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ÍNDICE

EDITORIAL - ANA PAULA AVELAR

DOSSIER TEMÁTICO - FUTUROS DA ÁGUA: RESILIÊNCIA, GOVERNAÇÃO E ADAPTAÇÃO

JORGE TRINDADE

Futuros da água : Resiliência, Políticas de Governação e Adaptação Local

Water Futures: Resilience, Governance, and Community Adaptation

CARLA FERNANDES; FÁTIMA ALVES

Água e desenvolvimento: a importância das percepções sociais em Marrocos

Water and Development: The Importance of Social Perceptions in Morocco

ANDRÉ BUONO SILVEIRA

A economia circular como inovação contra a poluição dos rios Tietê e Pinheiros

Circular economy as an innovation against pollution of the Tietê and Pinheiros rivers

LUÍS MORENO

Rega para agricultores familiares no contexto das alterações climáticas em Portugal: percepções, opções e necessidades

Irrigation for family farmers in the context of climate change in Portugal: perceptions, options and needs

MARIA DA GLÓRIA SALGADO GONÇALVES

Cheias no rio Vez: uma análise social através da Pirâmide de Freytag

Floods in the Vez River: A Social Analysis through Freytag's Pyramid

IDRISS SAMMAA; ALI TAOUS; MOHAMMED YAZAMI ZTAIT; IMAD EL GHALMI

Erosão fluvial e mudanças morfológicas do Oued Bouregreg no setor de Maaziz (Planalto Central, Marrocos)

Erosion fluviale et mutations morphométriques de l'Oued Bouregreg dans le secteur de Maaziz (Plateau central, Maroc)

IMAD EL GHALMI; ALI TAOUS; IDRISS SAMMAA; LAHCEN OUIABOUB

Impactos hidro-morfo-sedimentares da barragem de Sidi Chahed e mudanças da paisagem fluvial do baixo vale do Mikkès (bacia do Sebou, Marrocos)

Impacts hydro-morphosédimentaires du barrage Sidi Chahed et mutation du paysage fluvial de la basse vallée du Mikkès (bassin du Sebou, Maroc)

LUÍS ALÍPIO GOMES; TÂNIA SUELY AZEVEDO BRASILEIRO; HELANA MIRANDA DA C. GOMES

Sustentabilidade ambiental e o papel do ensino superior: um estudo de caso do rio Tapajós, na Amazônia

Environmental Sustainability and the role of Higher Education: a case study of the Tapajós River in Amazon

BERNARDO SALES; SÉRGIO C. OLIVEIRA; JORGE TRINDADE

Suscetibilidade e exposição à erosão costeira no município de Peniche – evolução recente e futura

Coastal Erosion Susceptibility and Exposure in the Municipality of Peniche – Recent and Future Evolution



ABDELLAH KHOUZ, JORGE TRINDADE, PEDRO PINTO SANTOS,
FATIMA EL BCHARI, SÉRGIO C. OLIVEIRA, RICARDO A. C.
GARCIA, ASMA BOUGAYOU, MUSTAPHA IKIRRI, MOURAD
JADOUD, SAID RACHIDI, AND BLAID BOUGADIR

Contributo de modelos estatísticos na avaliação da
suscetibilidade a cheias na província de Essaouira, Marrocos
*Contribution of statistical models in flood susceptibility assessment
in Essaouira Province-Morocco*

ASMA BOUGAYOU ; ABDELLAH KHOUZ ; FATIMA EL BACHARI;
JORGE TRINDADE; MUSTAPHA IKIRRI; SIHAM AFRAOU; FARID
FAIK; BLAID BOUGADIR

Avaliação do potencial de águas subterrâneas na área de Ait
Abdellah com recurso à deteção remota e SIG

*Assessment of groundwater potential in the Ait Abdellah area by
using remote sensing and GIS*

JOÃO CARRILHO, ABDELLAH KHOUZ, JORGE TRINDADE
Águas subterrâneas na governação do nexa Água-Energia-Ali-
mentação em áreas periurbanas exteriores

*Groundwater in the Water-Energy-Food nexus governance in
outer peri-urban settlements*

