Numerical modelling of the biophysical feedbacks of Salicornia at the constructed Marconi salt marsh

Salt marshes are valuable intertidal ecosystems because they increase flood safety and ecological value of the coastal area simultaneously. Recently, worldwide efforts have been made to restore and create these salt marshes. One of the recently constructed marshes is the Marconi salt marsh, which was constructed in the Ems-Dollard estuary at the end of 2018. The Marconi marsh is used to study the effects of different sediment compositions and sowing of seeds on salt marsh establishment and development. The sowing of *Salicornia* (glasswort) at the Marconi marsh gives an interesting opportunity to gain more knowledge on the establishment and development in a salt marsh of an important pioneer species. By using the Marconi project as a case study, this thesis aims to determine the impact of hydrodynamics and morphodynamics on the development of the pioneer vegetation *Salicornia Europaea* at a (constructed) salt marsh by using a numerical modelling approach.

To study the development of *Salicornia*, this study used a brand new hydrodynamic model (DFM) and combined it with a separate wave propagation model (D-Waves) as well as a vegetation growth model which comprises of the well-established Windows of Opportunity and population dynamics concepts for vegetation growth and simulates one growth season taking place between April-October (Figure 1). The Windows of Opportunity account for the relation of inundation and bed level dynamics with seedling establishment which takes up the first few months of the vegetation development, while population dynamics govern the growth and decay of established salt marsh vegetation and addresses the rest of the plants life-cycle over the years. The characteristics of the Marconi site and *Salicornia* were determined by combining literature with elevation and stem density measurements of the site.

The model results suggest that the morphodynamics are the most limiting factor for *Salicornia's* development, since *Salicornia* was found to die due to bed level change, even when forced by calm hydrodynamic conditions. Furthermore, the model revealed a significant impact of the inundation frequency, a hydrodynamic parameter, on the establishment and vegetation pattern of *Salicornia*. On the other hand, fully-developed *Salicornia* clusters were found to be more resilient to hydrodynamic factors. High-density groups were observed throughout the modelled site and appeared to form when two requirements were met; an early establishment to give *Salicornia* time to grow into fully-developed vegetation and a location that is protected well-enough from hydrodynamic energy to prevent excessive erosion or plant mortality due to shear stresses.

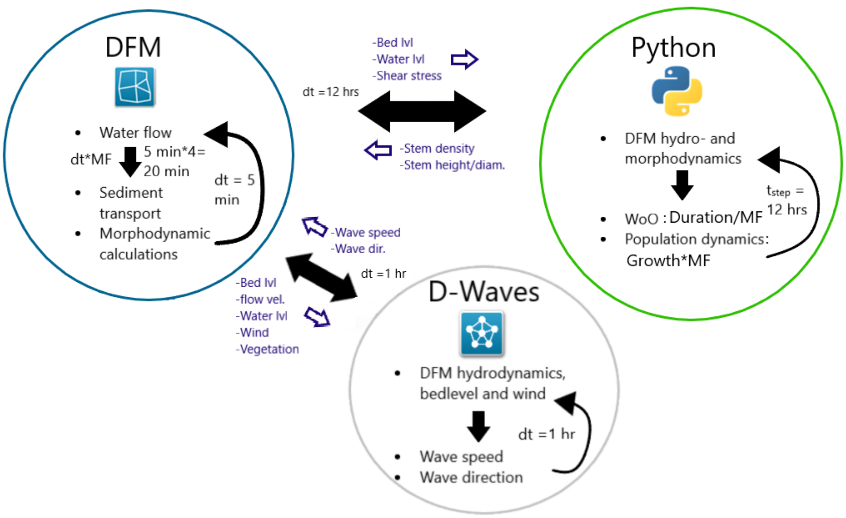

Figure 1: The interaction between the hydrodynamic model (DFM, top left), wave model (D-waves, bottom) and the vegetation model in Python (right) along with the phenomena the separate sections calculate and pass on. MF is a morphological factor which essentially multiplies the bed level change and vegetation development by a factor to enable much faster computation.

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