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Morphodynamics of intertidal bars near a seawall on a macrotidal beach, Wissant Bay, northern France

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Several studies on beaches with intertidal bar-trough (ridge-and-runnel) systems in settings with relatively large tidal ranges (> 3 m) have focused on cross-shore bar mobility; however a few recent studies have drawn attention to the potential role of longshore transport induced by a mix of wave-tide and wind-forced longshore currents in the morphodynamics of the bars and troughs. The aim of this paper is to briefly highlight the relationship between wind-forced currents on the shallow intertidal zone and rapid intertidal bar-trough morphological response on a macrotidal beach.

Fieldwork was conduced on Wissant beach, Wissant Bay, northern France, from 7 to 23 March, 2006. During the experiment, the beach (oriented NE-SW) exhibited three intertidal bar-trough systems and the upper bar was directly attached to a seawall. Seven digital elevation models (DEMs) were generated from high-resolution topographic surveys. Hydrodynamic measurements were obtained from five currentmeters (2 S4 and 3 ADCP) deployed on the bars crests and on the upper beach trough. Wave characteristics were obtained from the measured time series by spectral analysis using Fast Fourier Transforms. Wind speed and direction on the beach were measured using a portable weather station.

The mean wind speed and directions averaged every three hours highlight closely-spaced high-energy events during the experiment, with long phases of significant lateral wind stress (NE to ENE). The measured waves and currents showed rapid and strong response to both the changes in wind speed and direction. Longshore currents measured during the experiment on the upper intertidal bar-trough system showed a clear SW flow pattern in response to NE to ENE wind approach directions while the currents in the lower intertidal zone flowed northeastward during the flood, following the coastline, and southwestward during the ebb in response to the tidal current modulation. Strong longshore migration of the upper intertidal bar to the SW was observed during the course of this fieldwork. This longshore migration was attended by erosion of the upper beach in the northeast and accretion in the southwest. Bars in the lower intertidal zone were relatively stable. The SW migration process of the upper intertidal bar during the experiment occurred at rates that fluctuated with the intensity of the longshore current. The net beach volume over the experiment was quite stable, thus showing that morphological change, notably bar migration, simply reflected adjustments to hydrodynamic forcing without new sand inputs into the system.

The findings of the present study suggest that cross-shore currents are subordinate to, and may even be mitigated by, wind-forced longshore flows on this beach. The importance of longshore transport on the upper beach is due to hydrodynamic forcing over the shallow depth, with the seawall playing a probable additional longshore canalization effect. Longshore transport should be considered as an essential element of the morphodynamics of bar-trough beaches subject to large tidal ranges and significant lateral wind stress.