GUSTAVO DGEDGE, CELSO CHIVALE, JAIME MAGAIA, JORGE
TRINDADE

Avaliação das áreas suscetíveis a cheias na sub-bacia do rio
Revúboè, Moçambique

*Assessing Flood Susceptibility Areas in the Revúboè river
sub-basin, Mozambique*

ANDREIA ALVES DA SILVA; LUÍS PEDRO ALMEIDA; ANTÓNIO
H.F. KLEIN

Abordagem multiescalar baseada em dados de satélite
para a análise de tendências da linha de costa em Portugal
Continental

*Satellite-driven multi-scale approach for shoreline trend analysis
in Mainland Portugal.*

ANDREIA ALVES DA SILVA, JORGE TRINDADE; JORGE ROCHA
Avaliação do perigo e da exposição à subida do nível do mar
em Portugal Continental

*Hazard and Exposure Assessment to Sea Level Rise in Mainland
Portugal.*

MOHAMED LOUAZANI, ABDERRAFIE EL MAKNISSI

Sistemas de gestão da água nos oásis saariano e o desafio da
sustentabilidade face às alterações climáticas: estudo de caso
dos oásis de Oued-Noun, sul de Marrocos

*The Water Management Systems in Saharan Oases and the
Sustainability Challenge in the Face of Climate Change: A Case
Study of the Oued-Noun Oases, Southern Morocco.*

RICARDO ACÁCIO XAVIER; PEDRO PINTO SANTOS;
JOSÉ MANUEL MENDES

Risco de cheias em Moçambique: estratégias comunitárias para
a redução da vulnerabilidade a partir de dois estudos de caso

*Flood risk in Mozambique: communitarian strategies for
vulnerability reduction from two case studies.*

SUSANA PEREIRA; JORGE TRINDADE; ANDREIA ALVES DA
SILVA; PEDRO PINTO SANTOS; EUSÉBIO REIS; JOSÉ LUÍS
ZÊZERE

Perfis de risco de perigos costeiros em Portugal Continental à
escala da freguesia

*Risk profiles of coastal hazards in mainland Portugal at the civil
parish level.*



CHAIMA IMAM; MOHAMED CHAIBI; FATIMA EL BCHARI
Cartografia da sensibilidade à degradação dos solos na bacia hidrográfica do oued El Abid: aplicação do modelo MEDALUS
Cartographie de la sensibilité à la dégradation des sols dans le bassin versant de l'oued El Abid : Application de MEDALUS

GONÇALO BATISTA; MARIANA CONCEIÇÃO; RICARDO GARCIA, SÉRGIO OLIVEIRA, ANDRÉ TRINDADE, CLÁUDIA VIANA, JORGE ROCHA
Nova cartografia de solos à escala 1:100 000 para Portugal Continental
A New Soil Cartography at 1:100,000 scale for mainland Portugal

MARIANA CONCEIÇÃO, GONÇALO BATISTA, RICARDO GARCIA, SÉRGIO OLIVEIRA, ANDRÉ TRINDADE, CLÁUDIA VIANA, JORGE ROCHA
Delimitação de distritos de solos em Portugal Continental
Delimitation of Soil Districts in mainland Portugal

CHAIMA IMAM, MOHAMED CHAIBI, FATIMA EL BCHARI, MOHAMED AYT OUGOUDAL, ABDESSAMAD CHARIF, HALIMA AIT MALEK
Recuo de arribas costeiras e suscetibilidade ao perigo na região de Safi, Marrocos
Coastal Cliff Retreat and Hazard Susceptibility in the Safi Region, Morocco

SAMIR IDLLALÈNE; ABDESSAMAD AFIFI MOULAY; ALAZALI MOUNIA; MOHAMED MOUCH; BENABDERRAZIK RADIA; LAHCEN OUAHMANE; ABDERRAFIE EL MAKNISSI
Análise dos desafios jurídicos, ambientais e socioeconómicos das autoestradas da água em Marrocos: um estudo de caso
Analyse des enjeux juridiques, environnementaux et socio-économiques des autoroutes de l'eau au Maroc: une étude de cas

