COASTLINE RETREAT PROJECTIONS ALONG SOUTH ALGARVE DUE TO SEA LEVEL RISE DURING THE 21ST CENTURY

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Abstract

Introduction: The increase in the frequency of extreme atmospheric conditions and of the global sea-level rise (SLR) rate is now an established fact (IPCC, 2013). Coastal evolution forced by SLR and storms involve phenomena such as the increased inundation of low-lying lands, shoreface and coastline erosion, displacement of natural habitats and sediment accretion or erosion in lagoons and estuaries, depending on the sediment availability and accommodation space. Coastal erosion which is aggravated by the decrease of fluvial sediment supply to littoral cells (Sampath and Boski, 2016), prompts economic losses in tourism, aquaculture, habitats, real estate, and infrastructure. Realistic predictions of changes for the most vulnerable areas are thus crucial for the planning of adaptation measures included in holistic/systemic management of coastal resources. Despite their socioeconomic importance, trustworthy, decadal time-scale predictions are still rare. In particular, the sandy coast of the Algarve from "Olhos de Água" to the Guadiana river mouth is expected to be highly vulnerable to SLR due to its socio-economic importance and due to the sensitivity of ecosystems such as coastal dunes and salt-marsh habitats to SLR flooding and wave impact. Thus, the focus of the present study is on predicting the sandy coastline retreat of the South Algarve.

Methodology: Coastline evolution was estimated by integrating two approaches: 1) Dean (1991) approach to account for the impact of SLR, and 2) Hanson and Kraus (1988) approach to account for the long-shore sediment transport gradient along the sandy coastline. As Dean (1991) suggested, the coastline retreat rate due to SLR rate can be expressed based on the equilibrium beach profile assumption. The model parameters are: the depth of closure (h_c), the seaward distance of the active profile (W*) from its origin, dune height (B) and SLR (Dean, 1991). h_c and W* were estimated based on the wave-climate characteristic of the study area. Dune height was calculated using the topo-bathymetric digital terrain model from 2011 derived from the 2 m resolution Lidar data set available from the "Direção Geral do Territorio" of the Ministry of Environment, Portugal. Three SLR scenarios (Fig. 1a) were used for the study: the upper limit (95%) scenarios of RCP 8.5 and RCP 4.5 from IPCC (2013) and the worst case (S2) scenario of Antunes and Taborda, (2009). The approach of Hanson and Kraus (1988) is known as the GENESIS approach (GENESIS-GENEralized model for SImulating Shoreline change). According to GENESIS model, the predicted coastline retreat rate accounts with the gradient in the alongshore sediment transport and local sediment sources or sinks. In GENESIS, alongshore transport gradient was determined in terms of the breaker wave height (H_b) and the wave group speed (C_g), the alongshore gradient of breaking wave ($\Delta H/\Delta x$) and the angle of breaking waves at the local shoreline. Wave climate parameters and their frequency distribution were based on modelled wave

parameters. Tidal heights were estimated using 10 tidal constituents. The coastline was divided into 6 sectors to simulate the coastline retreat for 2040, 2070 and 2100. Predicting the large-scale geomorphological evolution of coastlines associated with estuaries and inlets in response to environmental and anthropogenic forcing was achieved by extending the behaviour-oriented biased hybrid approach developed in Sampath and Boski (2016). The hybrid model is based on the sediment budget approach to account the sediment supply from marine and fluvial sources. The main fluvial sediment supply source was the Guadiana River and the sediment supply from other rivers was assumed to be insignificant.

Results and Conclusions: According to results, coastline retreat or accretion show a high spatial and temporal variability during the 21st century (Fig. 1b). From "Olhos de Água" to "Praia da Rocha Baixinha", the coastline retreat due to SLR is insignificant. From Quarteira" to Faro, coastline retreat will be approximately 100 m due to RCP 8.5 SLR scenario by the end of 21st century and thus, is expected that infrastructures and settlements are highly impacted by SLR. In the eastern side of the Ria Formosa lagoon, the coastline shows an accretionary trend caused by the alongshore sediment transport gradient. However, the total coastline shows an erosional trend by the end of 2100 when the SLR RCP8.5 scenario is considered. In conclusion, results point out that the overall sandy coastline of South Algarve will be highly vulnerable to the worst case scenario of SLR predicted IPCC for the 21st century.

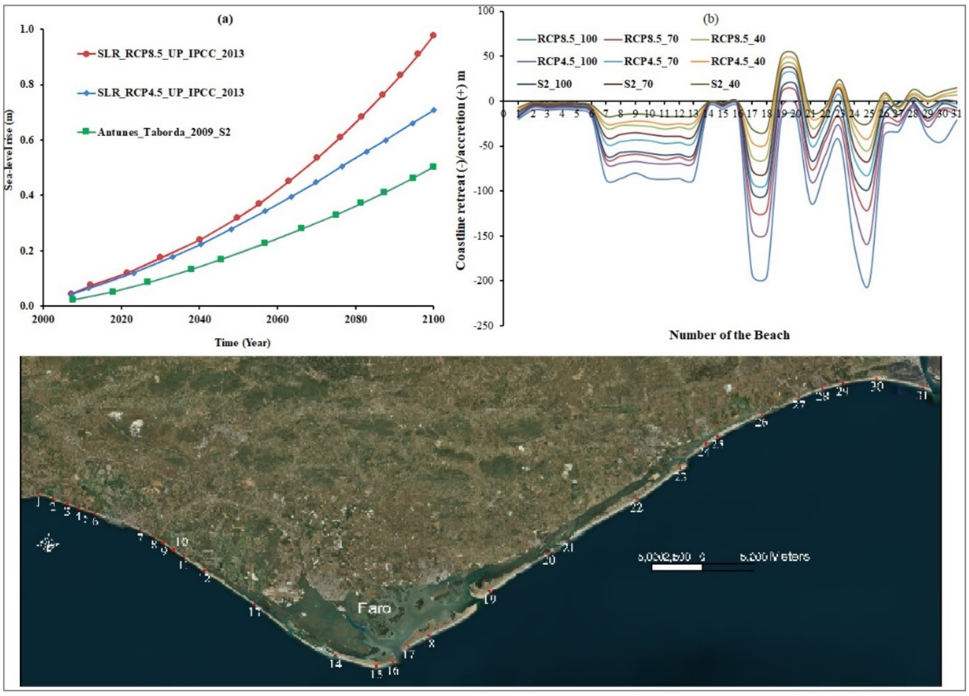

Figure 1: (a) Regional and global mean sea-level rise scenarios: the upper limit (95%) scenarios of RCP 8.5 and RCP4.5 from IPCC, (2013) and S2 scenario of Antunes and Taborda, 2009; **(b)** Coastline retreat and accretion from the Olhos de Água to Vila Real Santo António: Beaches 1) Olhos de Água, 2) Falésia, 3) Alfamar, 4) Poço Velho, 5) Praia dosTomates, 6) Rocha Baixinha, 7) Quarteira, 8) Almargem, 9) Trafal, 10) Vale do Lobo, 11) Garrão, 12) Ancão, 13) Faro, 14) Barreta, 15) Cabo de Santa Maria, 16) Barreta-Mar, 17) Farol, 18) Culatra-Mar, 19) Armona, 20) Fuseta, 21) Barra da Fuseta, 22) Barril, 23) Ilha de Tavira, 24) Golden Club, 25) Cabanas, 26) Fábrica, 27) Manta Rota, 28) Alagoa, 29) Praia Verde, 30) Monte Gordo 31) Vila Real Santo António

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