Breach the dikes! How to design saltmarsh restoration schemes for mitigating coastal flooding.

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Managed realignment (MR), a form of of nature-based coastal adaptation to reduce flood and erosion risk, involves the abandonment of existing sea defences and their relocation further inland. MR aims to (re)create intertidal habitats, such as saltmarshes, between the old and new lines of defence; as well as flood water storage. The newly created habitats dissipate wave energy and thus provide new natural coastal protection. However, the assessment of the success of MR is difficult, as restoration targets are often vague and data on project performance are scarce. The few studies that do exist show a lack of understanding about the effects of MR scheme design on high water level (HWL) attenuation and thus its coastal protection function.

Here we present the results of a 2-D hydrodynamic model, calibrated and validated against field measurements of equinoctial tides between August and October 2017, taken within, and seaward of, the Freiston Shore MR site, The Wash, eastern England. Using this model, we performed sensitivity analyses to explore whether or not, and how, the Freiston Shore MR scheme design affects HWL attenuation. For this purpose we changed the configuration of the old defence line and the breaches created within it for renewed tidal exchange and manipulated the digital elevation model of within-site topography. Specifically, we applied six scheme design scenarios (two scenarios with three breaches and varying MR areas, three single breach scenarios of different breach width and one bank removal scenario) and assessed High Water Level (HWL) attenuation rates for each scenario.

Our results show that scheme design, particularly storage area and number and size of breaches, of the Freiston Shore MR site had a significant effect on the site’s HWL attenuation capacity. When the tidal prism is varied by changing the number and size of breaches and the storage area kept constant, modelled HWL attenuation rates increased with decreasing tidal prism. However, largest HWL attenuation rates (> 10 cm km\textsuperscript{-1}) were only obtained if the MR area was of sufficient size, therefore, it is only the larger sites which are exhibiting effective coastal protection. Consequently, the maximum modelled HWL attenuation rate occurred (up to 73 cm km\textsuperscript{-1}) for the scenario with the largest area (142 ha).
The Mean High Water Depth (MHWD) from each of these scenarios explained most of the variation in HWL attenuation between the scenarios ($R^2 = 0.996$). This strong correlation may help to inform the construction of more efficient MR schemes with respect to coastal protection in the future.