CREEK RESTORATION EFFECTS ON TIDAL DYNAMICS IN MANGROVES

Erik Horstman, University of Twente, E.M.Horstman@utwente.nl
Rik Gijsman, University of Twente, R.Gijsman@utwente.nl
Rob van Zee, University of Twente, R.vanZee@student.utwente.nl
Sabine Engel, Mangrove Maniacs, Sabine@mangrovemaniacs.org
Jessica Johnson, Coastal Dynamics, info@coastal-dynamics.com
Daphne van der Wal, University of Twente & NIOZ, D.vanderWal@utwente.nl
Kathelijne Wijnberg, University of Twente, K.M.Wijnberg@utwente.nl

INTRODUCTION

Mangroves provide natural buffers between land and sea, protecting both coastal communities and nature as they attenuate waves and stabilize shorelines but also filter terrestrial runoff. Tropical mangroves are also biodiversity hotspots and provide other ecosystem services such as supporting fish and shellfish habitat, accommodating ecotourism and sequestering carbon. Nevertheless, mangrove coasts have become increasingly exposed to changing environmental conditions, a trend that has resulted in a declining mangrove cover on a global scale. At the protected Ramsar site of Lac Bay, Bonaire (Figure 1), large areas of mangroves have been subject to deterioration and tree mortality (Senger et al., 2021). Excessive sediment inputs from the land and mangrove growth have clogged existing creeks and reduced hydrodynamic circulation through the mangrove system. Resulting changes in sedimentation rates, submergence and water quality affect the survival of the inland mangroves in Lac Bay (Figure 2). The (re-)creation of suitable morphological and hydrodynamic conditions is key for mangrove restoration (Friess et al., 2019). This study investigates the potential of creek restoration to increase the hydrodynamic circulation in the mangroves of Lac Bay, thereby accommodating their survival.

FIELD INVESTIGATION

Lac Bay has an extent of about 700 ha, comprising coral reefs and a lagoon surrounded by mangroves. The forest fringe consists of *Rizophora mangle*, while the more saline and muddier inland forest is dominated by *Avicennia germinans* and *Laguncularia racemosa* (Senger et al., 2021). During a 6-week field campaign we monitored concurrent water levels and flow speeds throughout the area (Figure 1) and surveyed both the bathymetry and mangrove vegetation. Sediment concentrations and bed level dynamics were monitored simultaneously.

MODEL SIMULATIONS

A numerical model of Lac Bay is being created in Delft3D, allowing for accurate simulations of the tidal dynamics in the Lac Bay mangroves (Horstman et al., 2015). Vegetation-induced drag will be incorporated in the model through spatially explicit schematizations of the diameter, height and density of the mangrove stems and roots.
The validated model will first be deployed to quantify the current tidal circulation in the Lac Bay mangroves and the contribution of the creek system. Subsequently, scenarios will be simulated exploring the impacts of widening and deepening of the existing creeks as well as the extension of the creek system towards the areas suffering of mangrove die-back (Figure 1).

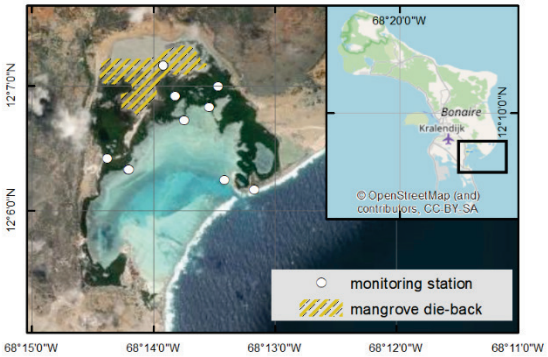

Figure 1 – Lac Bay, Bonaire (Dutch Caribbean).


Figure 2 – Mangrove die-back in the north of Lac Bay.

OUTLOOK

The comprehensive series of concurrent field data allows us to quantify the tidal dynamics in front, inside and behind the mangroves of Lac Bay. Initial field data analysis has shown a substantial delay of the high tide across the forest, identifying the impeded tidal exchange between the lagoon and the back-waters north of the mangroves. Results of the numerical model simulations will be used to quantify the contribution of the remaining creeks to the tidal exchange in Lac Bay, and the possibilities to increase this tidal exchange through creek restoration. These findings will provide a better understanding of the potential contribution of creek restoration activities in mangrove management and rehabilitation programs.

REFERENCES

Friess et al. (2019): The State of the World's Mangrove Forests: Past, Present, and Future. Annual Review of Environment and Resources, 44(1), 89-115.
Horstman et al. (2015): Tidal-scale flow routing and sedimentation in mangrove forests: Combining field data and numerical modelling. Geomorphology, 228, 244-262.
Senger et al. (2021): Impacts of wetland dieback on carbon dynamics: A comparison between intact and degraded mangroves. Sci. Total Environ., 753, 141817.