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SAND WAVE MORPHOMETRICS IN THE MAIN CHANNEL OF THE OUTER TAGUS ESTUARY

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Abstract

The geometric characteristics of sand waves in the main channel of the outer Tagus estuary are investigated, using high-resolution surveys conducted in 2019 and 2020. The relationship between bedform height and spacing over a 1400 m transect, at ca. 20 m depth, is in good agreement with the global mean trend equation proposed by Flemming (1988). The consistent ebb-oriented asymmetry suggests that the direction of net sediment transport is seaward. The apparent direction of sand wave migration obtained from the comparison between surveys is more variable, but on average also ebb-oriented.

Keywords: Bedform shape; Bedform asymmetry; Ebb tidal delta; Morphodynamics.

4. Introduction

Sand waves are flow-transverse bedforms, common in estuaries and shelf seas. They have practical implications for the maintenance dredging of access channels, the design of offshore infrastructure, and sediment management. Geometric characteristics, such as the ratio of height to wavelength, can provide information on bedform activity and sediment supply. Asymmetry is generally assumed to be indicative of the dominant direction of net sediment transport. This study investigates the geometric characteristics of sand waves in the seaward part of the main channel of the outer Tagus estuary.

5. Methods

The study is based on multibeam surveys of 2019 and 2020 (https://cosmo.apambiente.pt), available at a resolution of 0.3 m. The analysis focuses on the sand waves that occur in the seaward part of the main channel, along the edge of the main sand bank of the ebb-tidal delta (the Cachopo Sul shoal; Fig. 1a). A NE-SW transect of ca. 1400 m in length, approximately crestline-normal, was defined and divided into two sections. Morphometric parameters (sand wave height, length, steepness and asymmetry) were calculated in each section. Due to the presence of superimposed ripples, maxima and minima were calculated in two steps to help identify crests and troughs.

6. Results and discussion

Each half-transect shows 8 complete sand waves at an average depth of 21 m CD. The average wavelength is 80 m and the average height is 2.1 m, leading to an average steepness of 0.027. The spacing versus height relationship (Fig. 1b) is in good agreement with the global mean

trend equation established by Flemming (1988, 2022). The average bedform asymmetry, excluding two cat-back shaped (CBS) sand waves observed in the 2020 survey, is 0.34. All sand waves are ebb-oriented (Fig. 1c). Sand wave migration obtained from the comparison between surveys is more variable, with the presence of CBS sand waves apparently associated with divergent migration directions. In the examined transect, the average migration rate is 5-10 m year^{-1}, ebb-oriented, with the faster migration rate in the seaward half of the transect.

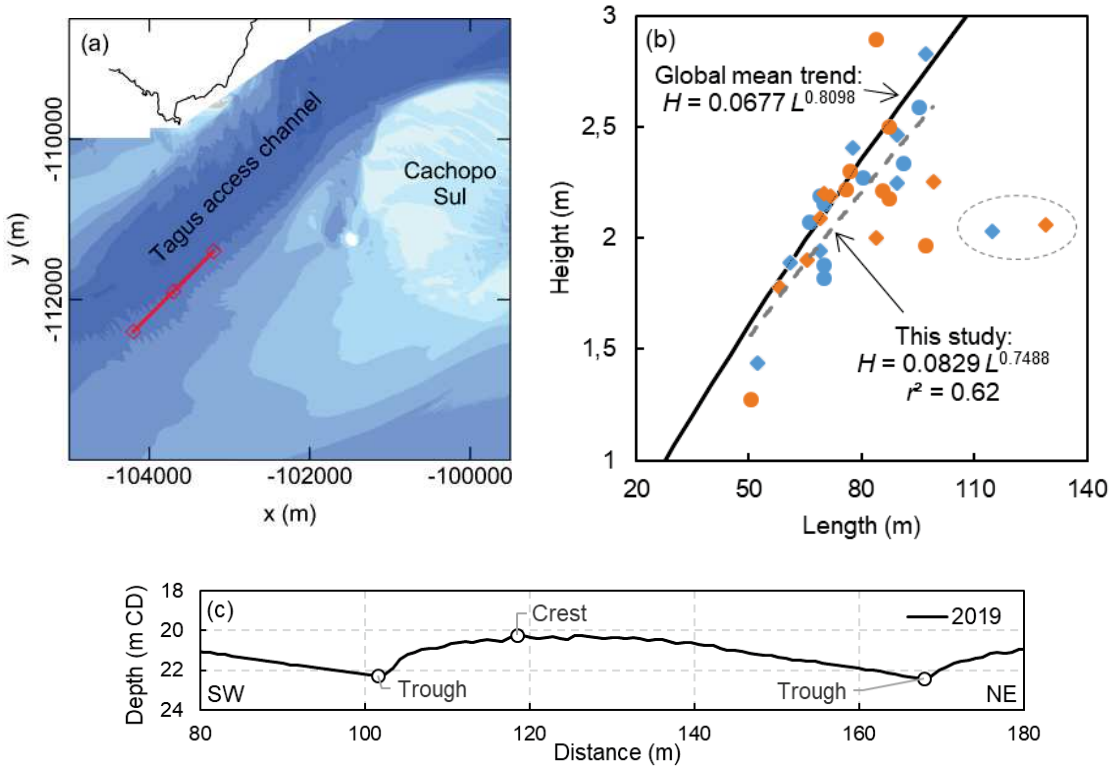

Figure 1. (a) Bathymetric map of the outer Tagus estuary showing the location of the NE-SW transect (red line). (b) Sand wave height and length relationship (circles: 2019; diamonds: 2020; blue: landward half-transect; orange: seaward half-transect). Global mean trend (Flemming, 1988; black solid line) and observed trend (grey dashed line; CBS sand waves indicated by the dashed ellipse not included). (c) Example of an ebb-oriented sand wave from the landward half-transect.

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