EL MEHDI EL JOUMDOUNI; ABDESSAMAD CHARIF; ABDELGHANI QADEM; BRAHIM EL OUTASSI; HALIMA AIT MALEK; MOHAMED CHAIBI; FATIMA EL BCHARI
Análise estatística do impacto das alterações climáticas na distribuição espaço-temporal da precipitação no norte da região de Abda (província de Safi, Marrocos)
Analyse statistique de l'impact des changements climatiques sur la répartition spatio-temporelle des précipitations dans le Nord de la région de Abda (Province de Safi – Maroc)

VARIA

JOÃO CARLOS MARQUES SIMÕES
A importância das grandes florestas tropicais e a segurança ambiental: perspetivas das florestas tropicais na região dos Grandes Lagos
The importance of large tropical forests and environmental security: perspectives on tropical forests in the Great Lakes region

JOSÉ DAS CANDEIAS SALES, SUSANA MOTA
José de Souza Larcher e o domínio inglês do Egipto nas Impressões de Viagem (1901)
José de Souza Larcher and British rule in Egypt in Impressões de Viagem (1901)

GUILHERME OLIVEIRA MARTINS
Vinte anos da Convenção de Faro
Twenty years since the Faro Convention



RECENSÕES

PAULO OSÓRIO

História do Pensamento Linguístico-Gramatical em Portugal e no Brasil de Batista, Ronaldo de Oliveira; Fernandes, Gonçalo; Bastos, Neusa Barbosa & Assunção, Carlos (eds) (2025).

JEFFREY CHILDS

Inventions of a Present: The Novel in its Crisis of Globalization,
by Fredric Jameson

TESTEMUNHO(S)

HERMANO CARMO

Prémio Armando Rocha Trindade

Suscetibilidade e exposição à erosão costeira no município de Peniche – evolução recente e futura

Coastal Erosion Susceptibility and Exposure in the Municipality of Peniche – Recent and Future Evolution

Bernardo Sales
Sérgio C. Oliveira
Jorge Trindade

Resumo

Este estudo avalia a evolução recente (2008–2023) e projetada da linha de costa de Peniche, combinando modelação de suscetibilidade a movimentos de vertente com a análise da evolução costeira através do DSAS. Os resultados evidenciam recuo significativo nos setores Gambôa – Baleal e Azenhas e pequena acreção em Molhe Leste – Consolação. O setor Baleal – Pico da Mota apresenta maior suscetibilidade à erosão. Apesar da reduzida exposição atual, recomenda-se monitorização contínua e modelos preditivos mais robustos para apoiar a gestão e o ordenamento costeiro.

Palavras-chave: Erosão costeira; Peniche; Suscetibilidade de arribas; Evolução da linha de costa; Gestão costeira.

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Abstract

This study assesses the recent (2008–2023) and projected evolution of the Peniche coastline, combining logistic regression modeling of cliff landslide susceptibility with shoreline change analysis using DSAS. Results show significant retreat in the Gambôa – Baleal and Azenhas sectors and minor accretion in Molhe Leste – Consolação. The Baleal – Pico da Mota sector exhibits the highest cliff erosion susceptibility. Although current exposure of residential areas is low, monitoring and improved projection models are essential for future coastal risk management and land-use planning.

Keywords: Coastal erosion; Peniche; Cliff susceptibility; Shoreline change; Coastal management.

Introduction

The recent evolution of the coastline, marked by sediment deficits, intense coastal erosion, and intensive or uncontrolled development of these areas, is one of the main issues that, must be understood for better, improved, and more effective coastal management and risk reduction. This is due to the dynamics of sandy systems or susceptibility to slope movements on cliffed coastlines.

On the cliff rocky coastlines, erosion mainly begins with the wear of the base, resulting in erosion due to undercutting, eventually leading to retreat. Cliff evolution also includes subaerial processes, which often cause erosion due to the instability of coastal cliffs, and processes related to hydraulic erosion, especially surface runoff, both concentrated (e.g., gulying and rill erosion) and un-concentrated. On the sandy coastline, erosion depends on the balance between sediments deposited and those transported by the sea, which, in turn, are influenced by natural and anthropogenic factors operating at various spatial and temporal scales, involving several processes, some of which are related to wave propagation to the shoreline (e.g., transformation processes: refraction, diffraction, dissipation, collapse, among others) (Trindade, 2010).

