A02

Toppling Failure by wave impact at northen part of Bengkalis Island Indonesia

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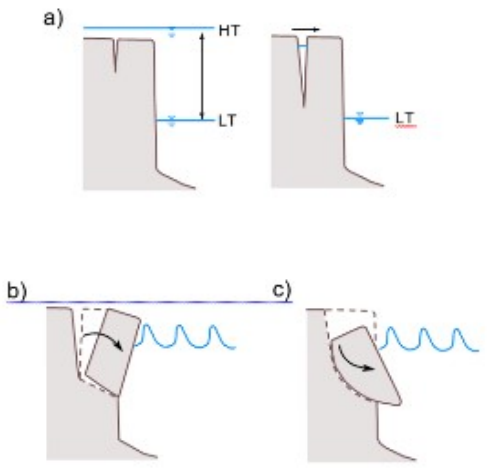
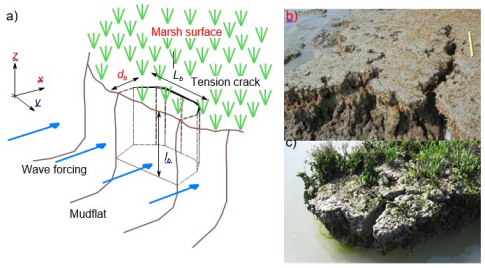
Bengkalis Island is located 8 kilometers from the coast of main island Sumatra and lies along the west side of Malacca strait. The total land area is roughly 900 km2, of which more than 70% of its area covered by peat soil with the thickness more than 1 m. The island is almost flat and has a maximum surface elevation of approximately 10-15 meter above mean sea level. Low-lying, swampy, and of peat formation, the island has heavy precipitation (haidar thesis), it is become issue for Indonesia that Bengkalis Island is also one of the outer islands that are directly adjacent to Malaysia. Problems began to arise when the island of Bengkalis experienced erosion which caused the retreat of the coastline, especially the coastline which is directly adjacent to Malaysia. This phenomena has been experiencing severe coastal erosion process since 1955 when Bengkalis Island was protected by mangrove forest (US Army Service,1955). Almost 70% erosion type that happen in bengkalis island is toppling failure, The effect of tidal wave oscillation promoted the formation and widening of tension cracks parallel to the bank edge The presence of tension cracks led to an unstable bank configuration, triggering mass failure, the tensile strength of the soil, rather than the shear strength, seems to be exceeded. Indeed, wave forcing transferred a torque on the failure surface, inducing alternating compression and traction of the soil fibres until the tensile strength of the soil was reached.

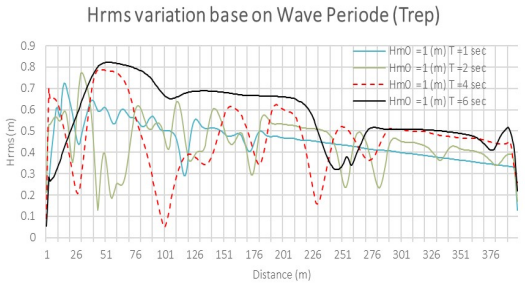


Sketch of the main processes observed during the experiments a) Formation and widening of tension cracks due to tidal excursion (HT: high tide, LT:low tide); b) Toppling failure; c) Sliding failure (figure by Michele Bendoni (2015)),a new formulation for the modelling of toppling failures has been develop by Michele Bendoni (2015)) using Xbeach 1D model, process-based numerical model to investigate The effect of vegetation in strengthening the soil matrix against shear erosion tends to be negligible for muddy banks. In tidal environments, surface erosion strongly depends on the interaction between sand and mud (i.e. a mixture of silt and clay). Sand-mud mixtures are generally characterized by fine sediment fractions and are modelled by the coupling of erosion and deposition formulations, a cross section of the bank in the x-z vertical plane and an approximately prismatic block of soil are considered. The block extends for a given width Lb along the longitudinal coordinate y.



a) Sketch representing an unstable bank configuration in which a block, subject to wave forcing, is identified by the presence of a tension crack. The thick black line identifies the geometry of the crack; dotted brown lines identify the hypothesized geometry of the block. b) and c) Pictures of tension cracks on the surface of salt marshes (Figure by G. Mariotti). The activity for data collection divides into two activities, namely hydrodynamic data collection and morphodynamic data collection.

Figure show one of the cliff near coast line of Bengkalis Island, 24 hour simulation base on hydrodynamic and morphodynamic data that have been collected from field activities show that Xbeach 1D model has the has the ability to predict the toppling failure and to identify the groups of waves which responsible for the final detachment.



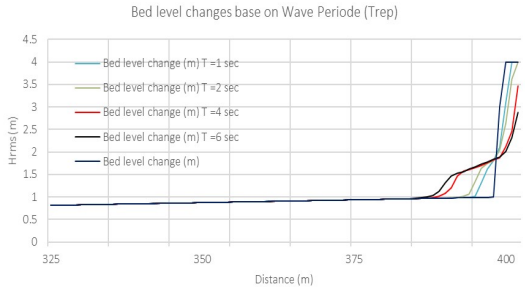


Figure above show wave high base on variation of wave period, below bed level changes from the cliff near coast line of Bengkalis Island.