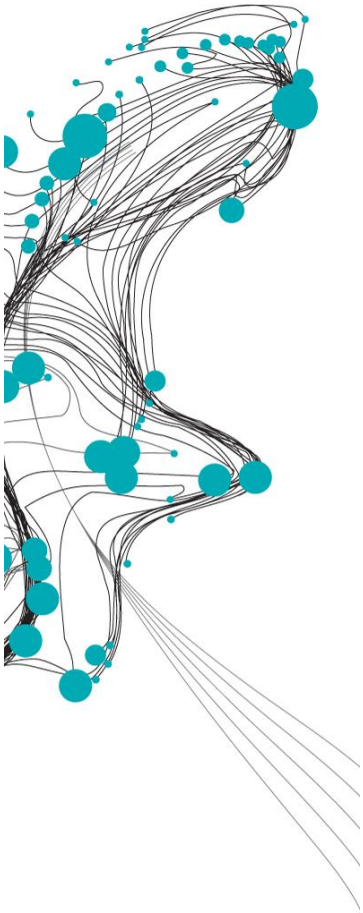
THE ROLE OF CREEKS FOR TIDAL EXCHANGE IN THE MANGROVE FOREST OF LAC BAY, BONAIRE



The mangrove forest in Lac Bay, Bonaire, experiences a die-off of trees in its northern area (Awa di Lodo). This die-off is caused by a combination of hypersaline conditions, long inundation periods and excess sedimentation. It is expected that an increase in the tidal exchange between Lac Bay and Awa di Lodo will improve environmental conditions for mangroves to grow. Due to mangrove roots growing into the creeks in combination with sedimentation, the creeks eventually close off, reducing the creek flow. The Mangrove Maniacs are restoring the creeks in Lac Bay (figure 2) to improve creek flow and they want a better understanding of the impacts of their work. This study aims to create more insight into the tidal-induced hydrodynamic processes in Lac Bay and the contribution of creeks in the mangrove forest to the tidal exchange.

During a field campaign from January to March 2022 field data were collected on flow velocities, water levels and topographic characteristics of Lac Bay. The field measurements show that the tidal wave is diurnal and has a negligible delay propagating through the open water of Lac Bay. In Awa di Lodo, high water is reached on average more than four hours later than in the open bay. During spring tide, the tidal range in the open water is sufficiently large to create an increasing trend in the water level in Awa di Lodo. The water level lowers again when the tidal range decreases during neap tide. Flow velocities in the creeks mainly depend on the water level difference between the open water and Awa di Lodo. Both ebb and flood dominant peak velocity asymmetries are observed in the creeks. A flood dominant tidal duration asymmetry in Awa di Lodo indicates that sheet flow during high tides is responsible for the fast increase of the water level in Awa di Lodo while during low tides the creeks are responsible for the outflow.

Based on the data from the field campaign, a hydrodynamic model (Delft3D) was built to analyse the effects of tidal creeks restoration on flow velocities, tidal exchange and water levels of Awa di Lodo (figure 1). The model shows that creeks significantly influence the tidal exchange between the open water and Lac Bay. A new creek connection to Awa di Lodo, either by extending the centre creek or by creating a new creek, is found to be the most efficient to increase the tidal exchange (table 1). It was concluded that the widening of the creeks, deepening of the creeks or extension of the eastern creek system would have a limited effect on the tidal exchange. Creek restoration is shown to be an effective measure to increase the tidal exchange in the mangrove forest of Lac Bay.

Table 1: Tidal exchange, residence time and the ratio of the residence time compared to the reference scenario of each modelled scenario. Red coloured rows indicate a decrease in tidal exchange and blue coloured rows indicate an increase in tidal exchange. A darker shade implies a greater decrease/increase

Scenario	Tidal exchange [10^5 m^3/day]	Residence time [/day]	Ratio of change in residence time compared to reference scenario [-]
Reference	1.09	4.15	1.00
No creeks	0.61	7.35	1.77
Increasing depth	1.20	3.76	0.91
Decrease depth	0.92	4.90	1.18
Increase width	1.23	3.65	0.88
Decrease width	0.94	4.79	1.16
Extension CC	1.38	3.27	0.79
New creek	1.59	2.83	0.68
Extension EC	1.13	3.99	0.96

Figure 1: Creek in Lac Bay opened by the Mangrove Maniacs

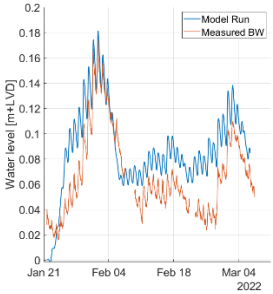


Figure 2: Modelled (blue) and measured (orange) water levels in Awa di Lodo

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