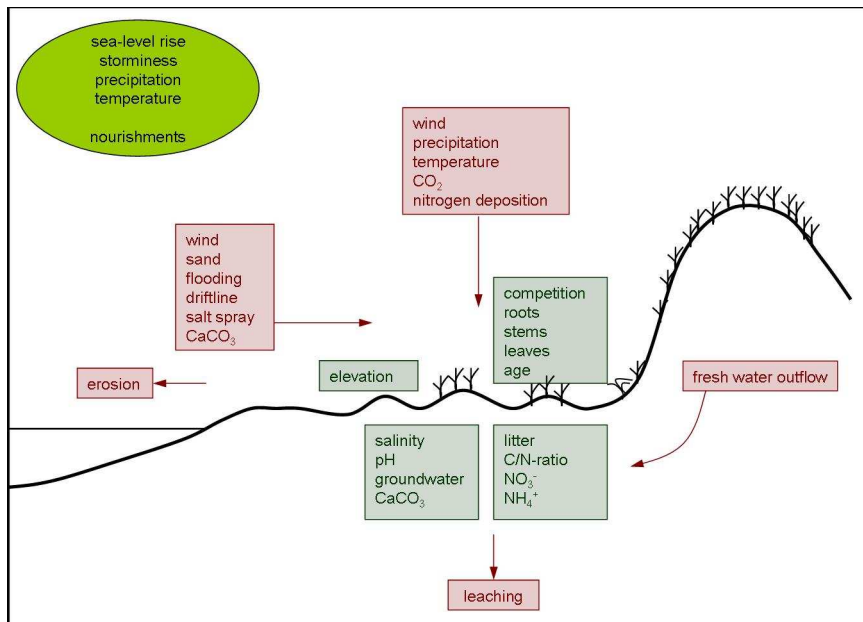


Figure 2. Processes included in the model.