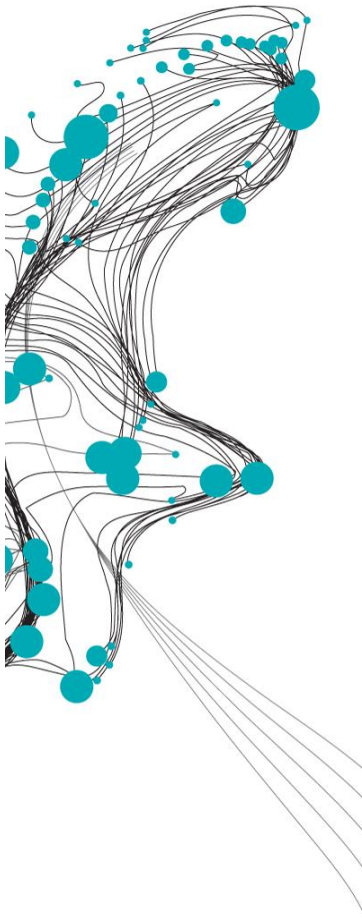


# EXPERIMENT-SUPPORTED MODELLING OF SALT MARSH ESTABLISHMENT

## APPLYING THE WINDOWS OF OPPORTUNITY CONCEPT TO THE MARCONI PIONEER SALT MARSH DESIGN



Worldwide, many projects are trying to create and restore salt marshes because of their ecological functions and their benefits for flood protection and erosion control. One of these projects is the Marconi pilot project that is planned in Delfzijl, The Netherlands. Its aim is to create a pioneer salt marsh and to obtain generally applicable knowledge about salt marsh creation by experimenting with different measures and designs. This thesis, done as part of the Marconi project, has the objective to determine under which conditions pioneer salt marsh vegetation can establish and how this knowledge can be applied in the design of the Marconi pioneer salt marsh.

To determine if vegetation can establish, the Windows of opportunity (WoO) concept of Balke et al. (2011) is used. This theory states that plants require subsequently a short disturbance-free period to grow roots (WoO1); a period with calm hydrodynamic conditions (WoO2) in which the plants can grow stronger and a period in which the high-energy events do not exceed the vegetation limits (WoO3). Because plants are very sensitive to erosion and a large part of this erosion occurs during relatively moderate events, this study defines the limits of the windows in terms of the critical erosion depth (CED) of plants (see figure 1).

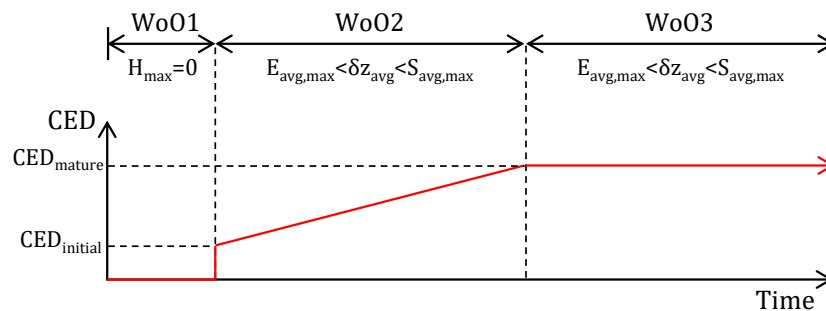


Figure 1: The Windows of opportunity framework as used in this study, with  $H$  indicating water depth,  $E$  erosion,  $\delta z_{avg}$  the average bed level change in a plant's life,  $S$  sedimentation and CED critical erosion depth

An experiment was used to determine the CED under varying environmental conditions. *Spartina anglica* and *Salicornia procumbens* plants were grown and subsequently tested in a wave flume to determine how much erosion they can handle before they topple over. This showed that the CED depends mostly on previous bed level change, supporting the choice to define the WoO framework in terms of bed level dynamics.

A Delft3D model of the situation at Marconi was set-up to predict the bed level dynamics and implement the WoO framework (see Figure 1). In this model erosion occurs, with a cliff forming around the high water line. As a result, vegetation establishment can only occur directly at the coast. The sensitivity analysis showed that the result is quite robust, with the expected establishment pattern being independent of the examined parameter values (durations and erosion limits of the WoO framework) and the sediment type and vegetation implementation in Delft3D. However, lower wave heights reduce the amount of erosion in the model and improve the establishment chances. A wave height reduction of 50 percent prevents nearly all erosion and enables the successful establishment of a pioneer salt marsh.

In short, this study showed that it is essential for the stability of the Marconi pioneer salt marsh pilot that wave-dampening measures are taken. For successful salt marsh establishment, a wave height reduction of 50 percent is probably sufficient. Furthermore, this study used the data from the experiment to calibrate and improve the WoO framework, thereby providing valuable information for future building with nature projects.

Balke, T., Bouma, T. J., Horstman, E. M., Webb, E.L., Erfemeijer, P. L., & Herman, P. M. (2011). Windows of opportunity: thresholds to mangrove seedling establishment on tidal flats. *Marine Ecology Progress Series*, 440, 1-9

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