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The processes and parameters underlying the failure of juvenile pioneer salt marsh vegetation in different sediments

Salt marshes are considered valuable habitats and provide a wide range of ecosystem services, including contributing to coastal protection, stabilising coastlines, carbon storage and providing habitat and marine nursery grounds. Therefore, many projects have attempted to create and restore salt marshes but are often hindered by a lack of thorough understanding of initial vegetation establishment. This thesis aims to determine under which conditions juvenile pioneer salt marsh vegetation fails and how this knowledge can be applied for the restoration and creation of salt marshes.

An experiment was used to study the above and below ground development of juvenile pioneer salt marsh vegetation in different sediments; the plants were subsequently tested in a wave flume using irregular waves to examine failure. For this experiment, the pioneer salt marsh species "*Salicornia procumbens"* was selected; this species is native to the Dutch coast and often one of the first plants to establish on bare intertidal flats.

The development of *Salicornia* seedlings aboveground was comparable in sediment of the cohesive and non-cohesive type, although, in cohesive sediment, the plants became more complex in a shorter period. Belowground, the bio morphology of the *Salicornia* seedlings was significantly different. A complex root system developed in sand with numerous long thin roots, while in cohesive sediment, the roots were thick and short and the root system relatively simple. This difference was most likely related to the consolidation in cohesive sediment and the increase in soil strength as a result of the consolidation and sediment type itself. Another consequence of this consolidation and increase in soil strength was that the erosion resistance increased rapidly in recently deposited cohesive sediment.

The irregular waves in the flume stressed the seedlings due to the to-and-fro motion of the plants and erosion as a result of the oscillating flow velocities produced by the waves. Seedlings in cohesive sediment received on average more wave energy over time because of the greater frontal surface area of these seedlings. Moreover, distinct failure mechanisms (Figure 1) were observed between the sediment types. In non-cohesive sediment, erosion was the dominant process causing failure, while in cohesive sediment, the to-and-fro motion of the plants that pried out and broke the roots was the dominant process causing failure Furthermore, the seedlings growing in cohesive sediment could withstand a more extended period of wave loading and more wave energy before failure, compared to seedlings of similar age in sand.

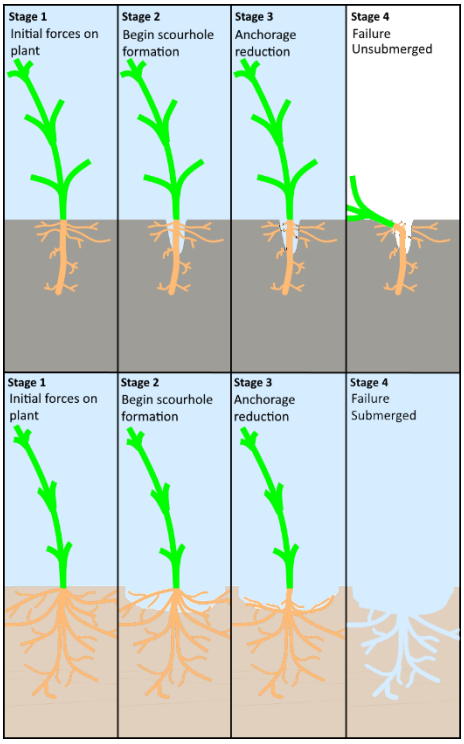

Figure 1 Ilusstration of the 4 stages of failure of Salicornia seedlings in clay and sand

In practice, sediment with higher clay content may result in a higher survival rate of *Salicornia* seedlings on the intertidal flats, especially near the regions with harsher hydrodynamic conditions. *Salicornia* stands enable perennial salt marsh plants to establish on the intertidal flat, for example, by trapping vegetive tillers of these plants. These species are essential for further increasing the biodiversity and plant succession on a recently established salt marsh as well as stabilising the soil. This, subsequently, will benefit the ecosystem services like wave attenuation, carbon storage and provides more habitat and marine nursing grounds.

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