The study area (Figure 1), is located in the municipality of Peniche, and consists of both sandy and rocky coastlines. The sandy coastline contains beach-dune and beach-cliff systems. The rocky coastline is predominantly composed of limestones and marls, with systems such as abrasion platforms cliffs, block cliffs, and a mixed system that corresponds to the abrasion platform with blocks and a submerged cliff system that is in direct contact with the sea. Both types of coastline, sandy and rocky, contain geomorphologically interesting features such as the tombolos of Baleal and Peniche.

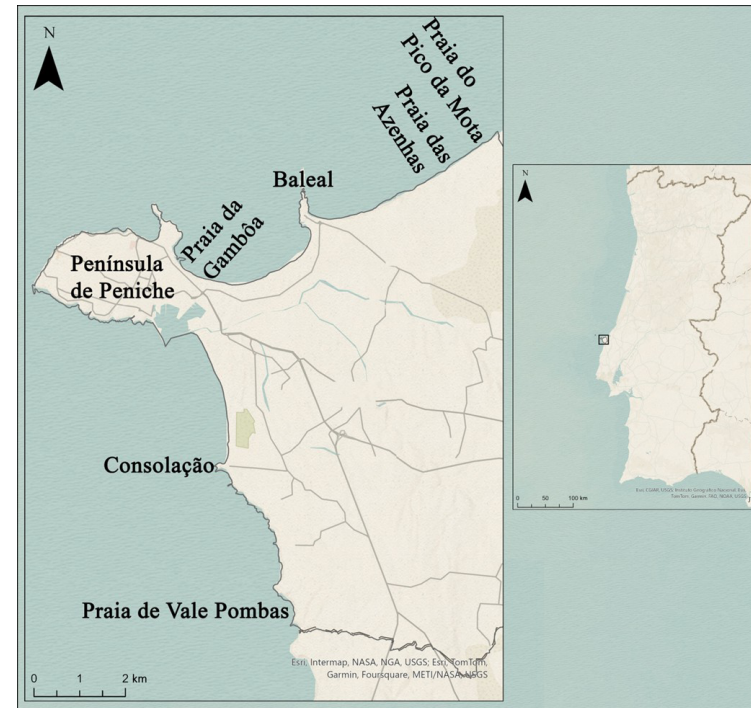


Figure 1. Geographic context of the coastline in the municipality of Peniche.

The study of coastal erosion, dynamics, and the evolution of the sandy coastline in Peniche (or covering larger areas, but including Peniche) has been developed by several authors in recent decades, which proves the relevance of the topic and study area. Examples of work on the sandy coastline include studies by Silva et al. (2013a,b,c), Ponte Lira et al. (2016), and for the rocky coastline, the works of Marques (1998), Penacho and Marques (2023). In this regard, the work to be carried out aims to continue studies on this topic, focusing on the assessment of the recent and future retreat of the coastline, considering the diversity of sandy and rocky systems present in the coastline of the municipality of Peniche, to identify and map the variation in the position of the coastline and exposure to coastal erosion.

Methods

The susceptibility to landslides on the rocky coastline was evaluated using the statistical method of logistic regression. This method allows for the estimation of the probability associated with the occurrence of landslides based on a set of independent explanatory variables, and is used in situations where the dependent variable is dichotomous in nature (0 – 1: absence – presence). This method has been applied in the assessment of landslide susceptibility in cliff coasts and non-coastal slopes, by various authors both internationally (Dai et al., 2001; Brahim & Elmoulat, 2018) and in Portugal (Marques et al., 2013; Marques, 2018; Queiroz & Marques, 2019; Penacho & Marques, 2023). Landslide susceptibility modelling was performed using IBM SPSS Statistics v29 software and an independent cross-validation process to train the final susceptibility model, this process was repeated five times, with the final model being the average of the five susceptibility models produced.

