

## Ecosystem processes and service provision in salt marshes facing varying sediment availability

A.R. Carrasco\*(1), K. Kombiadou(1), A. Matias(1), S. Costas(1), Ó. Ferreira(1)

(1) CIMA- Universidade do Algarve, Campus de Gambelas, Ed 7, 8005-139, Faro, Portugal. \*azarcos@ualg.pt; akompiadou@ualg.pt; ammatias@ualg.pt; scotero@ualg.pt; oferreir@ualg.pt

### Summary:

*The services of a coastal ecosystem are critical to the functioning of the Earth's life-support systems, and they are intimately governed by biotic and geologic couplings. This work assesses the temporal evolution of salt marsh ecosystems in a coastal lagoon, Ria Formosa lagoon, and analysis its triggering processes, both natural processes and human activities. We applied imagery analysis to investigate the capacity of tidal flats and salt marsh to develop and evolve under different hydrodynamics and sediment supply conditions. The studied marsh lays in the backbarrier of Culatra Island. A 60-year time-series of aerial photographs were used to measure states of marsh development and 2D maps were produced based on topography and sediment organic matter distribution.*

*Data analysis showed that the main sediment source for marsh development was driven from the nearby inlet flood delta. The obtained findings help to predict the fate of important ecosystem services facing sea-level rise.*

**Key words:** Ria Formosa lagoon, salt-marsh, aerial photographs, inlet, sea-level rise.

Tidal basins are threatened worldwide by the accelerated sea-level rise and anthropogenic interferences (e.g., dredging and inlets artificialization). A major concern is the progressive erosion and drowning of intertidal flats, which provide fundamental ecosystem services (Costanza et al. 1997). Intertidal flats and salt marshes are among the most productive ecosystems on earth and have great ecological value, namely in flood risk management and erosion control, pollution control and improvement of water quality, carbon sequestration, and habitat for target wildlife species (Caçador et al., 2016). Perched salt marshes on the back of barriers are no exception (see example in Fig. 1). Their role has been definitely confirmed by the inclusion of these ecosystems in the Water Framework Directive.

Salt marshes evolve over time from young marshes to old marshes, if enough fine sediment is available, and if the required nutrients are transported by flooding through the tidal channels. Marsh surface builds up above the mean high-water level for neap tides; the intermediate/high marsh plants invade, outcompete and replace the low marsh plants (or tidal flat). Today it is frequently questionable whether sediment import is sufficient for the tidal flats and salt marshes to keep pace with accelerated sea level rise. In order to examine whether the sediment import suffices, we need to identify and quantify the mechanisms leading to import and export of sediment.

This work assesses the temporal evolution of a salt marsh ecosystems located in the Culatra backbarrier (the Ria Formosa lagoon, Fig. 1), over the last 60 years. The Ria Formosa lagoon has been impacted by channels dredging and main inlet stabilization and natural inlets relocation. In order to restore its dynamic equilibrium, the tidal basin is continuously responding by channels bottom adjustment, inlets hydraulic readjustment, and backbarrier margins maturation (Ferreira, et al., 2016).

Data analysis showed that the main sediment source for tidal flat and salt marsh development was driven by overwashes and delivered from the nearby Armona Inlet flood delta (Garcia et al., 2002). Stages of tidal flat development were associated with the steps of narrowing of the Armona Inlet cross-section (Fig. 1A). Armona Inlet narrowed c. 20m/yr when the Faro-Olhão stabilization works started (~1927); and this increased to c. 43m/yr after the engineering works had finished (after 1958; Ferreira, et al., 2016).

Marsh accretion towards the lagoon between 1969 and 2014 was of 745 m<sup>2</sup>/yr (Fig. 1B; Kombiadou et al., 2018). Results showed that if enough sediment supply is provided, a low to intermediate marsh succession (development of different vegetation types at one place in time) can be fully established in less than 30 years. Low marsh is mostly composed of medium sand, whereas the tidal flat is characterized by a silty-sand intertidal bottom supporting an important meadow habitat in the lagoon system.

The observed marsh development is an indicator of backbarrier maturation (Carrasco et al., 2008). Moreover, is a symptom of the scarce hydrodynamic circulation capacity of the lagoon, and a symptom of

the long-term basin infilling process as a response to the rise of the mean sea level.

