COUPLED MODELLING OF DUNES AND COASTS – THE CODAC MODEL

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INTRODUCTION

Long-term forecasts of coastal evolution are becoming increasingly relevant in view of climate change and a further transition to sustainable long-term management of the coast. An integrated approach is required to deal with the decadal timescale interactions between the marine, beach and dune sections of the coast. A new coupled dune and coastal model, coDaC, has been created for this purpose, which is described in this paper.

THE CODAC MODEL

The coDaC model combines a semi-empirical cross-shore transport model, the CS-model (Hallin et al., 2019a), with a longshore transport and coastline evolution model, Unibest CL+ (Figure 1).

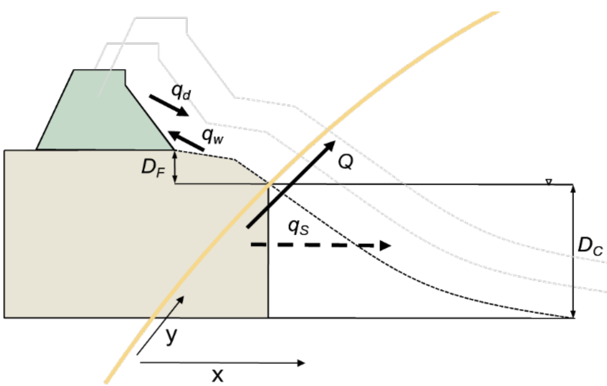

Figure 1 - Schematic illustration of the coDaC model.

The CS-model is applied to several cross-shore (CS) transects distributed alongshore on the Unibest CL+ coastline grid. During the simulation, a model coupler exchanges simulated sediment transport rates between the submodels. The CS-model simulates aeolian transport from the beach towards the dune, q_W [m^3/m/s], dune erosion, q_d, and overwash, and a Bruun-type morphological compensation for sea level rise, q_S. In return, Unibest CL+ exchanges gradients in the longshore transport, including impacts of beach and shoreface nourishments, *dQ/dy*. The simulation time step is about 3 hours to resolve storm events. The coastline evolution, *dx/dt*, is a result of both longshore and cross-shore transport rates within the active profile from the depth of closure, D_C, to the dune foot height, D_F,

$$\frac{dx}{dt} = \frac{1}{D_F + D_C}\left(q_d - q_w - qs - \frac{dQ}{dy} + nour\right) \quad (1)$$

The effect of the sediment budget on the long-term dune evolution is implemented through a parameterization of the sediment availability for aeolian transport, *V*,

$$\frac{dV}{dt} = q_d - q_w - a \cdot \left(q_s + \frac{dQ}{dy}\right) \quad (2)$$

where *a* is an empirical coefficient between 0 and 1.

RESULTS

Academic cases demonstrate that the coDaC model is capable of simulating the interaction between marine and aeolian transport processes in the longshore and cross-shore directions while conserving sediment. Positive gradients in the longshore sediment transport led to increased dune erosion and reduced dune build-up due to aeolian transport. In contrast, negative gradients result in sediment supply for aeolian transport and reduced dune erosion due to increased wave dissipation over a wider beach.

A hindcast of coastal and dune evolution was made for an 8 km long coastal stretch at the Kennemer Dunes in the Netherlands. Verification with a 22-year series of coastline data at the Kennemer dunes showed a very satisfactory representation of the beach and dune evolution (Figure 2). The parameterized sediment supply for aeolian transport (eq. 2) was key to replicating a large observed variability of dune growth rates (Hallin et al., 2019b). The reduced complexity approach and very short simulation time make the coDaC model a promising tool to predict coastal evolution for (multiple) climate change and coastal management scenarios.

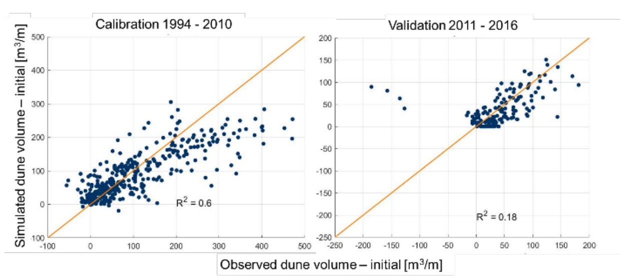

Figure 2 - Dune volume evolution in the Kennemer case.

ACKNOWLEDGEMENT

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