The study regarding coastline evolution began with the selection of an appropriate coastal indicator. This indicator must be suitable for the temporal scale of the study, which in this case is medium-term (2008-2023). To ensure consistent measurement, the chosen indicator should be as independent as possible from frequent changes in water levels and the seasonal morphological cycle of the beach. Thus, the vegetation line indicator was chosen for the sandy coastline, as most of the sandy coastline consists of dunes bounded by vegetation, and due to the difficulty of precisely identifying the foot of the dune from aerial photographs. For the rocky coastline, the cliff crest was considered as the indicator, as it is easily identifiable through photointerpretation. The coastline line for the sandy coastline was delineated for the years 2008, 2015, and 2023. For the rocky coastline, only the years 2008 and 2023 were considered. The rates of coastline evolution were calculated using GIS with the Digital Shoreline Analysis System v6.0.168 (DSAS) tool (Himmelstoss et al., 2024).

Based on the evolution rates obtained from the previous method, a linear projection of the coastline was made. The projection was carried out for a future scenario of 15 years, as the evolution rate data acquired in this study also correspond to a period of 15 years (2008–2023). In applying this projection, all values related to accretion (+0) were considered to be in dynamic equilibrium. Thus, the retreat value obtained for each terrain unit (TU) corresponds to the evolution rate (ER) of each TU, multiplied by the time period (TP) for which the projection is to be made, which in this case is 15 years (TP15). The equation is given by: $TP15 = ER * 15$.

This projection was made in an exploratory manner due to a lack of data and time to create a robust model of coastline position evolution for future scenarios. It is a simple linear projection based on the evolution rates recorded in the present, assuming that the trends observed in the last 15 years will remain similar to those expected for an equal period in the future. This assumption is valid as long as no significant changes in the conditions that govern coastal erosion in the study area occur in the short term. This projected short-term trend may be biased by the dynamics present in the sandy coastline, and thus the use of these trends is accepted, assuming their exploratory nature.

Based on the observed average retreat value for each terrain unit and coastline retreat projections, a landwards future position of the coastline was created for each TU, thus allowing for the evaluation of whether the expected coastline retreat could have any impact on existing residential infrastructure.

Results

In this study, 149 landslides were identified, resulting in a loss of cliff surface area of approximately 9,028 m². Spatially, these landslides are predominantly clustered in the Baleal – Praia Pico da Mota section, where 142 landslides are present. The remaining 7 are located in the Consolação – Praia de Vale Pombas section.

One of the reasons for this low number of occurrences is a series of anthropogenic interventions aimed at mitigating the occurrence of geomorphological instability manifestations in this sector, including the presence of hexagonal grids and protection through the application of sprayed concrete. No landslides were observed in the Peniche Peninsula sector during the study period.

The final susceptibility map for landslides in coastal cliffs, as mentioned earlier, resulted from the integration of the five landslide susceptibility models produced. The area under the curve (AUC) values for each model are represented in Table 1. The final susceptibility score is defined by the average value of the scores obtained for each TU across the five previously defined susceptibility models. This approach allows for independent cross-validation of each susceptibility model and, by using all TUs with occurrences, enhances the predictive capacity of the final susceptibility model.

Model	AUC
Model 1	0.632
Model 2	0.833
Model 3	0.830
Model 4	0.878
Model 5	0.731

Table 1. AUC values of each slope movement susceptibility assessment regression model on coastal cliffs.

In the final susceptibility model (average of the five models), it was observed that the most susceptible sector is the Baleal – Praia do Pico da Mota stretch, where the very high and high susceptibility classes predominate, it is also in this sector where the highest number of landslides occurred. In the Peniche Peninsula sector, as mentioned earlier, no landslides were observed (none were identified) during the study period (2008-2023). This record confirms the predominance of the class corresponding to low and very low susceptibility. The last sector corresponds to the

Consolação – Praia de Vale Pombas stretch, where only 5 terrain units were affected by landslides. As also mentioned earlier, this sector is heavily protected from erosion by a series of (preventive) interventions aimed at limiting landslide occurrences. Therefore, some of the TUs with no landslide occurrences but classified with high susceptibility may require additional monitoring.

The study of the coastline evolution over the last 15 years (2008-2023) revealed a strong erosive trend on the sandy coastline in the Praia das Azenhas and Praia da Gambôa – Praia do Baleal Sul sectors, with the latter stretch being particularly severe. In contrast, in the Praia do Molhe Leste – Praia da Consolação sector, accretion values were observed, although they were very insignificant, as shown in Table 2.

