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Rapid shoreline erosion induced by human impacts in a tropical muddy coast context, an example from western French Guiana.

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The Guyanas coast (French Guiana, Surinam and Guiana) is the longest muddy coast in the world (1500 km). It is under the influence of mud banks in transit from the Amazon delta in Brazil to the Orinoco delta in Venezuela. This westward mud bank migration induces a strong geomorphic control on the shoreline which can be summarized in terms of “bank” (shoreline advance and wave energy dissipation) and “inter-bank” phases (erosion of shoreline by waves).

Our study site, rice polders close to Mana city (western French Guiana), is a fine example of the exacerbation, by human activities, of the erosional dynamics on this muddy coast during an “inter-bank” phase. The polders cover 50,000 ha, in 200 x 600 m compartments flanked by earth dikes and canals. They were built in the muddy Holocene coastal plain in the 1980s and are rapidly eroding. Waves (mean significant height = 1.5 m height) comprise Atlantic swell and local trade wind-waves, and the tidal context is semi-diurnal and meso-tidal.

We determined historical shoreline evolution from satellite (Landsat & SPOT) and orthophotography images, and conducted four field campaigns between October 2013 and October 2014, comprising topographic (RTK-DGPS) and hydrodynamic (pressure sensors) measurements.

The results show intense erosion of 150 m/year affecting the polders since 2001, and lesser retreat (30 to 100 m/year) of the adjacent sectors colonized by mangrove forests. The erosive shoreface shows the same structure in each polder compartment: a chenier beach which freely retreats backwards under the influence of wave overwash. The chenier retreat rate is 100 m/year and it appears to be more intense (net retreat of 45 m) during the high wave-energy season (December to March), which generates more overwashing. In front of the chenier, we observed a large (50 m) inter-tidal mud bed showing different levels of induration and bioturbation by mangrove roots. The mud shorefaces exhibit an erosion rate of 100 m/year on average during our study, with large spatial variations, ranging from 80 m/year in the western side of the study area, to 150 m/year in the eastern side, which is more exposed to waves. The main erosion process clearly appears to be a differential and mechanic one determined by the degree of bioturbation and desiccation (during low tide) of muds layers. Indeed, we observed that breaking wave stresses result in the shearing of large mud blocks from networks of bioturbated alveolar and desiccation faults, producing large erosion scars and scarps. These erosional processes are reinforced by the polder engineering structures. Cross-shore dikes segment the shoreline and chenier deposits, and also enhance wave reflection. The absence of mangrove colonization in these empoldered areas also implies that cheniers are not fixed by vegetation and are therefore subject to free and rapid retreat. These polders are therefore likely to be completely eroded in the coming years, illustrating short-sightedness in the use and management of these muddy coastal lands.