

SEDIMENT TRANSPORT DYNAMICS ACROSS SHORE-ATTACHED SAND RIDGES

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INTRODUCTION

As sea levels rise many coastal areas are predicted to experience beach erosion. However, this erosion can potentially be partially mitigated by natural onshore transport from offshore sediment reserves. While offshore sediment reserves have been recognized as a potential source of sediment, the mechanisms by which this sediment makes its way toward the coast (often up-slope) where it can be further transported onto beach has been less well studied. Further the non-linear wave motions that have primarily been hypothesized to drive onshore transport (e.g. Elgar et al., 2001) are poorly resolved in most phase-averaged (spectral) wave models used to simulate coastal change over management timescales.

Here, using co-located and contemporaneous observations of sea floor sediment mobility (via bedform migration) and near-bed velocity, we aim to understand the physical drivers of onshore sediment transport across shallow shore attached sand ridges.

OBSERVATIONS AND METHODS

The nearshore waters around Perth, Western Australia include two large (~5 km long), shallow (<5 m depth) shore-perpendicular sand ridges that have long been hypothesized to be essential natural sources of sediment to the adjacent coastal regions. To quantify onshore sediment transport dynamics across these sand ridges, detailed measurements were collected at four sites in late 2022 and 2023 across summer and winter. At each site, the seabed mobility, particularly the formation and movement of ripples (height and wavelength order 10 cm), was quantified using a rotary sonar and stereo photogrammetry system which both produced detailed elevation models of the seabed (~1 m²) 12 times daily (Figure 1). Ripple evolution and migration rates were determined by cross-correlation of successive elevation models.

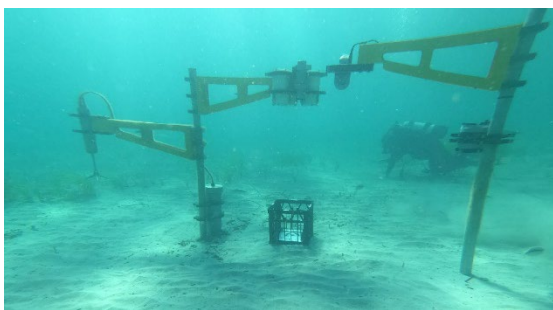


Figure 1 - In situ instrument set up including rotary sonar, ADV and photogrammetry system

Currents and wave conditions were simultaneously

recorded by a near bed acoustic Doppler velocimeter (ADV) which sampled continuously at 4 Hz.

RESULTS

During the month-long deployments, the sites experienced a range of conditions including the dominant swell and local wind seas (both with significant wave heights less than 2 m). While 'reset' events occurred where all bedforms were wiped out due to sheet flow conditions, a majority of the data set consists of ripple evolution and migration (Figure 2). The dominant drivers of the ripple migration, assumed a proxy for near bed sand transport, are currently being determined by correlating the bedform properties and migration rates with the concurrent near bed velocity data.

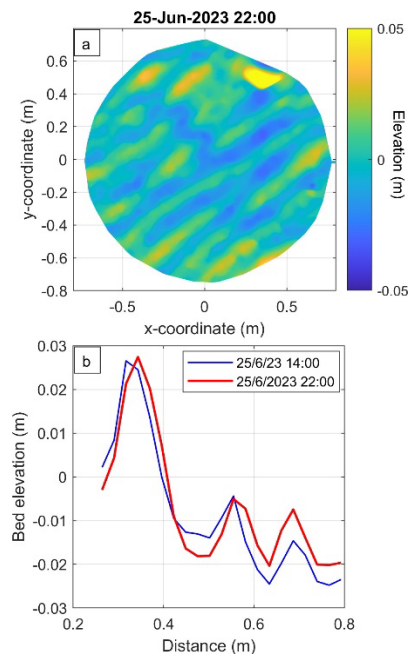


Figure 2 - (a) Rotary sonar scan. (b) elevation transect perpendicular to dominant ripple crest orientation, two transects are shown with 8 hours between them.

The analysis completed to date indicates cumulative ripple transport rates are correlated with the wave orbital velocity skewness (cube of the cross-ripple velocity as measured by the near bed ADV, e.g., Cuttler et al., 2019). Further analysis will determine the relationship between ripple properties (height, wavelength) and the wave orbital and mean current fields.

Improved knowledge of onshore transport dynamics in inner-shelf waters will inform potential natural mitigation of predicted coastal erosion as well as inform the design of nearshore nourishment projects.

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