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Wave overtopping forces at transitions on the crest and the landward slope

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Introduction

Wave overtopping on grass-covered dikes results in high hydraulic loads on the dike cover which may lead to erosion of the dike cover. Transitions in cover type and in geometry are vulnerable locations for dike cover erosion. Changes in bed roughness can create additional turbulence and geometric transitions can lead to impact of the waves. The effect of transitions on the forces of the overtopping wave are unknown, since these forces are hard to measure during this highly turbulent flow and measurement equipment damages the grass cover and thereby affects the flow. We developed a hydrodynamic model to calculate the forces of the overtopping waves and investigate the effects of transitions on these forces.

Methods

A 2DV model for the overtopping flow over the crest and landward slope is developed in the open-source software OpenFOAM (Van Bergeijk et al., 2020). The model requires the flow velocity and layer thickness as boundary conditions, which can be generated from the overtopping volume. The model output includes the flow velocity, pressure, shear stress and normal stress as function of time, cross-dike location and height. The dike geometry is varied to simulate various geometric transitions and the roughness height in the turbulence model is adapted to simulate changes in cover type.

Results

The model results show that changes in roughness have no significant effect on the pressure, shear and normal stress. The flow velocity increases from a rough to a smooth cover which is well presented by the friction coefficient in analytical models (Van Bergeijk et al., 2019). Geometric transitions, such as the transition from the crest to the landward slope and the toe, lead to a high peak in the modelled pressure. The dike geometry has a large affect on the overtopping forces, where both the maximum shear stress and maximum pressure along the slope increase with increasing slope steepness (Figure). Additional model simulations are currently performed in order to study why the pressure increases at geometric transitions and to study other geometric transitions such as erosion holes or vertical cliffs.

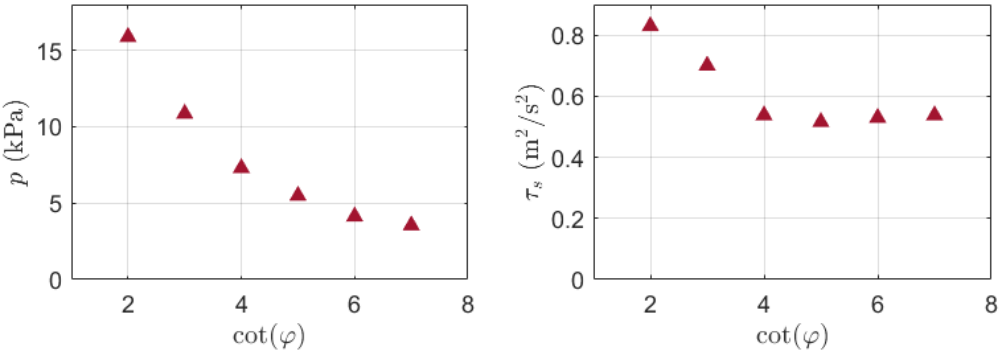

Figure: The maximum pressure p and the maximum shear stress τ_s *as function of the slope steepness cot(*φ*) for an overtopping volume of 4000 l/m.*

Acknowledgements

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Mud Volcano Induced Seasonal Mangrove-Mudflat Dynamics

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Introduction

The Porong Delta in Indonesia has been experiencing a rapidly prograding delta along with mangrove expansion in 15 years. It was triggered by an extreme mud volcanic eruption called LUSI. This eruption was at a peak rate of up to 180,000 m^3/day in 2006 and declined to 50,000m^3 in September 2011. LUSI is still actively erupting at a considerably reduced rate. The diversion operation has been conducted since 2009 by storing and conveying the mudflow to the Porong River. This operation has increased sediment concentration and loads of the Porong River by a factor of three to four compared to pre-LUSI conditions. As a result, we observed the build-up of the delta lobes and the mangrove expansion. The Porong area has a tropical monsoon climate characterised by the wet and dry season. We observed the seasonal river discharge fluctuation that correlates with the seasonal pattern of mangrove expansion. The objective of this study is to analyse the seasonal mangrove dynamics in the cloud computing Google Earth Engine (GEE) by creating three-monthly mangrove and age class maps.

Methods

The random forest supervised classification in GEE was used to classify the mangroves. Our maps are more frequent than commonly produced annual mangrove maps. Based on these validated time series of mangrove extent maps, we further estimated the age of the forest and developed the age class map. The age class map was referenced to November 2019 and derived backward to 2009. Additionally, by taking advantage of the high-resolution Canopy Height Model (CHM) from previous study and this age map, a relationship of mangrove height dependent on stand age was setup.

Results

Our analysis shows a unique and high spatiotemporal resolution of mangrove extent maps. We observe a recession of the mangrove extent during the transition of dry to wet season and regrowth during the wet and dry season. Generally, the net development trend of the mangrove area is positive. We can see that the high-low signal amplitude differs in the period of 2013-2017 from that in 2018-2019. It is likely in the beginning, mangroves start growing on the newly deposited mud. Due to the presence of mangroves, sediment is deposited at the margin of the forest, thus creating the basin mangrove type in a certain area. Since the young mangroves are more sensitive to salt and drought, they might die under that condition. Therefore, we observe the seasonal pattern of recession and expansion of the mangrove forest.

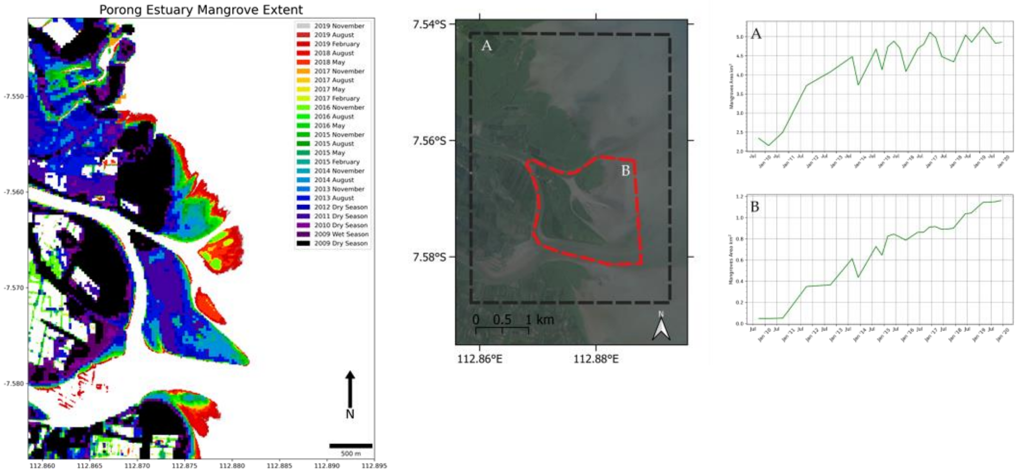

Figure: Porong Estuary mangrove extent from 2009-2019 (left figure) and time series of mangrove extent area development (right figure).