

# ON THE RELATIONSHIP BETWEEN THE ÓBIDOS LAGOON INLET MIGRATION PATH AND THE OFFSHORE WAVE POWER

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## Abstract

The inlet of the Óbidos Lagoon is a wave-dominated tidal inlet located on the Portuguese coast. It is known for its unstable behaviour, which often leads to erosion issues on its margin or to its complete closure. Over twenty years of satellite data were compiled to document this behaviour. The reconstructed behaviour was compared to the contemporary offshore wave climate. The comparison showed that the inlet's preferred migration direction could differ from the relative orientation of the offshore wave power; it was particularly the case when the longitudinal component of the wave energy flux strongly or durably deviated from its long-term average. In contrast, the inlet closed more frequently when this deviation was smaller.

*Keywords:* Tidal inlets; Littoral drift; Wave climate reanalysis; Satellite-derived shorelines.

## 1. Introduction

The Óbidos Lagoon is located on the central west coast of Portugal. The tidal inlet that connects the lagoon with the Atlantic Ocean is wave-dominated (Bertin et al., 2009). As a result, the inlet is highly unstable both spatially and in terms of cross-section. Between April 2016 and October 2023, the inlet closed three times, and it persistently migrated southward until late 2020 before it started to migrate persistently northward (Portela et al., 2023). To better understand this behaviour, satellite and wave data since 1999 were analysed.

## 2. Methods and results

The inlet position and width were measured from 136 satellite-derived shorelines (Landsat LE7, 8 and 9) from 1999 to 2023 (Figure 1), created with the CASSIE online tool (Almeida et al., 2021). The offshore wave climate ( $H_s$ ,  $T_p$ , mean Dir) was retrieved for the period 1940-2023 from the ERA5 reanalysis database (Hersbach et al., 2023). The longshore wave energy flux was computed as the longitudinal component perpendicular to its long-term (i.e., 1940-2023) average direction.

Between 2002 and 2005 (Figure 1A), and between 2005 and 2010 (Figure 1B), the inlet migrated in the opposite direction to the one of the dominant longshore wave energy flux. In both periods, the net annual wave power strongly and durably deviated from its long-term average direction. In contrast, from 2013 to 2022, the longitudinal component of the wave power only moderately deviated from its long-term value and the inlet migration was mostly aligned with this deviation (Figure 1C&D). This second period was also remarkable due to the frequent

closure events that occurred in December 2013, March 2015, May and December 2018 and March 2022 (Figure 1).

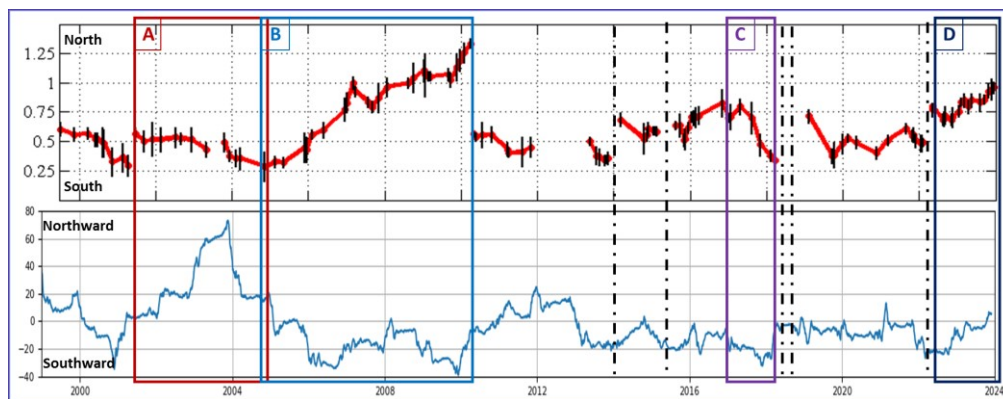


Figure 1. Top: alongshore position and width (km) of the Óbidos Lagoon inlet; bottom: one year cumulated net wave energy flux (kW/m) perpendicular to long-term mean wave energy flux direction; vertical dash-dotted bars indicate documented closure events.

### 3. Discussion and conclusions

The inlet of the Óbidos Lagoon may migrate in the opposite direction to the one of the dominant littoral drift. This seems to be the case when the average annual longshore wave power strongly and durably deviates from its long-term average. In contrast, when the longitudinal component of the wave power only moderately deviates from its long-term value, the inlet migration seems to be aligned with this deviation and then with the littoral drift. In this latter case, the closure events may also become more frequent.

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