Understanding the effect of permeable brushwood dams on the hydro- and sediment dynamics on a tropical mangrove mudflat

Dax Boot (1), Maarten van der Vegt (1), Marije Smit (2)
1 Utrecht University, bootdax@gmail.com, M.vanderVegt@uu.nl,
2 Witteveen+Bos, marije.smit@witteveenbos.com

Introduction and background

- **Problem:** Severe coastal erosion due to mangrove removal.
- **Question:** What is the effect of permeable brushwood dams on the hydro- and sediment dynamics on a tropical mangrove mudflat?
- **Aim:** Determine effectiveness of such a dam as a function of water level, wave conditions and position of the dam.
- **Hypothesis:**
  1. More energetic conditions➜dam has larger effect
  2. Larger effect on sediment dynamics than on hydrodynamics
  3. Larger water depth➜less effect dam
  4. Waves cause erosion while tides transport sediment.

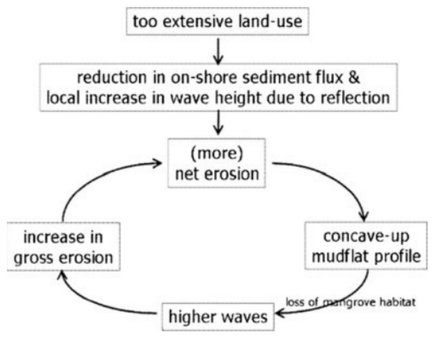

Figure 1: Problem definition, Winterwerp et al. (2013).

Figure 2: Example of brushwood dams in Indonesia. Source: Ecoshape.nl

Methodology

- 2DV numerical modeling in SWASH.
- Dam modeled with vegetation module in SWASH.
- Waves and tides are coupled through tidally induced water levels for stationary wave runs (24 per tidal cycle).

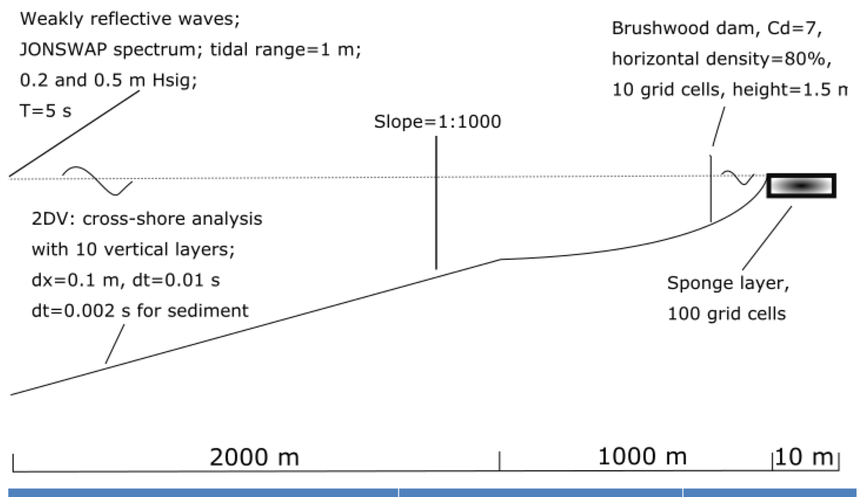

Figure 3: Model setup for concave profile.

	Hydrodynamics	Sediment dynamics
Dam loc (m from shoreline):	100, 150, 200, 300	200
Hsig (m):	0,2 and 0,5	0,2
Profile:	Concave and convex	Concave

Table 1: Overview model runs.

Results

1. Hydrodynamics

- Brushwood dams cause a decrease in wave height, near bottom orbital velocity, velocity and vertical eddy viscosity.
- Wave height transmission (Kt) smaller for lower water depths.
- Dam slightly more effective in more energetic conditions.

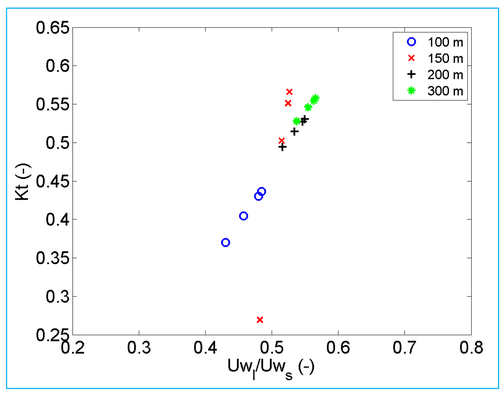

Figure 4:
Orbital velocity ratio landward and seaward of dam against transmission coefficient.

