Morphodynamics of a mixed-sediments (sand and mud) macrotidal estuarine beach under contrasted energy conditions (Vilaine estuary, Fr ance)

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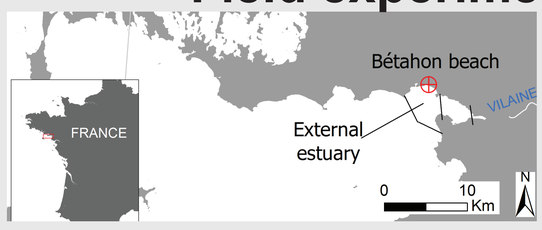
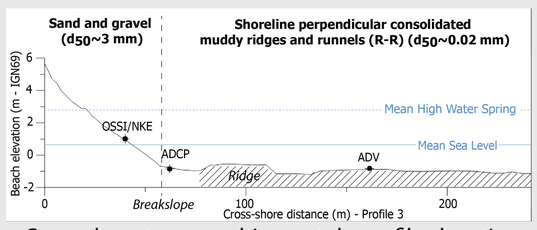
Introduction

Estuary and bay beaches are important areas for human activities. Topographic and sedimentary, like mud-infilled, occur on these environments due to multiple forcings. Betahon beach (South Brittany, France) is an estuarine intermediate beach (Low Tide Terrace) which is exposed to a permanent input of clay/silt sediments. This mixed-sediments beach presents a reflective sandy-gravelly upper part and a large dissipative mudflat in its lower part. Seasonal monitoring of the beach shows a variable topography and morphology of the mudflat. Ridges and Runnels (R-R) system, perpendicular to shoreline, can occur. This pattern can be totally in-filled by liquid mud and mudflat can increase of 60 cm above the ridge. On a vertical profile, mudflat sediments shows alternation of sandy and muddy shapes, introducing the hypothesis of two cohesive and non-cohesive sediments dynamics. In order to identify these processes, two field experiments, coupling topography, hydrodynamic measurements and photography, have been conducted on a cross-shore central profile during high/moderate and low energy conditions. Based on seasonnal observations and field experiments, the objectve of this work is to develop a preliminary conceptual model of the central part of this mixed beach, along a cross-shore profile.

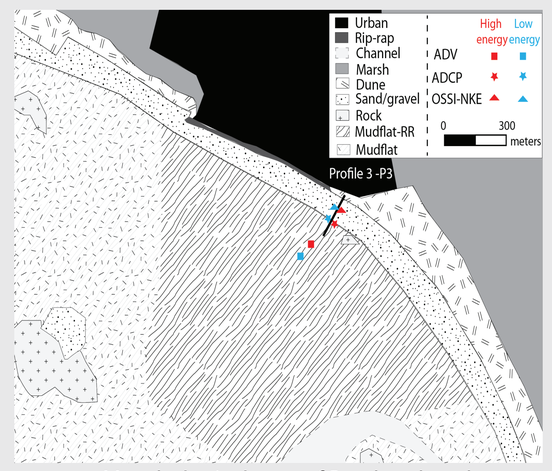
Field experiments - Environment



Location of Betahon beach in Vilaine estuary (France)



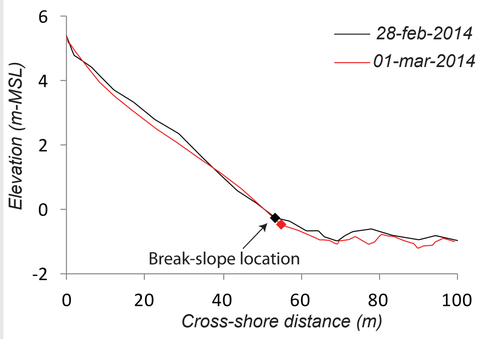
Cross-shore topographic centrale profile ; location of instruments on reflective and dissipative parts



Morphological map of Betahon beach ; Location of hydrodynamic intruments

RESULTS - Topography, sediments and currents

Dynamic under high energy conditions (storm)

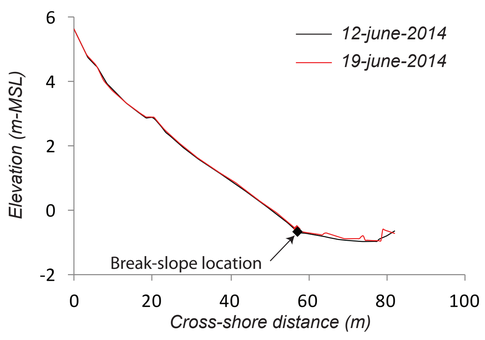


Beach profile reaches its new equilibrium after a daily storm - seaward moving (1.1m) of break-slope and erosion of mudflat ridge