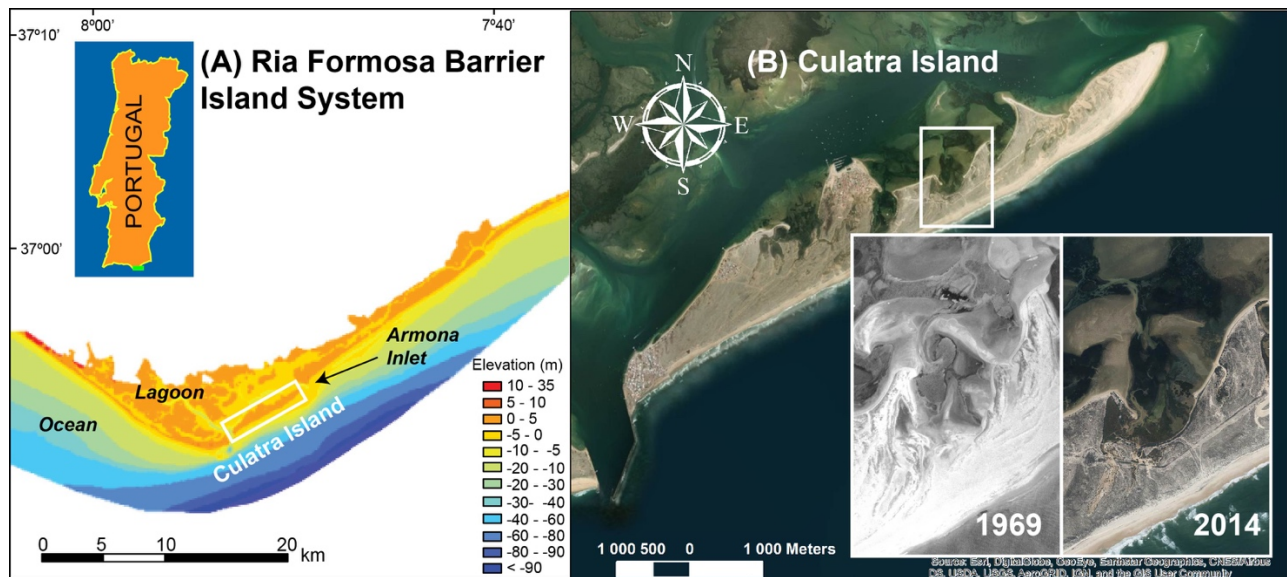


Fig. 1. The Ria Formosa barrier island system; view to Culatra Island and the location of the studied embayment, as well as the photos of the embayment from 1969 and 2014.

#### Acknowledgments:

The data were collected and analysed under the framework of the EVREST project (PTDC/MAR-EST/1031/2014). A. R. Carrasco was supported by the grant SFRH/BPD/88485/2012, A. Matias and S. Costas were supported by the contracts IF/00354/2012 and IF/01047/2014, respectively, all funded by FCT, Portugal.

#### References:

- Carrasco, A.R., Ferreira, Ó., Davidson, M., Matias, A. & Dias, J.A. (2008). An evolutionary categorisation model for backbarrier environments, *Marine Geology*, 251(3-4), 156-166.
- Caçador, I, Duarte, B., Marques, J.C. & Sleimi, N. (2016). Carbon Mitigation: A Salt Marsh Ecosystem Service in Times of Change. *Halophytes for Food Security in Dry Lands*, 83-110.
- Costanza, R., D'Arge, R., de Groot, R.L., Farberk, S., Grasso, M., Hannon, B. Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, V., Raskin, R. G., Suttonk, P. & van den Belt. M. (1997). The value of the world's ecosystem services, *Nature* 397, 253-260.
- Garcia, T., Ferreira, Ó., Matias, A. & Dias, J.A. (2002). Recent evolution of Culatra Island. *Proceedings of 6th International Symposium Littoral 2002*, 423-429.
- Ferreira, Ó., Matias, A. & Pacheco, A. (2016). The East Coast of Algarve: A Barrier Island Dominated Coast. *Thalassas: An International Journal of Marine Sciences*, 32: 75.
- Kombiadou, K., Matias, A., Carrasco, A.R., Ferreira, Ó., Costas, S. & Vieira, G. (2018). Towards Assessing the Resilience of Complex Coastal Systems: Examples from Ria Formosa (South Portugal). In: Shim, J.-S.; Chun, I., and Lim, H.-S. (eds.), *Proceedings from the International Coastal Symposium (ICS) 2018 (Busan, Republic of Korea)*. *Journal of Coastal Research*, Special Issue No. 85, pp. 1–5. Coconut Creek (Florida), ISSN 0749-0208.