Sedimentation and erosion at intertidal vegetated foreshores

Storms consisting of short waves are partly responsible for failure of the primary coastal defenses (sea dykes). Vegetated foreshores (salt marshes), which are located in front of these dykes, are capable in breaking and attenuating waves. However, vegetated foreshores are highly dynamic and their stability, efficiency and especially long-term sustainability are not yet fully understood. The BE SAFE (Bio-Engineering for Safety using vegetated foreshores) project uses SED (Surface Elevation Dynamics) sensors to study the morphological behavior of intertidal vegetated foreshores. This SED sensor lacks an autonomous script for translating raw voltage data into bed level dynamics. Therefore, the objective of this study is to develop an autonomous script for the SED sensor by taking into account the influencing aspects that cause uncertainty in determining the bed level.

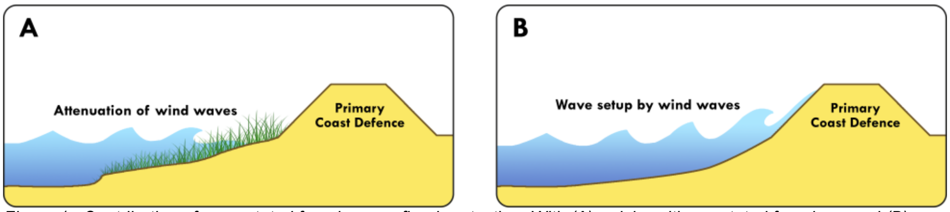

Figure 1: Contribution of a vegetated foreshore on flood protection. With (A) a dyke with vegetated foreshore and (B) a dyke without vegetated foreshore. The vegetated foreshore breaks and attenuates the waves, which reduces the wave setup at the dyke.

The SED sensor is a stand-alone measuring device designed by NIOZ (Koninkelijk Nederlands Instituut voor Onderzoek der Zee) to study bed level dynamics within intertidal vegetated foreshores and tidal flats. The SED sensor uses light sensitive measuring cells along the shaft to find the transition of belowground (low voltage outputs) to aboveground (high voltage outputs). This transition is defined as the transition slope and the bed level can be found at the top of this slope. However, within the signal analyses, several influencing aspects were considered responsible for creating noise in the voltage profile. These aspects can be defined as processes that affect the light availability of the sensor cells. The influencing aspects were quantified with field experiments at NIOZ in Yerseke. Aspects as dirt and vegetation biomass causes the light intensity to drop aboveground, scouring results in two transition slopes, submerged and especially nocturnal conditions causes the transition slope to disappear and varying light intensities affects the amount of measuring cells in the transition slope.

After determining the influencing aspects, the script was developed with data from a tidal flat (Kapellebank) and a salt marsh (Rilland). These two datasets were used for setting up the parameter values in the script which are required for more precise predictions. The script predicts its bed level by an intersection method. This intersection is conducted by a tangent line of both the transition slope and aboveground voltage outputs.

The validation of the script was executed with an experiment at a tidal flat (Roggenplaat), where bed level changes of a sand suppletion were studied. The validation holds a comparison with SEB's (Sediment Erosion Bars) and erosion pins. This dataset was also used for a comparison with the former script of Zhan Hu. The newly developed script has a coefficient of determination (R^2) with the SEB's and erosion pins of respectively 0.87 and 0.90, where the former script of Zhan Hu scores respectively 0.76 and 0.73.

At last, the applicability of the script was tested while analysing the bed level changes within salt marsh Rilland for the summer of 2015. This analysis showed that the mudflat experiences instantaneous bed level changes compared to the marsh, that the bed level gradually grows in the marsh and that the combination of water levels and wave heights give the largest relation with these bed level changes. The accuracy of the script in determining bed levels was defined with a standard deviation of an enclosed measuring period. On average this is for the bed level 4 mm. For the scour depth this uncertainty increases, where the standard deviation could grow up to 16 mm. This uncertainty is in all probability caused by the variation of the water level in the scour hole.

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