Sector		2008 - 2015	2015 - 2023	2008 - 2023
Praia das Azenhas	Coast Change Rate (m/year)	-0,03 ± 0,14	-0,30 ± 0,17	-0,18 ± 0,10
	Total Coast Change Rate (m)	-0,21	-2,4	-2,7
Praia da Gambôa – Praia do Baleal Sul	Coast Change Rate (m/year)	-1,37 ± 0,14	-1,25 ± 0,17	-1,32 ± 0,10
	Total Coast Change Rate (m)	-9,59	-10	-19,80
Praia do Molhe Leste – Praia da Consolação	Coast Change Rate (m/year)	-0,21 ± 0,14	0,26 ± 0,17	0,05 ± 0,10
	Total Coast Change Rate (m)	-1,47	2,08	0,75

Table 2. Average yearly and total evolutionary trend for the sandy coastline.

In the rocky coastline (Table 3), the sector with the greatest retreat was the Praia das Azenhas – Praia do Pico da Mota sector, where a total retreat value of 3 m was recorded, followed

by the Consolação sector with a total retreat of 1.35 m. Lastly, the Baleal – Praia das Azenhas sector showed a total retreat of 0.3 m.

Sector		2008 - 2023
Praia do Baleal Norte – Praia das Azenhas	Coast Change Rate (m/year)	0,02 ± 0,08
	Total Coast Change Rate (m)	0,3
Praia do Baleal Norte – Praia das Azenhas	Coast Change Rate (m/year)	0,02 ± 0,08
	Total Coast Change Rate (m)	0,3
Praia das Azenhas – Praia do Pico da Mota	Coast Change Rate (m/year)	0,20 ± 0,08
	Total Coast Change Rate (m)	3
Consolação	Coast Change Rate (m/year)	0,09 ± 0,08
	Total Coast Change Rate (m)	1,35

Table 3. Average yearly and total evolutionary trend for the rocky coastline

Based on the evolution values present in Table 2 and assuming that the conditions governing erosion in these sectors will not change significantly compared to those observed in the last 15 years, an average retreat of 17.20 m is expected in the Gambôa – Baleal sector, 2.02 m in the Molhe Leste – Consolação sector, and 7.08 m at Praia das Azenhas.

The same process was applied to the rocky coastline, resulting in an expected average retreat of 1.55 m in the Baleal Norte – Pico da Mota sector, and an average retreat of 0.16 m in the Consolação – Vale Pombas sector. Although these values do not represent a highly pronounced erosive trend, they should not be underestimated, as they may occasionally correspond to more significant retreats associated with the occurrence of larger magnitude slope movements.

Regarding exposure in the study area, mainly due to the extent of the dune system, no TU in the sandy coastline was found to have residential buildings within the expected retreat zone.

In the rocky coastline, two situations were identified that may jeopardize the stability of certain buildings, as the expected retreat includes some urban fabric, particularly part of a parking lot and the wall/fence of a property/residence. Although no housing is directly affected, the proximity to slope movements observed in recent years, combined with the expected retreats, could undermine the stability of the cliff in the short/medium term, potentially affecting the housing itself. Therefore, there is a need to monitor this sector.

Conclusion

In conclusion, the results obtained point to retreat values related to recent coastal erosion in the rocky coastline sector, Baleal – Praia do Pico da Mota, and in the sandy coastline sectors, Gambôa – Baleal and Praia das Azenhas. The sandy sector Molhe Leste – Consolação stands out as the only sector with accretion values, although these are not significant. The Peniche Peninsula (rocky coastline) emerges as the least susceptible sector to coastal erosion during this study period (2008-2023).

The assessment of susceptibility to erosion is essential in studies addressing the coastline, as it helps identify the most critical sectors to be considered in future land-use planning.

For future studies, there is a particular emphasis on the need to apply a more robust coastline projection method that takes into account dynamics primarily related to erosion and coastal flooding, especially in sandy systems. This includes the use of different sea-level rise scenarios for the end of the century, storm surge, wave run-up, and other factors.

