EFFECTS OF WAVE LOAD ON THE LONG-TERM VEGETATION DEVELOPMENT AND THEIR RESISTANCE AS GRASS REVETMENTS ON SEA DIKES

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INTRODUCTION

Construction and design processes of revetments, sea dikes and estuarine dikes along the German coastline adhere the paradigm to protect and safeguard reliably the coastal hinterland from wave attack and storm surges. Following these standards coastal protection structures provide only poor ecosystem services in any proper design or maintenance approach. As a result, the EcoDike-project has been started with the aim to quantify and enhance the ecosystem services of revetments, sea dikes and estuarine dikes while preserving or possibly even enhancing the existing safety standards. Therefore, a profound understanding of the complex long-term interactions between wave load and vegetation development on sea dikes is inevitable. To achieve these objectives a typical seadike in prototype scale is tested under realistic and long-term wave loading in the new outdoor wave basin at the Ludwig-Franzius-Institute in Hannover (Germany).

STATE OF THE ART

Silinski et al. (2015) showed that vegetation can adhere avoidance and tolerance strategies for different life stages and thus interacts differently to wave load or currents in its lifetime. Heuner et al. (2015) describe this approach as an ecosystem engineering that results from a dynamic relationship between effects and response traits of vegetation and wave load. The transplantation experiments from Blanchette (1997) proof the high potential of vegetation to adapt to changing wave load following the avoidance strategy by decreasing size and stiffness to reduce the drag forces. Further investigations from Coops et al. (1996) showed that vegetation will also react with different root depths and densities to changing wave load. Considering the top layer of soil with a dense net of roots as the major component for the safety standard of the revetment, the enhancement of the ecosystem services of dikes demands a profound understanding of the interactions between the chosen target vegetation and the wave load to guarantee the dike resistance and durability of revetments and sea dikes for coastal protection.

METHODOLOGY

To identify the effects of wave load on the long-term vegetation development, a typical prototype seadike with a height of 1.5 m, width of 14 m and slope of 1:6 is constructed in an outdoor wave basin. The dike is divided into two sections in order to investigate the vegetation development with and without stresses induced by wave loads. Each of these sections is further divided into four subsections containing four target vegetation with different ecological values. For the upcoming vegetation period 2018, the target vegetation will be exposed to storm surges with wave heights of 0.1 to 0.3 m and periods of 1 to 3 s for 7 to 10 h every second week. Furthermore, short test sets with regular waves to estimate wave run-up heights and maximum flow velocities on the dike for different stages in the anticipated lifetime of the target vegetation will be conducted. After the vegetation period, the vegetation development (for e.g. root depth, -density, coverage index, species composition) and the resistance of the dike will be quantified and analyzed. The shear strength and the maximum vertical uplift force is estimated to evaluate the dike resistance. In addition, the direct and indirect effects is investigated by monitoring the soil quality and soil nutrition content. Furthermore, the chlorophyll fluorescence will be measured to test if it is possible to detect wave stress by this parameter.

RESULTS

At the time of the presentation current monitoring data is presented. In the full paper, results help understanding the effect of the wave loads on the vegetation development on seadikes. Thus, correlations between measured parameters for vegetation development (for e.g. root density) and dike resistance (for e.g. shear strength and vertical uplift force) are identified. Furthermore, it is possible to quantify the effect of wave load on the dike resistance regarding the vegetation development for innovative dike monitoring approaches.

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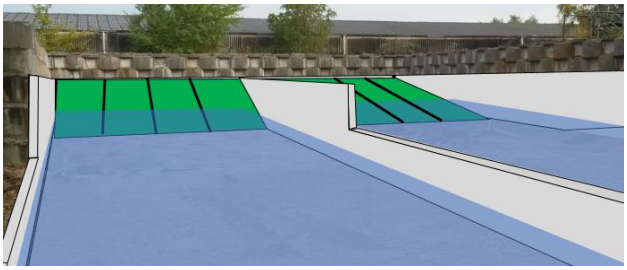

Figure 1 - Model dike with two 7 m sections each containing four 1.75 m subsections with target vegetation

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