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Evolution of the barrier islands of eastern Ria Formosa, Portugal

Gustavo Vieira, Katerina Kombiadou, Ana Matias, Susana Costas, Rita Carrasco, and Óscar Ferreira
University of Algarve, Centre for Marine and Environmental Research (CIMA), Faro, Portugal (akompiadou@ualg.pt)

Sand barriers are landforms that occupy about 15% of the world's coastal zones and, apart from hosting ecological resources and infrastructure, often offer protection from storm damage to the inland and to coastal ecosystems. Ria Formosa in southern Portugal is such a system, governed by strong and complex dynamics. The recent evolution of its two easternmost barriers, namely Cabanas Island and Cacela Peninsula, investigated in the present work, is an example of the dramatic changes that can occur over circa 50 years.

To quantify the type and rate of such changes, historical aerial photographs and recent ortho-photographs were analysed, covering the period from 1947 to 2014. Data processing consisted in scanning, georeferencing and mosaicking of aerial photographs with a GIS software. Photo-interpretation of the available raster datasets involved: 1) identification and mapping of individual sub-environments (dune, saltmarsh, channel, etc.), 2) characterization of sub-environmental changes (density, colours, patterns) and 3) quantification of shoreline and vegetation density changes and of washovers' area.

Results evidenced the contrasting evolution of the two barriers. The alongshore elongation of Cabanas Island was fast during the 1970s (reaching more than 100 m/yr), while dune development on the barrier was relatively slow, yet consistent, over the decades. This development was artificially enhanced in the 1990s and 2000s through dune fencing, plantation of grass and beach nourishment. Contrastingly, Cacela Peninsula experienced erosion during the same period and generation of several washover breaches. This eroding and shortening tendency of the island was altered by a series of human interventions, including nourishments and artificial inlet opening. Both barriers exhibit rollover behaviour in the same period, with barrier inland migration average rate of 4.5 m/yr in Cabanas and east Cacela and significantly lower rates, of 0.8 m/yr, in the western part of the peninsula. Similar transgression rates are observed in dunes that reformed over the newly developed barrier. The evolution of barrier area up to 1996 (first artificial nourishment) shows positive rates (growth) in Cabanas Island and negative ones (loss) in east Cacela, of +1.8 m^2/m/yr and -2.7 m^2/m/yr, respectively; these values correspond to a variability of -23 to +33% for Cabanas and -56% to +5% for east Cacela. In the western part of the peninsula, the values range between -20% and +37%, with no significant trend. At the same time, the total barrier area of the subsystem remained relatively stable during the period, fluctuating within ?10%. This shows that, by developing a transgressive behaviour, the subsystem was able to retain the bulk amount of sand, even though it underwent significant alterations (breaching, overwashes etc.).

Knowing how this system evolved naturally and artificially during the past decades provides information about the type and extent of potential changes in barrier islands and lays the foundation for the assessment of the resilience of such systems in response to several driving factors, such as storms, sea-level rise and human interventions.