MODELLING THE EFFECT OF SALT MARSHES FOR COASTAL PROTECTION

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BACKGROUND

Salt marshes are populated in the East Frisian Wadden Sea behind the barrier islands and in the foreland areas, functioning as a coastal protection measure and carbon sink, and enhancing biodiversity and ecology. Increased understanding of the interactions of salt marshes with hydro-morpho-dynamics supports to use them as a nature-based-solution (NBS) for the coastal protection.

The main objective of this study within the framework of the EU REST-COAST project is to quantify the role of salt marshes in wave attenuation and mitigation of coastal erosion for different present and future scenarios, and to increase awareness of policy/coastal managers using salt marsh as a potential NBS for coastal protection.

This investigation is being carried out using the exemplary salt marsh community in Ley Bay, which has dimensions of about 5 km × 5 km, and is located in the tidal basin behind Borkum and Juist barrier islands, adjacent to the Ems-Dollard estuary (Fig. 1a). The salt marsh community covers about ⅓ of the bay area lying around +2 m NN attached to the foreland dyke (Fig. 1b and c: green-polygon). The study area is characterised by semi-diurnal meso-tides (mean tidal range ~2.5 m) and high waves (Hs) from the N-W sector reaching up to about 6 m (at 20 m depth) (Herman et al., 2009).

APPROACH

Two numerical experiments were carried out using the process-based modelling tool Delft3D to investigate the effect of salt marsh on hydro-morpho-dynamics. Forcing during the storm event *Herwert* occured in October 2017 (water level > 2.5 m and Hs > 1.2 m in Ley Bay) and lasted more than 45 hours, was selected for the experiments without and with the salt marsh application, which was implemented based on Baptist (2005). The model domain (OEMS: 40 km × 40 km) covers the entire inlet-basin system between Borkum and Juist islands, and the offshore boundary is located around 20 m depth contour. A model nesting of 2 domains was used to downscale local hydrodynamics. The largest domain was forced with spatiotemporal water levels and waves, obtained from a North Sea model (Jacob et al., 2023). Simulated water levels, currents and waves were used for the forcing of the highest resolution OEMS domain, which has a maximum grid resolution of about 30 m × 100 m in the Ley Bay area. Bed sediment composition has a spatial varying sediment thickness and 6 fractions ranging from mud to 0.4 mm coarse sediment. No morphological acceleration was applied for the simulations. Predicted hydrodynamics at P1-P6 (Fig. 1c) and morphodynamics in Ley Bay were analysed to explore the salt marsh effect. The model was initially calibrated and validated with respect to water level and wave prediction.

RESULTS

Calibration and validation show good agreements with the measured water levels ($RMSE_{max}$= 0.20 m) and Hs ($RMSE_{max}$ = 0.05 m). P1, located in a narrow salt marsh area, has fairly same water levels and Hs in both experiments. Locations in the middle of salt marsh P2, 4 and 6 show no water level variations and almost zero Hs in the salt marsh experiment compared with the other (e.g., at P4: water level 3 m and Hs 0.45 m). Of them, the maximum reduction of hydrodynamics (~100%) is found at P2, furthest point from the salt marsh edge. Both P3 and 5 located close to the edge show reductions of water level and Hs by 8% and 20% respectively. Only P1,3 and 5 in Fig. 1c show velocities (maximum reduction > 90%). Strong erosion and sedimentation in the salt marsh area is shown only with the experiment without the salt marsh implementation. The maximum morphodynamics vary about ±0.03 m during the storm impacts (Fig1b and c).

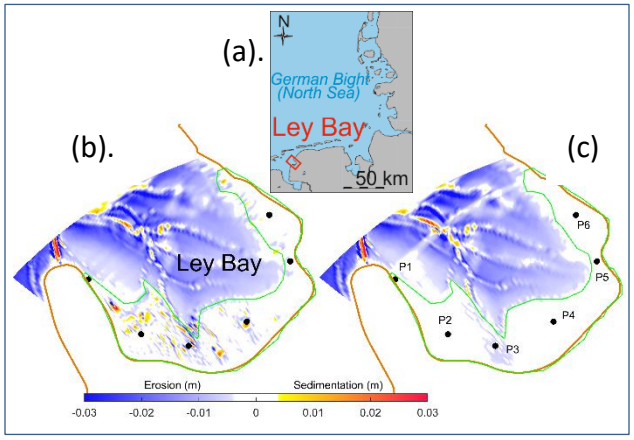

Fig. 1 Location of Ley Bay in the East Frisian Wadden Sea, German Bight (a), predicted morphodynamics (for clarity only a part of the model domain is shown) without (b) and with (c) Salt marsh area (green-polygon) during the storm *Herwert* (Oct-2017). Monitoring points: P1 – P6.

PRELIMINARY CONCLUSIONS

Obviously salt marshes play a significant role in damping hydrodynamics and thus erosion prevention. On-going study focuses on implementing different plant species and growth of salt marsh during morphodynamics, which is not yet available in the modelling tool, in simulating salt marshes as a potential NBS for coastal protection.

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