Ridges and Runnels eroded and destructured

A runnel filled by ripple-marked coarse sediments from upper reflective beach

Dynamic under low energy conditions

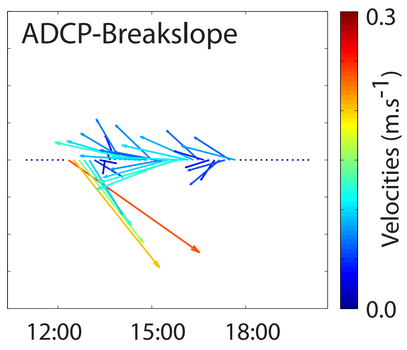


Unsignificant topographic variation of beach profile after 5 days of low energy conditions - landward migration (0.2 m) of break-slope

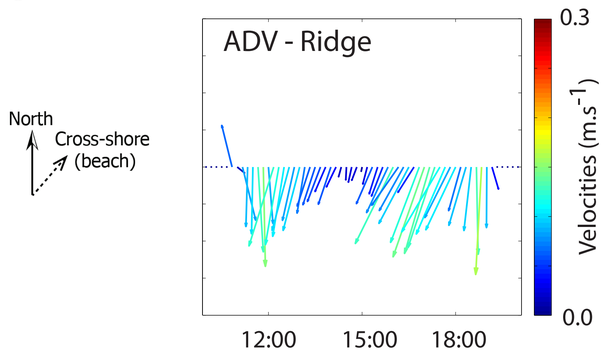
Flatened mudflat with Runnels totally infilled by fluid mud

Infilling of runnels to breakslope by fine silty cohesive sediments

Mean currents during a tide - Hs maximum=0.75m

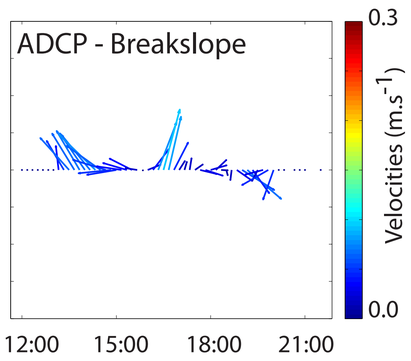


Preferential flow corridor between breakslope and mudflat cliff-like. Spinning currents

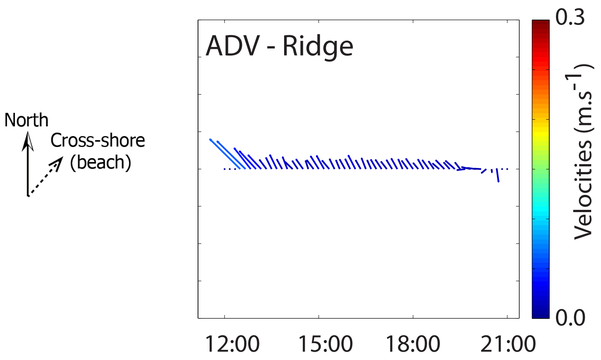


All-tide long «bed return flows» over a ridge of mudflat

Mean currents during a tide - Hs maximum=0.13m



Onshore/longshore currents in a preferential flow corridor - onshore currents during high tide



Onshore/longshore current almost all-tide long, Ebb component of tide weaks and time-reduced

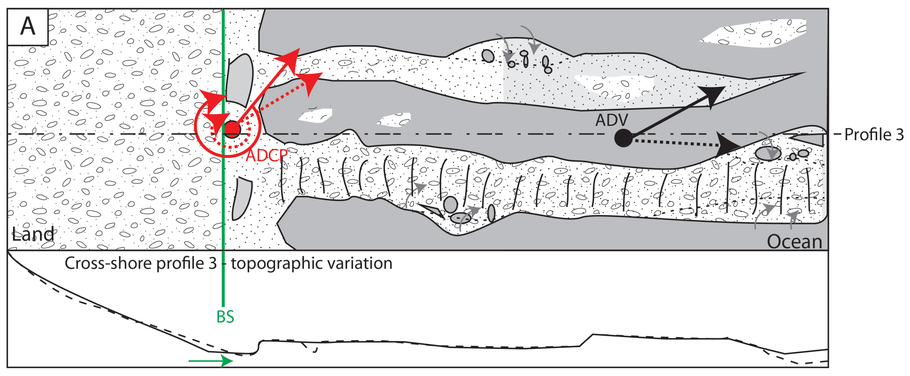
CONCEPTUAL MODEL - Cross-shore profile morphodynamic

