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Modelling coastal dune formation and associated vegetation development

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Coastal areas generally exhibit a high degree of natural dynamics. If conditions are suitable, the interaction between wind, vegetation and sand may lead to the formation of coastal sand dunes. Dunes are considered valuable for coastal defence, recreation and nature conservation, but are easily affected by global change and human activities. An example of a constructive human impact is the recent increase in young dune formation along the coast of the Netherlands, as a result of the large-scale application of beach nourishments for coastal protection. With this in mind, some beach nourishments are currently being designed with dune growth as intended side-effect. It is however still difficult to predict quantitatively under which conditions new dunes will build, what type of developmental pathways exist for these dunes and the associated vegetation, and how stable they will be under changing environmental conditions.

We present the development of a spatially explicit model for simulating young dune formation and vegetation succession. The model integrates two existing terrestrial models, both of which need to be adapted for the specific situation of the coast. The dune formation module is based on the DECAL algorithm (Baas and Nield, 2007). It is a cellular automata model that is capable of simulating realistic dune landscapes, by including a limited set of behavioural rules to moving sand slabs. The influence of the sea was added by letting the beach part of the model domain periodically revert to equilibrium beach profiles. Instead of the simplistic vegetation description of the original DECAL model, the dynamics of the vegetation and soil development are described by adapting the existing model NUCOM (Van Oene et al., 1999). This new vegetation module introduces a more mechanistic description of the vegetation growth, that allows further extension of vegetation processes in future. The model was originally developed to simulate competition between grasses and ericaceous species in dry heath-land systems. It is now modified to include plant species relevant for the dune ecosystem, such as Marram grass and dune slack species. Further, specific processes observed in coastal settings, such as salt spray, burial by sand and the abrasive forces of blowing sand are being added.

Coupling the two models will yield more insight in how the interaction between vegetation and dune formation shapes the coast. Further the model allows simulating various scenarios of sand input (either natural or by nourishments) and climatic change and their effect on dune morphology and vegetation distribution.

References

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