Title of the project: Living on the Edge - Tipping points for mangrove dynamics in an urban environment	
Assignment no.: 37.18	**Internal/external:** Internal
Head graduation committee: K.M. Wijnberg	**Daily advisor:** E.M. Horstman P.W.J.M. Willemsen B.W. Borsje
Name(s) of participating companies or institutes: -	**Start of the project:** 1st quarter of 2019

Short description and objective of the project:

This project focusses on the sheltered Mandai mangrove ecosystem on the north shore of Singapore. The urban setting of this mangrove forest and the presence of a stop bank at the landward side of the mangroves cause physical stresses in terms of the sediment supply to, and limited accommodation space of the mangroves. We have previously studied the consequences of these urban impacts on the hydrodynamics and sediment dynamics at this site, concluding that the sediment dynamics in Mandai mangrove currently are compromised by these stresses. Survival of Mandai mangrove is critically dependent of the establishment and development of new seedlings. Field measurements and the numerical model we developed before lacked vegetation dynamics (i.e. establishment and survival of seedlings) and their feedback on hydro- and sediment dynamics. In the proposed project you will fill this gap by addressing the impact of the (affected) tidal hydrodynamics and wave-induced sediment dynamics in the urban Mandai mangrove on seedling survival and development and the subsequent feedback mechanisms.

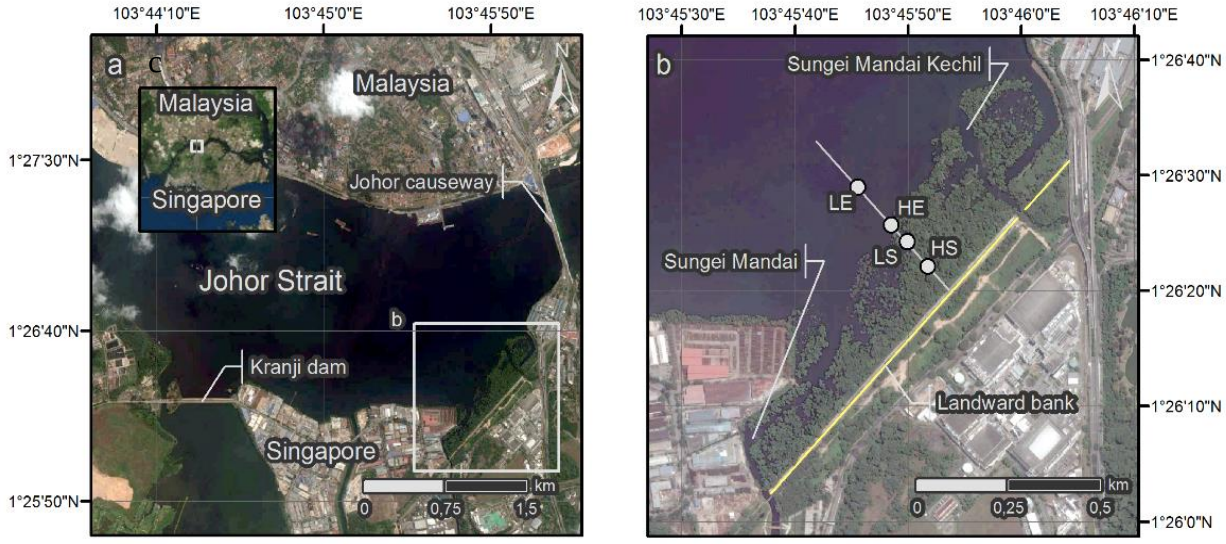

Figure 1 – Study site: (a) the location of Mandai mangrove at Singapore's North shore; and (b) plan view of Mandai mangrove with four planned monitoring sites (LE = low-elevation and exposed; LS = low-elevation and sheltered; HE = high-elevation and exposed; HS = high-elevation and sheltered).

In this project, you will develop a mangrove vegetation dynamics model, combining the Windows

of Opportunity required for seedling establishment [*Balke et al.*, 2011; *Balke et al.*, 2015], complemented by rules for tree growth and competition [*Berger and Hildenbrandt*, 2000; *Chen and Twilley*, 1998]. You will then link this vegetation dynamics model with an updated version of the previously developed Delft3D model of Mandai mangrove, including the area's current topography and vegetation cover [*Willemsen et al.*, 2016]. The new model will run in Delft Flexible Mesh (DFM) to allow for the proper implementation of the seedling dynamics and to improve computational performance. With the coupled DFM and mangrove forest dynamics model (DFM-MFD) you can run combined simulations of the hydro- and sediment dynamics, the resulting morphological change, its impact on mangrove establishment and development, and the subsequent feedback on hydro- and sediment dynamics.

There might be a possibility to conduct fieldwork in Singapore for a period of three months (March/April/May or June/July/August), to collect measurements of vegetation, hydrodynamics and sediment dynamics. Those measurements, in addition to already obtained field data, will be used to calibrate and validate the DFM-MFD model

Eventually, this model can help to study the resilience of the Mandai mangrove to (further) external disturbances and to quantify potential tipping points in their development.

This assignment requires a keen interest in programming, numerical modelling and conducting fieldwork abroad. We expect you to have finished the courses Long waves and Tidal Morphodynamics, Short Waves and Coastal Dynamics (or Marine Dynamics and mathematical Physics) Data Analysis and Morphology.