A- High energy conditions

- Classical adjustement of upper reflective profile with sediment transport to breakslope. Breakslope moves seaward (Masselink *et al.,* 2006)

- Over the mudflat, all-tide long strong bed-return flows, off-shore directed, lead to a fill of mudflat runnels by coarser sediments (Le Hir *et al.,* 2000). Current are chanelized and are stronger in runnels (Williams *et al.,* 2008). Cohesive sediments can be transport seaward. Shoreline perpendicular flanks of mud ridges are eroded and rolled by waves to form mud pebbles (Anthony, 2008). R-R system is destructured.

- Near breakslope, currents follow a preferential flow corridor between breakslope to mudflat shoreline parrallel cliff-like of ridges. Bed return flows and spinning currents are also observed.

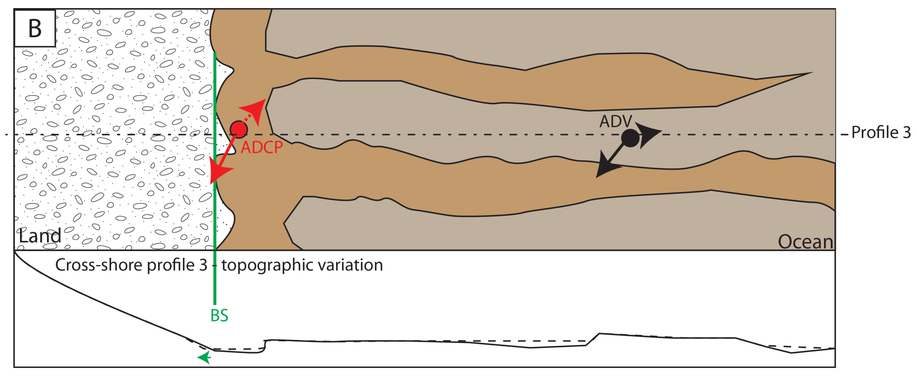


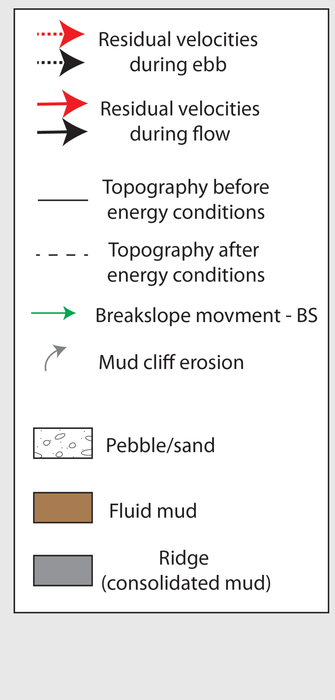
B- Low energy conditions

- Unsignificant topographic variations of upper beach profile. Breakslope moves landward with increasing tide range.

- Over the mudflat ridge, almost all-tide long weak long-shore currents are on-shore directed. Swash bores (no breakers) «wash» and put in suspension fluid mud over the 1km mudflat. Runnels are filled by water first. When water reaches breakslope and overtops the ridge, sediment begin to settle down (Bassoulet *et al.*, 2000, Anthony, 2008). Cohesive sediments are transport also onshore and trapped near breakslope and runnels when water retreats. Ebb component, quasi zero, not allows offshore migration of sediments.

- Near breakslope, long-shore currents are a little stronger and follow the preferential flow corridor. Onshore currents are mesured during high-tide.





Conclusion

The particular mixed-sediments estuarine beach of Betahon show two contrasted dynamics. In its central part, during high energy events, upper beach coarser non-cohesive sediments are transported to fill runnels on mudflat due to strong bed and return flow. Under low energy conditions, runnels are filled by fine cohesive sediments leading to an accretion of the mudflat. Succession of high/moderate and low energy condtions can also explain the alternated shape of sand and mud identified on a vertical sediment profile in the mudflat. These preliminary results will help to understand seasonal dynamics of this beach, coupling short-terms and monthly topographic monitoring, kite aerials imagery and photogrametric analysis, core-drilling and mud shear resistance field experiments.

Literature cited

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