References

BRAHIM, L. A., & ELMOULAT, M. (2018). Application of logistic regression method to produce landslide susceptibility map: A case study of Tetouan Mazari, Morocco. *MATEC Web of Conferences*, 149, 02082. <https://doi.org/10.1051/mateconf/201814902082>

DAI, F. C., LEE, C. F., LI, J. X. Z. W., & XU, Z. W. (2001). Assessment of landslide susceptibility on the natural terrain of Lantau Island, Hong Kong. *Environmental Geology*, 40(3), 381–391. <https://doi.org/10.1007/s002540000163>

HIMMELSTOSS, E.A., HENDERSON, R.E., FARRIS, A.S., KRATZMANN, M.G., BARTLETT, M.K., ERGUL, A., MCANDREWS, J., CIBAJ, R., ZICHICHI, J.L., and THIELER, E.R., 2024, Digital Shoreline Analysis System version 6.0: U.S. Geological Survey software release, <https://doi.org/10.5066/P13WIZ8M>

MARQUES, F. (2018). Regional scale sea cliff hazard assessment at Sintra and Cascais counties, western coast of Portugal. *Geosciences*, 8(3), 80. <https://doi.org/10.3390/geosciences8030080>

MARQUES, F. M. S. F. (1998). Sea cliff retreat in Portugal: overview of existing quantitative data. *Fifth Cong. Nacional Geologia*, 18-20 Nov. 1998, Lisboa, 75-78.

MARQUES, F. M. S. F., MATILDES, R., & REDWEIK, P. (2013). Sea cliff instability susceptibility at regional scale: a statistically based assessment in the southern Algarve, Portugal. *Natural Hazards and Earth System Sciences*, 13(12), 3185–3203. <https://doi.org/10.5194/nhess-13-3185-2013>

PENACHO, N. D., & MARQUES, F. M. (2023). A statistical approach for sea cliff hazard and setback lines mapping in the northeast of Peniche, Portugal. *Geomorphology*, 430, 108669. <https://doi.org/10.1016/j.geomorph.2023.108669>

PONTE LIRA, C., NOBRE SILVA, A., TABORDA, R., & FREIRE DE ANDRADE, C. (2016). Coastline evolution of Portuguese low-lying sandy coast in the last 50 years: an integrated approach. *Earth System Science Data*, 8(1), 265-278. <https://doi.org/10.5194/essd-8-265-2016>

QUEIROZ, S. M., & MARQUES, F. M. (2019). Sea cliff instability susceptibility considering nearby human occupation and predictive capacity assessment. *Engineering Geology*, 253, 75–93. <https://doi.org/10.1016/j.enggeo.2019.03.009>

SILVA, A.; TABORDA, R.; LIRA, C.; ANDRADE, C.; SILVEIRA, T.; FREITAS, M.; (2013a); “Determinação e Cartografia da Perigosidade Associada à Erosão de Praias e ao Galgamento Oceânico”; Entregável 1.3.2.a, Consultoria para a Criação e Implementação de um Sistema de Monitorização do Litoral abrangido pela área de Jurisdição da Administração Regional Hidrográfica do Tejo, FCUL, Lisboa.

SILVA, A, N. PONTE LIRA, C. ANDRADE, C, F. TABORDA, R., & FREITAS, M, C. (2013b). “Análise da evolução da linha de costa em litoral baixo arenoso nos últimos 50 anos”; Entregável 1.2.2.2.a, Consultoria para a Criação e Implementação de um Sistema de Monitorização do Litoral abrangido pela área de Jurisdição da Administração Regional Hidrográfica do Tejo, FCUL, Lisboa.

SILVA, A, N. PONTE LIRA, C. MATILDES, R. ANDRADE, C, F. TABORDA, R., & FREITAS, M, C. (2013c). “Utilização de ortofotomapas e fotografias aéreas para a delimitação da linha de costa”. Entregável 1.2.2.2.c, Consultoria para a Criação e Implementação de um Sistema de Monitorização do Litoral abrangido pela área de Jurisdição da Administração Regional Hidrográfica do Tejo, FCUL, Lisboa.

TRINDADE, J. (2010). Dinâmica morfossedimentar de praias dominadas por sistemas de arriba: (Peniche-Cascais) (Dissertação de doutoramento, Universidade Aberta). <http://hdl.handle.net/10400.2/1733>

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