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LARGE-SCALE TEST OF EXTREME HYDRODYNAMIC CONDITIONS OVER COASTAL SALT MARSHES

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KEYWORDS: real salt marsh vegetation; large scale 2D – experiment; wave attenuation; extreme design waves.

1 INTRODUCTION

Hard coastal structures such as dikes covered with asphalt or placed block revetments have been widely used in the past for coastal protection in densely populated deltas around the world. Nonetheless, in recent years the effectiveness of hard structures has been questioned in light of the inevitable effects of climate change and their static nature. Decades of research on how salt marshes can play a role within a comprehensive coastal protection scheme suggest that these low environmental impact structures (Maza et al., 2015) might have the capability of dissipating wave energy and hence be technically and formally considered within hybrid coastal erosion and flood protection systems (Borsje et al., 2011). However, only very few studies investigated wave attenuation by real salt marsh vegetation in large-scale laboratories (Ghodoosipour et al., 2022; Maza et al., 2015; Möller et al., 2014) and none of them addressed extreme hydrodynamic design conditions in terms of wave energy and water levels. As a result of this knowledge gap, salt marshes in The Netherlands and all around the world have never been formally considered within the coastal flood protection systems and the underlying risk assessment. With this contribution our aim is to provide an overview of the first worldwide large-scale test focused on the interaction between a salt marsh (i.e. vegetation and shallow foreshore) and extreme hydrodynamic conditions, the adopted measurement techniques and the preliminary results in terms of wave damping, erosion and removed biomass.

2 METHOD

Aiming to assess the hydrodynamic load reduction on a dike due to a salt marsh, one month test series is planned in Deltares' Delta flume (291 m long, 5 m width and 9.5 m high) for late winter 2024. The laboratory set-up consists of 71 m long salt marsh composed of two model sections of 35 vegetated clay blocks. The first 8 and the last 2 blocks per section are 2 m wide, 2 m long and 0.7 m high and are installed at the edge of the salt marsh and at the intersection with the dike toe where the largest hydrodynamic load is expected. The remaining 25 blocks share the same planar dimensions but are 0.4 m high. The offshore salt marsh edge is made of a 0.6 m step to reproduce the seaward cliff resulting from the horizontal gradients in sediment deposition and consolidation, Colosimo et al., 2023. The 2.1 flume bottom is realised with sand covered with a layer of light concrete to avoid erosion outside the measurement sections. Roughly 40 m long foreshore is built off the salt marsh cliff with a steepness of 1:45, while 12.5 m steeper slope (i.e. 1:9) is realised to allow a smooth bottom transition, natural wave propagation and to save construction material. Shoreward the measurement sections are bounded by a light concrete 11 m high dike with 1:3.6 slope. Figure 1 summarises the laboratory set-up.

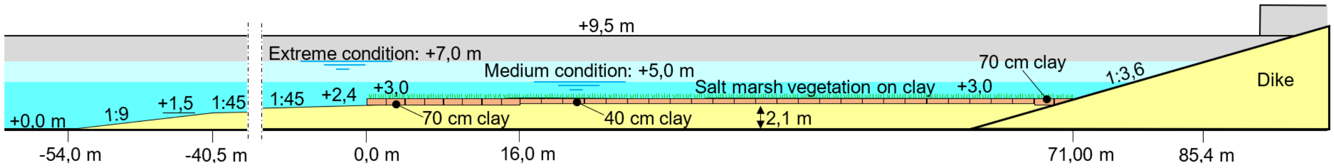

Figure 1. Laboratory set-up

The blocks composing the laboratory salt marsh were collected during September 2023 in the Peazemerlannen Nature Reserve located in Friesland in the northern part of the country, **Error! Reference source not found.**. The location selection was based on the presence of an relatively undisturbed high salt marsh with the locally dominant climax vegetation species *Elymus athericus* mixed with *Atriplex spp.* and *Aster tripolium*. Samples of the soil material were analysed to characterise the grain size composition and its dependence with the erosion.

