EXPERIMENTAL INVESTIGATION OF CROSS-SHORE BEACH PROFILE PATH TO EQUILIBRIUM UNDER RAPID WAVE REGIME CHANGE

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BACKGROUND & MOTIVATIONS

Coastal areas are highly dynamical systems forced by both natural and anthropogenic causes. Given the extreme sensitivity of sandy beaches to the upcoming changes (sea level-rise and the expected increase in the frequency and intensity of extreme events), it is of prime interest to understand the processes leading to beach accretion or erosion.

The path to equilibrium for cross-shore profile has been considered regarding the classification based on the Dean number ($\Omega = H_0/T_0 w_s$) for microtidal wave dominated environments. This view has been declined in a number of shoreline-equilibrium models considering a quantity D whose distance to equilibrium controls the beach response. D can be the wave energy or the Dean number among others. A history term named "beach memory" is sometimes incorporated to account for a delay towards equilibrium associated with morphodynamic feedback (Yates et al., 2009 ; Davidson et al., 2013). Yet, the physical ingredients to quantify these different processes remain poorly characterized. Then, such shoreline-equilibrium models still suffer physical-based parametrizations.

The present study aims at focussing on such physical mechanisms by exploring the behavior of a 2D cross-shore laboratory profile to rapid wave change. Focusing on the definition of nearshore equilibrium, swash slope, sediment exchange and shoreline response are monitored to understand the dependency between zones and the global path to equilibrium of the whole profile.

EXPERIMENTAL SET-UP

The experiments were carried out in an unidirectional wave flume of 14 m long, 0.3 m high and 0.14 m wide. Monochromatic wave regimes are generated by a wave paddle at one end of the flume. At the other end, a rigid, non-erodible slope ($\alpha = 0.06$) is used to impose an artificial shoaling zone and thus, allows control of the distance from the breakpoint to the beach (see figure 1). Such finite sand volume set-up is expected to model closed beaches like pocket beach or bay beach that are only exposed to longshore drift inside their bay. We only consider experimental timescale short enough to only recreate cross-shore transport in the field and to ignore beach rotation.

In order to recreate rapid wave regime changes, an initial random beach profile is exposed to constant wave regime until nearshore equilibrium is reached. The profile is then exposed to a series of well known forcing. The experimental duration of each wave climate is chosen such that nearshore equilibrium has been reached in the time interval. In the set of parameters considered here, beach resilience to storm-like wave regime is also investigated.

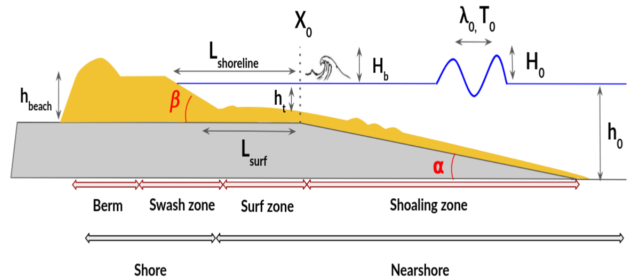

Figure 1 – Schematic view of the nearshore laboratory beach model.

DISCUSSION & CONCLUSION

The results introduce the notion of sediment exchange as a characteristic time for the beach evolution. In particular, they highlight a rapid adaptation of the beach face slope compared to a longer time scale associated with migration of the breakpoint. The controled hydrodynamic forcing allows us to investigate the relation between Ω and the shoreline response in a physical-scaled laboratory model. Altogether, it provides insights on the different paths toward nearshore equilibrium. Finally, results are compared with a high temporal resolution data base of a sandy beach bay in Vietnam to explore the similarities and differences between the field and the laboratory. An example of field beach profiles are shown in figure 2. This shows a seasonal evolution of the beach profile from a low tide terrace beach towards a reflective beach, associated with seasonal variation of Ω.

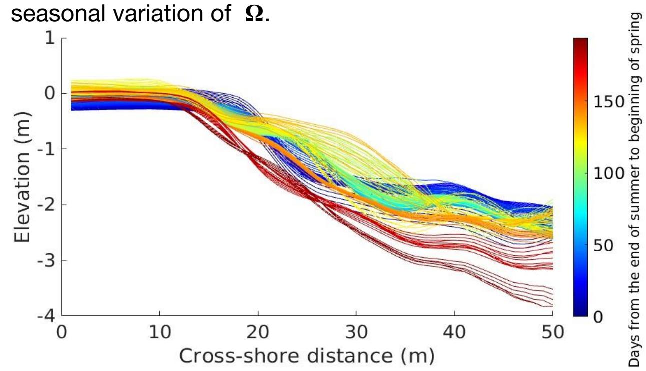

Figure 2 – Seasonal variation of the cross-shore profile. Nha Trang Bay, South Vietnam.

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