NATURE-BASED COASTAL PROTECTION: WAVE DAMPING BY FLEXIBLE SALT MARSH VEGETATION

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INTRODUCTION

The ability of coastal vegetation to attenuate waves has been well established (Möller et al., 2014). Salt marshes are vegetated coastal wetlands that can act as nature-based coastal defenses. They exhibit a range of plant species, which have been shown to differ in the amount of wave damping they provide (Mullarney & Henderson, 2018). Recent studies have shown that plant flexibility is a key parameter that controls wave energy dissipation (Paul et al., 2016). Yet, no model exists that includes plant flexibility in computationally efficient manner for large-scale coastal zones. Therefore, we have developed a new model for flexible vegetation based on the key mechanisms in the wave-vegetation interaction and applied it to an estuary with diverse salt marsh vegetation.

STUDY AREA

The Taf estuary in South Wales, UK, is a macro-tidal estuary with extensive salt marsh areas (Fig. 1). The vegetation ranges from stiff shrubs such as *Halimione Portulacoides*, to flexible grasses such as *Puccinellia Maritima*. The town of Laugharne relies on salt marshes for flood protection as no hard defenses are in place.

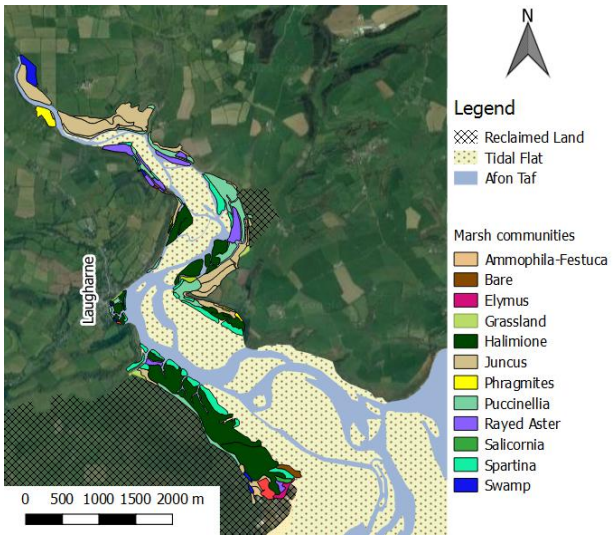

Figure 1 - Map of the Taf estuary.

METHODS

We have conducted physical and numerical modelling to quantify the impact of plant flexibility on wave damping by vegetation. Experiments using rigid and flexible artificial vegetation were conducted in the Swansea University Coastal Engineering Laboratory. Wave attenuation, wave velocity fields and plant motion (Fig. 2) were measured simultaneously for the first time. The key physics in the wave-vegetation interface were identified based on this combined dataset. Subsequently, a new model which considers the two-way wave-vegetation interaction was developed for flexible vegetation, including the effect of wave forcing on plant motion and the feedback of plant motion on wave forces. Finally, we have implemented the model in large-scale coastal modelling suite Delft3D (Lesser et al., 2004) and applied it to study wave attenuation over multiple species in the Taf estuary.

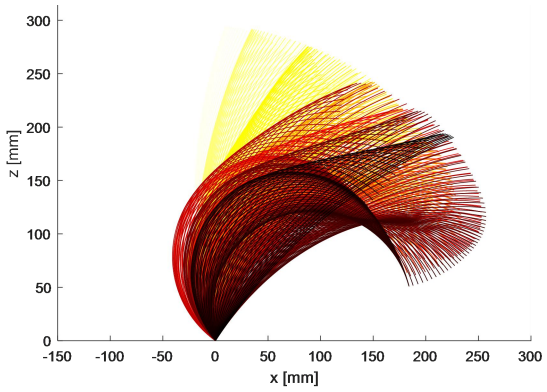

Figure 2 - Observed plant motion over eight wave cycles. Shading indicates the timestamp of each plant position. They range from yellow (start) to black (end)

RESULTS

Our model successfully reproduces wave damping over two types of artificial vegetation and three real salt marsh species with variable flexibility. We find that flexible vegetation can reduce wave damping by an order of magnitude depending on the biomechanical properties of the plant and wave conditions. This can significantly affect the protection provided by nature-based defenses.

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Rural Affairs. This research was supported by the UK Research Councils under Natural Environment Research Council award NE/N013573/1, Title CoastWEB: Valuing the contribution which COASTal habitats make to human health and WEllBeing, with a focus on the alleviation of natural hazardsTvV acknowledges funding from Swansea University for his PhD studentship.

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