2. Sediment dynamics

- Lower sediment concentration landward of dam.
- Decrease in concentration towards surface.
- Waves erode sediment, tides transport it.

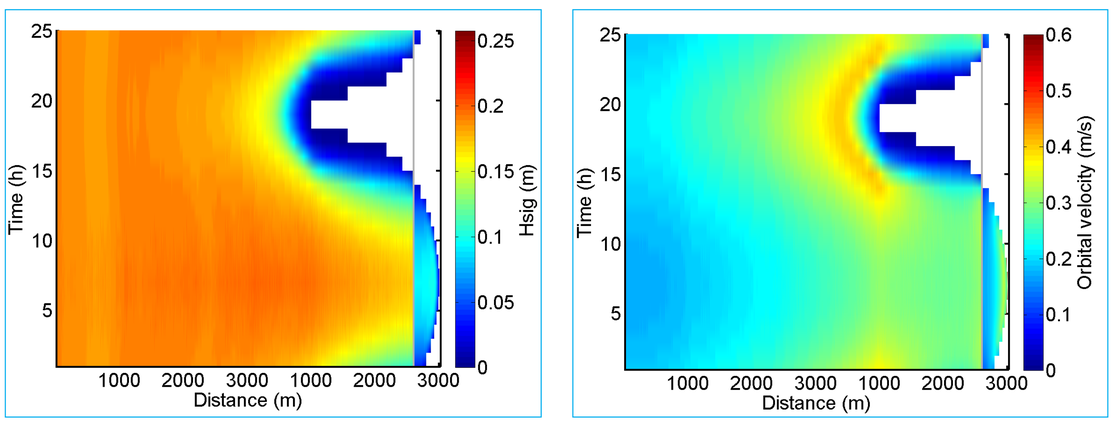

Figure 5:
Wave height (left) and near bottom orbital velocity (right) at cross-shore locations in time.

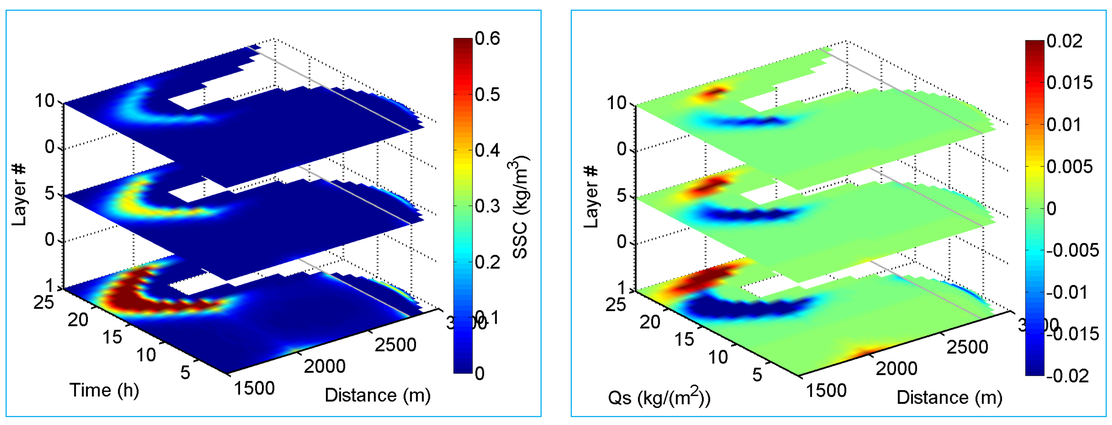

Figure 6:
Suspended sediment concentration (left) and Sediment transport (right) at cross-shore locations in time.

Conclusions

- All hypotheses confirmed:
  1. Under larger energetic conditions dam has a larger effect.
  2. This effect is larger for sediment than for hydrodynamics.
  3. Water depth is important in effectivity of the dam.
     - Dam more effective at lower water depth
  4. Waves mainly cause erosion, tides dominate sediment deposition.
- Eroded sediment on foreshore will be transported to the upper flat and deposited.
- Results suggest and imply that eventually feedback loop of Winterwerp et al. (2013) will reverse.

Limitations

- Due to numerical instabilities only a limited number of simulations have been performed.
- Field data is missing against which model results can be validated.

Further research

- Study long-term morphodynamic evolution.
- More sensitivity on dam design.
- Data collection to improve model.

References

Winterwerp, J., P. Erftemeijer, N. Suryadiputra, P. Van Eijk, and L. Zhang (2013). Defining eco-morphodynamic requirements for rehabilitating eroding mangrove- mud coasts. Wetlands 33(3), 515–526