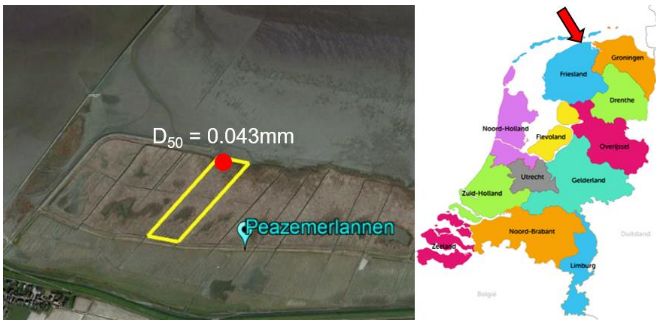

Table 1. Example of soil composition

Soil composition			
Gravel	(2 mm - 63 mm)	[%]	-
Sand	(63 µm - 2 mm)	[%]	37
Silt	(2 µm - 63 µm)	[%]	43.4
Clay	(< 2 µm)	[%]	19.7

Figure 2. The red dot indicates the seaward location of the marsh blocks collection

A civil contractor supported the blocks harvesting process making use of heavy cranes, steel and wood boxes to facilitate the cutting, collection and transport of the boxes, Figure 3. The collected boxes were transported to the Delta flume where they are stored and maintained with continuous watering activities both with fresh and salt water to realistically reproduce the (saline) water content in the field.

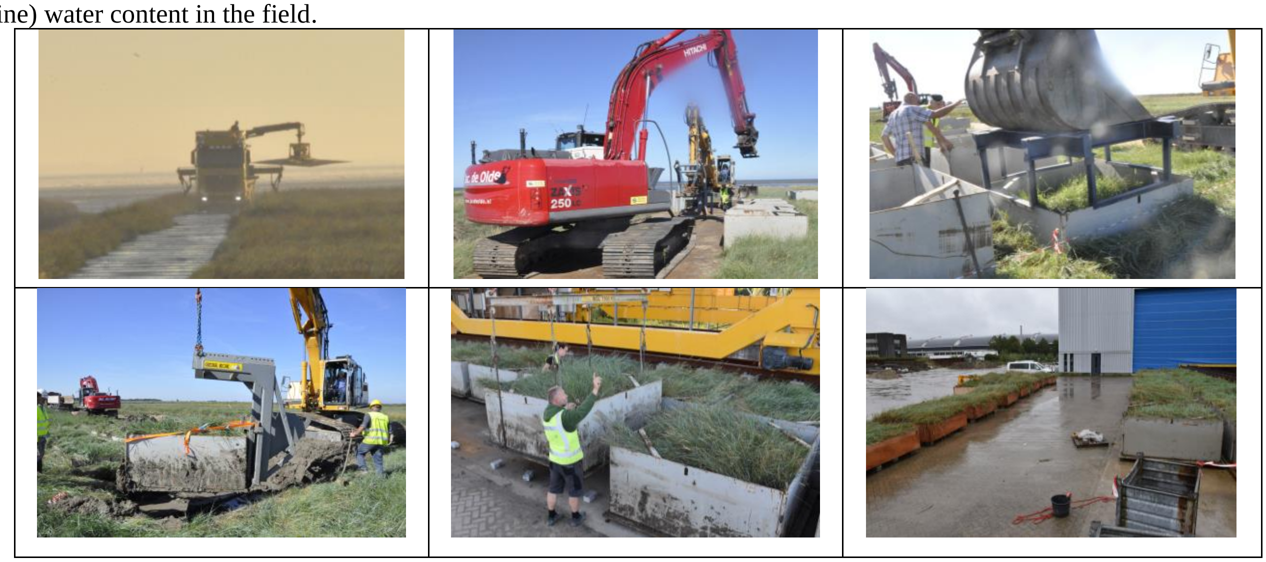

Figure 3. Sequence of field activities during salt marsh boxes collection and transport to the Delta flume

During the test the water surface elevation will be measured with three laser scanners and several wave gauges. Wave induced pressure on the dike and inside the cliff will be measured as well as water velocity along the water column and at the salt marsh bottom. Accelerometers will be installed within the cliff soil boxes to identify the timing of internal fracture otherwise invisible. Run-up and overtopping will be both measured through optical technique and wave gauges. The behaviour of vegetation during the runs will be observed. Combination of three water levels (+6.9, +5.0 and +3.0m) and extreme waves with H_S up to 2,0 m will be run, while after each test the removed biomass and erosion will be measured as well.

3 RESULTS

At the conference the preliminary results in terms of measurement techniques effectiveness, incident wave field transformation, wave pressure and removed biomass will be presented as well as the adopted procedures to maintain the salt marsh vegetated blocks.

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