MORPHODYNAMICS OF THE TAGUS ESTUARY MOUTH: CONTRIBUTIONS FROM A CITIZEN-SCIENCE PROJECT

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1. Introduction

Due to their exposure to various forcings such as tides and waves, estuary mouths constitute dynamic coastal environments where sediment transport can result in abrupt and significant morphological changes. They concentrate relevant socio-economic and ecological values, which will become even more challenging in the climate change context. Despite their importance worldwide, the dynamics of these environments remains partly understood only and fosters many studies from the scientific community. This work is part of a citizen-science project (named *Nouveaux Commanditaires Sciences*) which aims at studying the hydro-sedimentary dynamics of the Tagus estuary mouth (bordered by a metropolitan area of 2 million inhabitants), especially during storms, by combining *in-situ* field observations, remote sensing data and numerical modelling. This research program has been set up following the request for a better understanding of the coastal erosion and marine flooding during storms expressed by severely affected inhabitants from an informal neighbourhood, Segundo Torrão (Southern margin of the inlet). In addition, local populations provide support for instrumental deployments and data acquisitions. In return, new knowledge derived from scientific studies will be used to improve coastal management over these threatened areas. In this presentation, we will present the main actions that are being carried out in the scope of this project.

2. Assessment of morphological changes from remote sensing and bathymetric data

Satellite images from Sentinel 2 and Landsat (5 and 8) missions and bathymetric data are being used to investigate past morphological changes over the estuary mouth. Qualitatively, the data set provides evidence for major evolutions of the system over the last decades with a significant retreat of the coast at the southern margin and a very dynamic behaviour of the Bugio Bank that is part of the estuary ebb delta (see Lira and Taborda, 2014). Different inversion algorithms are being tested to reconstruct past bathymetry from satellite images (e.g. Capo et al., 2014; Lira and Taborda, 2014). Sensitivity analyses revealed that several parameters linked to seabed, water (e.g. turbidity) or atmospheric properties have a large impact on the accuracy of depth estimates. Numerous inversions were made starting from the 1980's, with an extensive

validation effort focused over the 2015-2017 period along the Costa da Caparica Beach (southern adjacent shoreline of the estuary). The exploitation of reconstituted and measured bathymetries enabled to highlight a dynamic behaviour of seabed structures over key regions like the Bugio Bank. The links between these observed evolutions and forcing conditions (e.g. wind, waves) are being investigated based on existing retrospective simulations and available measurements (e.g. Bertin et al., 2013; Fortunato et al., 2016).

3. Infragravity waves: a major forcing acting on coastal erosion and flooding?

Pressure sensors were deployed at Segundo Torrão Beach (cf. Introduction) in order to provide first insights on hydrodynamics at this location particularly sensitive to extreme events. Data acquired during 12 days in December 2018 revealed the presence of significant infragravity waves (long waves associated with the presence of groups in incident short waves), reaching up to 0.8 m at the coast under moderate-energy offshore wave conditions (around 3-4 m). This suggests that infragravity waves could be a good candidate to explain flooding events reported by the local populations during extreme events.

4. Conclusions and perspectives

Inversion methods were used to derive bathymetries from satellite images starting from the 1980's. Their combination with additional bathymetric data revealed that the Tagus Estuary Mouth experienced major morphological evolutions at decadal timescales. In addition, a dynamic behaviour of seabed structures has been underlined over the last years, the reasons of which are being investigated. Significant infragravity waves measured at Segundo Torrão motivate the setting up of new field campaigns to assess hydrodynamic conditions and the associated sediment transport at key locations of the estuary. A sophisticated numerical model (resolving circulation, waves and sediment transport) is currently in development and will be applied to assess the link between the morphological evolution of the estuary mouth and coastal flooding occurring during extreme events at particular sites, like Segundo Torrão.

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