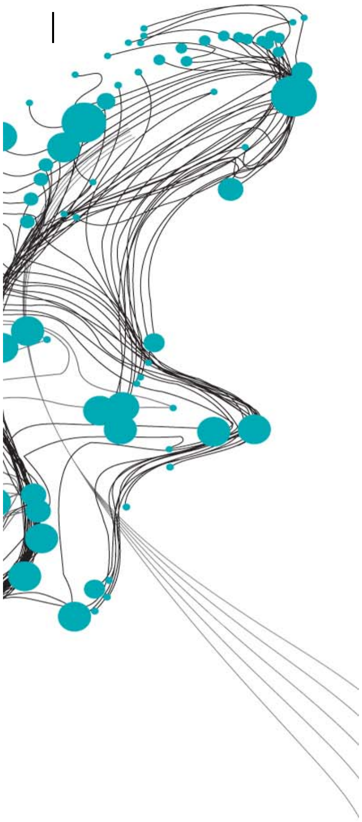
REPRESENTING SPATIALLY VARIABLE BATHYMETRY AND VEGETATION IN A HDYRODYNAMIC MODEL: A SUBGRID-BASED CASE STUDY IN THE WHITIANGA ESTUARY, NEW ZEALAND



Mangrove eco-systems have proven to be a cost-effective and sustainable alternative to traditional 'hard' engineering solutions and can be used for complementary coastal protection. At the same time, mangroves are vulnerable ecosystems and their functionality as coastal defence can collapse if hydrodynamic thresholds are being exceeded. To learn more about the functioning and persistence of mangroves, hydrodynamic models are often used to explore the sensitivities of these systems. The problem with hydrodynamic models is that often a trade-off must be made between the spatial resolution and computational times. However, the relatively new modelling method of subgrid hydrodynamic modelling has shown to be able to accurately deal with high-resolution spatial data without hugely influencing computational cost of the model.

This research focuses on how vegetation can be accurately represented in a subgrid hydrodynamic model for an intertidal mangrove forest. Firstly, the effect of the subgrid is tested to find out wat the potential is for simulating hydrodynamics in intertidal areas. Next, two vegetation representations have been tested; a spatially varying bed roughness and flow through a porous medium. The results of the different models demonstrate that the use of subgrid has significant potential in the modelling of the dynamics of intertidal areas, as including high-resolution spatial data is important for the largely bathymetry-driven flow in intertidal areas. With the subgrid modelling method, the model is around 100 times faster than for a traditional modelling approach with the same spatial resolution, due to the use of larger computational grid cells.

The results of the vegetation representations show that spatially varying bed roughness did improve the capability of the model to reproduce the observed tidal dynamics in a mangrove forest in the Whitianga estuary in New Zealand. Due to the increased bed shear stress on the forest platform, more water is routed via the creeks, increasing the flow velocity in the creeks in accordance with the measurements. On the other hand, the varying roughness did show to have only minor effects on the highest water levels modelled in the study area, due to the decreased influence of the bed roughness at larger water depths. The flow through a porous medium, implemented via an interflow layer, showed to have no significant effect on the simulated highest water levels in the area and showed to have less predictive capability on the low water levels simulated for the creek due to the decrease of the effect of the bathymetry on the flow. However, the interflow layer did improve the modelled flow velocities on the forest platform.

For future research, it would be recommended to look further into using the subgrid modelling technique to model intertidal areas like mangroves, as it has shown to decrease computational cost without massively affecting the modelled hydrodynamics. Additionally, it is recommended to further develop the interflow layer, so that the interflow layer can be applied to parts of the model domain with dense vegetation only. Lastly, it is recommended to explore other vegetation representations that scale with the water depth, as the roughness raster has shown to be less applicable for highly variable water levels.

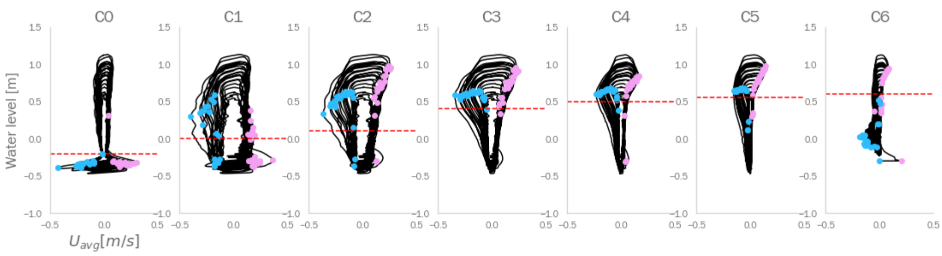


Figure 2 Tidal stage-velocity curves modelled with a roughness raster.

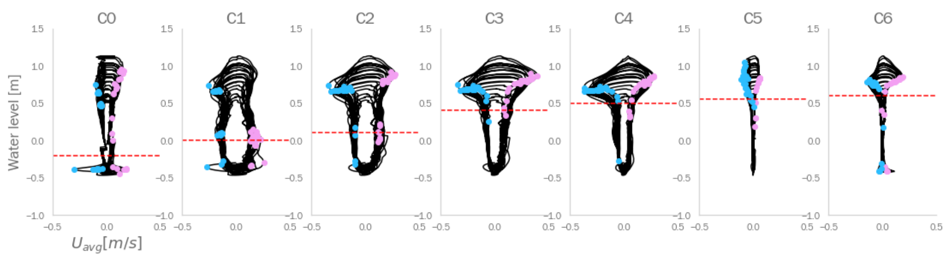


Figure 1 Tidal stage-velocity curves modelled with an interflow layer.

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