SEASONAL DRIVERS FOR MANGROVE SEEDLING ESTABLISHMENT

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INTRODUCTION

Mangrove forests are located along (sub)tropical shorelines and can contribute to flood risk reduction and shoreline stabilization. Evidence of the wave-attenuating function of mangroves is increasing, but knowledge gaps persist regarding the critical conditions to mangrove forest development. The implementation of mangroves in coastal engineering practice also requires a firm understanding of these critical conditions (Gijsman et al., 2021).

Conditions and thresholds for mangrove seedling establishment are key in the long-term development and survival of mangroves. Compared to mature mangrove trees, establishing young mangrove seedlings are much more vulnerable to daily to seasonal fluctuations in hydrodynamics and bed level dynamics (Balke et al., 2015).

This study aims to develop a mangrove seedling establishment model to study the biophysical interactions and feedbacks between mangrove forests, tides, waves, sediment dynamics and seedlings. Combining field observations and numerical modelling, we will assess the critical conditions for mangrove seedling establishment on a daily to seasonal timescale.

FIELD SITE

This study considers a rapidly accreting mangrove forest in the Firth of Thames estuary, New Zealand (Figure 1). Over the last 50 years, the combined accretion and presence of inter-annual climate variability have induced several seedling establishment events that have created a clear zonation in the mangroves. These events are related to periods of calm weather (Lovelock et al., 2010). The Firth has also been actively monitored for more than a decade, comprising (intermittent) measurements of water levels, wind, waves, suspended sediment concentrations, bed level dynamics and surface elevation changes. The measurements take place along a cross-shore gradient from the unvegetated mudflat through the mangrove forest fringe (Figure 2).

MODEL DEVELOPMENT

The field data are used to calibrate a process-based numerical model (Delft3D-FM), which is online coupled to a newly developed individual-based seedling establishment model. The seedling establishment module incorporates rules for the delivery, anchoring and early development of mangrove propagules in the same area (cf. Balke et al., 2015).

The model is validated by comparing hindcasts of past seedling establishment events with the observed mangrove zonation in the Firth.

Figure 1 – Firth of Thames estuary, New Zealand

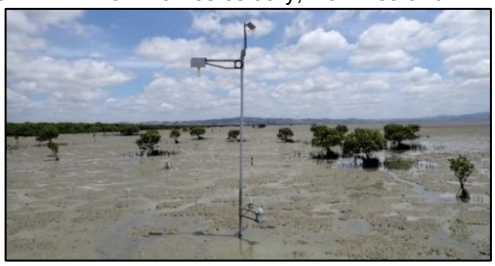

Figure 2 – Monitoring station in the mangrove forest fringe

RESULTS AND OUTLOOK

The combined field data and numerical model allow us to investigate critical establishment conditions for mangrove seedlings. In addition to the daily hydrodynamics that can dislodge mangrove seedlings, preliminary results indicate a clear monthly variation in seedling amounts related to spring-neap cycles. This variability is dominated by spring tides that increase the daily hydrodynamics inside and in front of the forest, but they also form a source for seedling delivery. An extension of the modelled time frame will accommodate a study on the effects of seasonal variability in hydrodynamics. These simulations will reveal the critical establishment conditions for seedling in the Firth of Thames and can support wider assessments of the importance of (restoration of) suitable hydrodynamic conditions for seedling establishment in mangroves.

REFERENCES

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