

# Geomorphologic evolution of subtidal mud bank area through an estuary mouth. The case of Kaw mud bank (French Guiana)

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## Introduction

Muddy shores located between the Amazon and the Orinoco deltas are subjected to a westward migration of huge mud banks (1.8-3km.yr<sup>-1</sup>). Their migration is mainly generated by trade-wind waves and tidal currents. Located in shallow waters (5 to 20m), mud banks are derived from mud supplies of the Amazon sediment discharge (5 to 13x10<sup>8</sup>m<sup>3</sup>.yr<sup>-1</sup>, Martinez *et al.*, 2009). Many studies have focused on processes driving mud banks migration (Augustinus, 2004; Gardel and Gratiot, 2005), on the impacts on shoreline dynamics and mangrove ecosystems (Allison and Lee, 2004; Anthony *et al.*, 2008; Gratiot *et al.*, 2008; Proisy *et al.*, 2009) and mud bank characteristics like topography, sediment concentrations or wave-mud interactions (Winterwerp and Van Kesteren, 2004; Winterwerp *et al.*, 2007). However, the dynamic of the mud bank subtidal area is poorly documented although it constitutes the major and the most dynamic area of a mud bank. The purpose of this study is to analyse the geomorphologic evolutions of the mud bank subtidal area and its effects on shoreline mobility in an estuary mouth.

## Methods

### *In situ monitoring*

To monitor geomorphologic evolutions of the subtidal area, bathymetric surveys are conducted annually with a single beam, bi-frequency (33-210kHz) echo sounder. Measurement area covers approximately 425km<sup>2</sup> off the estuary mouth. In the same area, 3 campaigns including 110 points each one are also performed to determine the in situ density of the bed sediment. To complete this dataset, acoustical measurements are conducted with a sub-bottom profiler (4-24KHz), well designed to work in shallow waters and to provide high-resolution imageries on cohesive sediments. It allows the estimation of the thickness and the volume of mud siltation layers with time. Acquisition of hydrological parameters (waves and tide) is also realized with pressure data loggers and tidal gauge.

### *Satellite imagery*

Landsat (Land Satellite) and SPOT (Système Pour l'Observation de la Terre) images are used to extract shoreline with a semi-automatically process based on using of SAVI vegetation index to distinguish the limits of dense vegetation. In this way, mangrove forests are used as an indicator of shoreline mobility. Combined with bathymetric surveys, it will allow to estimate the interaction between the shoreline mobility and the subtidal area dynamic to determine the necessary time to swing in erosion to accretion regime.

## Results

The analysis of bathymetric maps points out a strong variation of geomorphology with time. Since 2007, the east side of the navigation channel is enduring a severe settling reaching approximately 147.8x10<sup>6</sup>m<sup>3</sup> and characterized by a high sediment deposition rate along the leading edge of mud bank (Fig. 1). As described on previous studies, intensive erosion induced by waves occurs in the trailing edge. Conversely, on the west side of the navigation channel, a strong wave damping induced by slight mud deposits has been noticed in front of the beaches.

Fig. 2 illustrates the density map obtained from the first survey at wet season. It underlines (i) a homogeneous leading edge mainly composed of fluid mud (1050-1250kg.m<sup>-3</sup>) particularly in

the navigation channel and the estuary mouth and (ii) a trailing edge characterized by higher-density areas ( $> 1400 \text{ kg.m}^{-3}$ ) which are spatially heterogeneously distributed. It confirms a 'classic' migration behaviour with the erosion of the trailing edge by waves inducing a fluid mud displacement with alongshore currents toward the leading edge of mud bank.

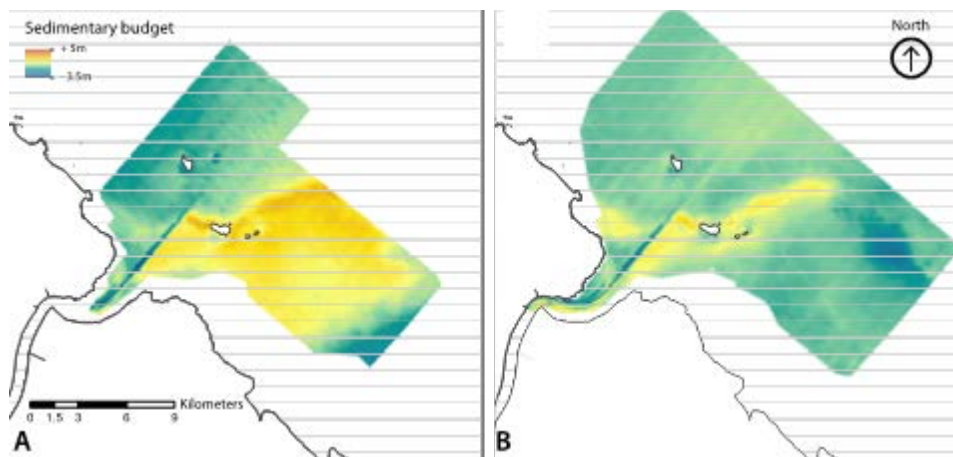


Fig. 1. Sedimentary budget (A) from 2007 to 2013 and (B) 2012 to 2013 off the Mahury mouth.

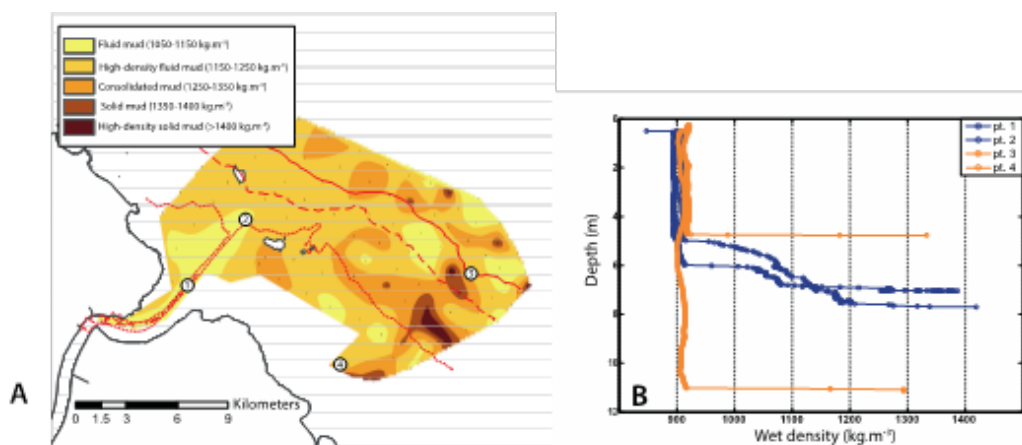


Fig. 2. (A) In situ density map of bottom sediments and (B) instantaneous density profiles over the water column for 4 measurement points.

### Conclusion and perspectives

Preliminary results highlight a strong geomorphological changes over few years with contrasted areas of deposit and erosion for respectively, both leading and trailing edges. In this context, the navigation channel of the harbour seems to be a preferential area for fluid mud deposits requiring continuous dredging to ensure maritime traffic. These results will be used to set up a numerical model in order to understand more accurately the mud banks migration and its key role on mud deposits into an estuary.

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