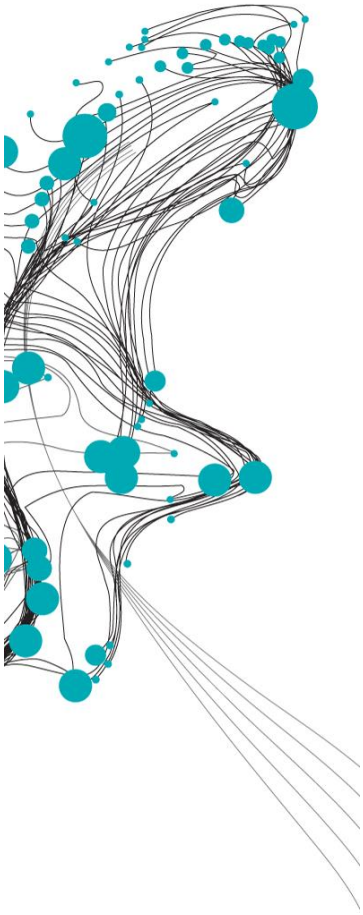
EXPLORATORY PROCESS-BASED MODELLING OF ESTUARINE SAND DUNES

The influence of environmental and empirical model parameters on expected wave lengths, growth rates and migration rates



All over the world, large-scale rhythmic bedforms can be found, one example being estuarine sand dunes. Estuarine sand dunes are influenced by both marine and fluvial processes. But they are also affected by estuarine-specific processes, like gravitation circulation. To understand the dynamics of the development of estuarine sand dunes, Van der Sande et al. (2021) developed a linear process-based model. This process-based model describes the initial development of estuarine sand dunes from a flat bed, and is based on shallow water equations forced by tide, river and a longitudinal salinity gradient. They choose their parameter settings to represent the Gironde Estuary. However, these parameters vary for different estuaries and locations within an estuary. Here, we investigate how the model parameters influence the characteristics of the Fastest Growing Mode (FGM), being growth rate, wavelength and migration rate.

We divide the parameters in two types: environmental parameters (water depth, depth-averaged M2 tidal velocity amplitude, depth-averaged river flow velocity, grain size and salinity gradient) and empirical model parameters (drag coefficient, slip parameter, slope correction factor in the sediment equation and the bed load exponent). This is done to discern between natural variation and model uncertainty. The second step is to perform a one factor at the time (OFAT) sensitivity analysis. This analysis shows the influence of different environmental and model parameters on the characteristics of the FGM. The effect predicted based of the model outputs overestimates the impact, since one parameter change effects the other input parameters and the current model only gives insights in the initial growth of the wave lengths. The last step was the validation of the current Gironde model for three new locations, two in the Scheldt and on in the Elbe estuary. The validation compares the modelled wave lengths and migration rates of the sand dunes with the measured values based of local measurements.

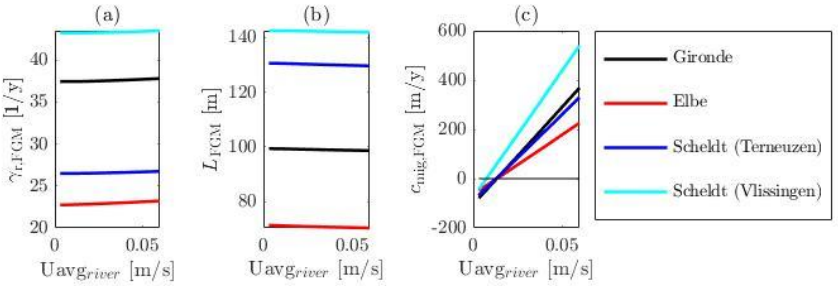


Figure 1: The validation of the model based on two locations at the Scheldt estuary and one in the Elbe estuary, compared with the original data of the Gironde Estuary.

van der Sande, W. M., Roos, P. C., Gerkema, T., & Hulscher, S. J. M. H. (2021). Gravitational circulation as driver of upstream migration of estuarine sand dunes. Geophysical Research Letters, 48, e2021GL093337. https://doi.org/10.1029/2021GL093337

Dieuwke Maas

Graduation Date:
20-05-2022

Graduation committee:
University of Twente
Prof.dr. S.J.M.H. Hulscher
Dr. Ir. P.C. Roos
Ir. W.M. van der Sande

UNIVERSITY OF TWENTE.