© 7ª Conferência sobre Morfodinâmica Estuarina e Costeira | MEC2024,
Livro de Resumos, 2024, Aveiro - Portugal. ISBN 978-972-789-912-8

INSIGHTS INTO MODELLING COASTAL SPIT EVOLUTION USING "SHORELINE_S" MODEL

Francisco Sancho[1], Alphonse Nahon[1]
[1] *Departamento de Hidráulica e Ambiente, Laboratório Nacional de Engenharia Civil, Lisboa, Portugal, fsancho@lnec.pt; anahon@lnec.pt*

Abstract

ShorelineS is a recent coastline evolution model allowing for extreme coastline curvatures and spit formation at high-angle wave incidence. This paper investigates ShorelineS's capabilities in reproducing longshore sediment rates, spit elongation and inlet migration, such as those observed at Langue de Barbarie, in Senegal. Moreover, it addresses the influence of the sediment transport formulation and other model parameters on the representation of shoreline instabilities downdrift of the Senegal river main inlet.

Keywords: Langue de Barbarie; Senegal; Barrier island; Inlet migration

1. Introduction

The coast of Senegal is located on the relatively narrow West African continental shelf and is characterized essentially by sand barriers. The dominant swell-wave regime from the Atlantic Ocean generates sustained longshore sand drift responsible for the construction of numerous sandy barrier systems and spits (Anthony, 2015). These form a rather irregular coastline, with various lagoons and tidal embayments, particularly at conjunctions with outflowing rivers and delta developments, such as the Senegal river delta.

The Senegal delta is a classical wave-dominated delta, characterised by the presence of a persistent sand spit, the Langue de Barbarie. The spit width varies between 100 and 400 meters and this is an extremely mobile feature, subject to repeated past breaches, associated with phases of delta-mouth migration. Rates of spit growth were reported to vary from 100 to 700 m per year (Bergsma et al., 2020), depending on variations in wave characteristics, river discharge and river mouth dynamics, combined with barrier-breaching events. Based on a 32-year wave data record, Sadio et al. (2017) estimated the longshore sediment transport rate (net drift) at Langue de Barbarie to be of the order of 611×10^3 m^3/year, southwards.

This paper aims to study the ShorelineS model capabilities in reproducing longshore sediment transport, spit elongation and inlet migration rates, at the Senegal river delta.

2. Methodology and results

The ShorelineS model (Roelvink et al., 2020) is a free-form shoreline evolution model, driven by longshore transport gradients that result from coastline curvatures and allowing for spit formation at high-angle wave incidence (Elghandour and Roelvink, 2020). The model admits developing shoreline undulations and formation of spits, migrating and merging islands. An updated version of the model was applied and validated at Langue de Barbarie spit, using Satellite Derived Shorelines as input (Figure 1).

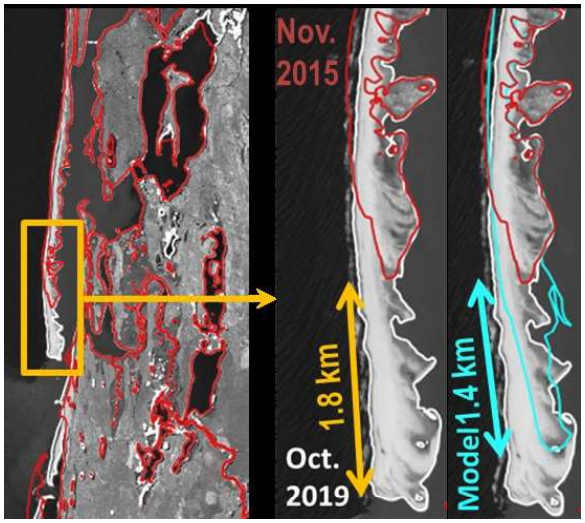

Figure 1. Left: Satellite derived shorelines in study area in 2015 (red contour) and 2019 (white contour); right: model validation against observed spit-elongation.

The application covered a period of nearly 4 years, between October 2015 and November 2019. Most default model parameters were used, while several tests were carried out in relation to the parameters that most influenced the inlet dynamics, namely the alongshore sediment transport magnitude, the coastal orientation, the inlet channel width, and the barrier width.
Results indicate that promoting an increase in the sediment transport rates enhances inlet migration and spit growth rates, and may trigger spit instabilities and breaching. Further ongoing tests look to find the balance necessary for accurately predicting the downdrift flying spits.

Acknowledgements

The authors acknowledge the financing from *Programa de Cooperación INTERREG MAC 2014-2020, Proyecto RES-COAST*, and warmly thank Dano Roelvink for providing the ShorelineS code. Wave hindcast data used in this study is available at https://zenodo.org/records/8139334.

References

Anthony, E.J., 2015. 'Patterns of Sand Spit Development and Their Management Implications on Deltaic, Drift-Aligned Coasts: The Cases of the Senegal and Volta River Delta Spits, West Africa', https://doi.org/10.1007/978-3-319-13716-2_2.

Bergsma, E.W.J. et al., 2020. 'Sand-spit evolution and inlet dynamics derived from space-borne optical imagery is the Senegal-river inlet closing?', Proc. Int. Coastal Symposium (ICS) 2020 (Seville, Spain). J. of Coastal Research, S.I. No. 95, pp. 50-54, ISSN 0749-0208.

Elghandour A., and Roelvink D., 2020. 'Arctic Alaska barrier Islands: improving the fidelity of morphological impact predictions', Phase 1. IHE Delft Report.

Roelvink, D. et al., 2020. 'Efficient Modeling of Complex Sandy Coastal Evolution at Monthly to Century Time Scales', *Front. Mar. Sci.* 7:535, doi: 10.3389/fmars.2020.00535.

Sadio, M. et al., 2017. 'Shoreline Changes on the Wave-Influenced Senegal River Delta, West Africa: The Roles of Natural Processes and Human Interventions', *Water* 9, no. 5: 357, https://doi.org/10.3390/w9050357.