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Estimate of longshore sediment transport rate based on the volumetric growth of the Guadiana ebb delta

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RESUMO

Longshore sediment transport is the main driver of the shoreline planform evolution along many coastal environments and must be reliably quantified for sustainable management and planning. Updrift of the Guadiana estuary mouth, longshore transport rates proposed in the literature vary from 6,000 m^3/yr to 300,000 m^3/yr. This wide range illustrates the difficulty of such assessment in relation to the complexity of the longshore transport process and to the large temporal (from hours to centuries) and spatial (from tens of meters to hundreds of kilometres) scales at which it impacts nearshore environments.

The objective of this study is to better constrain the average (decadal) longshore sediment transport rate in the updrift region of the Guadiana ebb delta. The approach relies on morphometric observations of the modern delta development since jetty installation at the estuary mouth (in 1972-1974), which is documented by 13 bathymetric grids ranging from 1969 to 2017. A sediment budget analysis is conducted at the outer shoal (i.e., the terminal lobe with a typical horseshoe shape in plan view and located seaward off the estuary mouth), for which the various contributions (i.e., sources of sand) and associated sediment (inputs and outputs) pathways are established. The total average sediment input rate to the outer shoal since its development (in response to jetty installation) to 2017 is obtained from an inverse application of the Inlet Reservoir Model, an analytical model describing the long-term evolution of deltas based on sediment mass conservation. The best fit (r^2 = 0.92) of volume observations to predictions from the model yields an average decadal input rate of ~160,000 m^3/yr. The sediment contributions to this total average input rate include the locally reworked material from the historical (i.e., pre-jetty) delta, the river export and the longshore sand transport from the updrift beach. The decade average contribution of locally reworked material (~55,000 m^3/yr) is evaluated based on observed volume variations at the adjacent updrift lateral bar and inlet channel areas, while river export (~20,000 m^3/yr) is derived from previous studies. The balance of these contributions with the total input rate to the outer shoal yields a decade average longshore transport rate of ~85,000 m^3/yr, which is in good agreement with the values generally accepted for the region.

Overall, the present study proposes an alternative method to constrain the average longshore

transport rate in the vicinity of modern ebb tidal deltas from a "response approach", integrating and averaging all potential variables such as morphology, grain size, wave climate, etc. The accuracy of the obtained rate largely depends on the temporal extent and quality of the bathymetric dataset considered to quantify the outer shoal volumetric growth. Hence, the method is specifically applicable to modern ebb tidal deltas which evolution in response to jetty installation or barrier breaching is well-documented.

Palavraschave: Longshore transport; Ebb tidal delta; Inlet Reservoir Model, Guadiana estuary