Seasonal variation in salt marsh vegetation

Impact of physical stressors on the development, decay and seed retention of *Salicornia Europaea*

Salt marshes are increasingly being used as (part of) nature based flood defences. A salt marsh is an intertidal area at the coastline with salt-tolerant vegetation species such as *Salicornia Europaea*. These intertidal areas are flooded during high tide, during which the vegetation might reduce the waves and increase sedimentation rates. As *Salicornia Europaea* is seasonal vegetation, the decay of the aboveground vegetation and the development of the seedbank are important dynamics to predict changes in the vegetation cover over the years. Currently, these dynamics are modelled by a sudden decay of *Salicornia* vegetation from a fully grown cover to zero vegetation at the start of winter and by a random constant seed availability. Therefore, the aim of this research is to parameterise the vegetation decay and the seed retention with local hydro- and morphodynamics such as flow velocities, wave height, surface elevation changes and inundation frequency.

This study is based on field data collected at an artificially created salt marsh near Delfzijl in the northeast of the Netherlands: Marconi (Figures 1-2). Waves, tides, flow velocities and bed level changes have been monitored from November 2020 until April 2021. Moreover, vegetation density, length, strength, root length, number of side roots, length of the longest side root and the number of seeds of the dominant *Salicornia Europaea* have been measured throughout the winter season. The different dynamics and vegetation properties have been correlated by a multiple linear regression analysis to find the driving factors for the development and decay of the vegetation as well as for seed retention.

The results show that the density of the fully grown *Salicornia* vegetation at the end of summer is limited by the maximum significant wave height. During the winter season the decay of the vegetation density is increased by the maximum significant wave height. The retention of seeds is positively affected by the density of the vegetation that is still present and negatively affected by the flow velocities. The obtained parameterisations (Table 1) can be used in modelling studies to predict the vegetation density (decay) based on the wave height and to predict the number of seeds in the seedbank based on the vegetation density and the flow velocities at the marsh. When these parameterisations are implemented into numerical models, it is possible to simulate the impacts of physical stressors on the short-term and long-term vegetation development in salt-marshes. This will help to develop effective management and restoration strategies for salt-marshes.

Table 1. Parameterisations of the vegetation density decay and number of seeds in the seedbank. Wherein $H_{s,max}$ is the maximum significant wave height [cm], ρ_{veg} is the vegetation density [%] and u_{max} is the maximum flow velocity [m/s].

Parameter	Parameterisation
Vegetation density decay [%]	$-5.02 + 1.9 * H_{s,max}$
Nr. of seeds in seedbank [per 100 cm^2]	$1.54 + 2.03 * \rho_{veg}$
Nr. of seeds in seedbank [per 100 cm^2]	$224.25 - 439.68 * u_{max}$

Figure 1: Marconi salt marsh during the growing season.

Figure 2: Marconi salt marsh during the winter season.

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