

Geological and hazardous mapping of the coastal zone:

Contribution to the promotion of sustainability, defence and enhancement of the Portuguese coast

January 2021



Algarve, Armação de Pera and Galé: The coast as a strip of territory where multiple economic and leisure activities are promoted.



The importance of the coastal zone

The Portuguese coastal zone, where $\frac{3}{4}$ of the population lives and where the contribution to GDP is estimated at 85%, plays an important role in the national economic context, which is not only reflected on the budget dedicated to the management and mitigation of current risks due to climate change, but also because of its strategic importance in environmental, social and leisure terms.

The geological hazards of the coastal zone

In Portugal, the coast is a part of the territory where **geological risks** assume greater relevance, either due to the direct consequences of the **land loss** and **destruction of infrastructures**, due to changes in the coastline, or indirectly through the **economic consequences** caused by the change in the typology of the coast and **degradation of the coastal environment** (disappearance of beaches, destruction of dunes, overwash...).



Pedrogão: Degradation of the coastal environment due to sand scarcity



Algarve, barrier islands: Destruction of infrastructures due to coastline retreat

The Coastal zone in Portugal...

- **Population density of 215 inhabitants/km²**
- (national average of 125 inhab/km²);
- About **1/3 is occupied** by buildings and port infrastructures;
- **Contributes to the GDP in 85%;**
- It has a unique natural, economic and culture value, whose importance is widely recognized.

(Santos and Miranda, 2006; SIAM II)



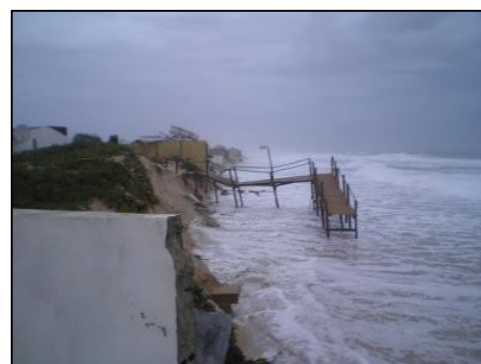
Coastal erosion in the context of climate change

Due to ongoing climate change and sea level rise, probably accelerated by anthropogenic processes, the coastal zone will be subject to greater natural risks (coastal erosion, oceanic overwash, collapse of sea cliffs, destruction of existing infrastructure...), therefore it is urgent to increase the knowledge about the processes and dynamics of the coast.

The sea level rise, the increase in the intensity of storms and the scarcity of sediments in coastal drift are some of the phenomena that underlie the current problems that occur in the coastal zone.



Costa da Caparica: Sand deposit erosion



Fuseta, Algarve: Foredune erosion.

Economic impact of risk mitigation on the coastal zone of mainland Portugal

Since the middle of the last century, the defence of the infrastructures built along the coast began to have a **relevant economic expression**, either due to the development of the urban areas installed there, or due to the accentuated retreat of the coastline as a result of the decrease of sediment in the coastal drift. The rigid defence pattern was replaced by the **artificial sand recharge** pattern, whenever possible, in order to avoid a severe degradation of the coastal environment.



Costa da Caparica: Coastal defence with seawall and spurs.

Enchimento de praias para travar erosão costeira custa milhões ao Estado

A intervenção feita na orla costeira “tem um custo significativo e não é uma solução definitiva, porque o mar continua sempre. É de uma teimosia imparável”, diz investigador da Universidade do Algarve. A alimentação artificial das praias da Caparica, por exemplo, teve um custo total de 19,9 milhões de euros.

Lusa

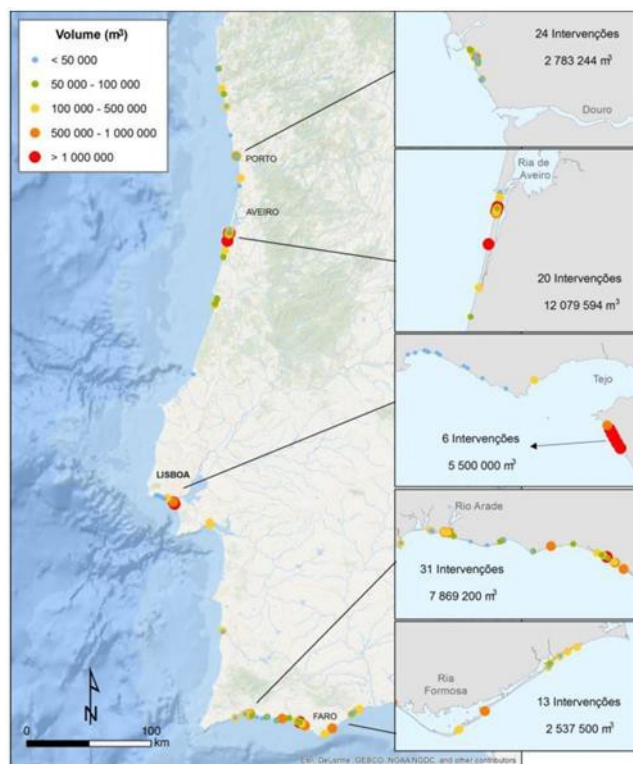
18 de Julho de 2019, 10:04



Erosão costeira na praia da Cova Gala PAULO PIMENTA

Source: <https://www.publico.pt/2019/07/18/ecosfera/noticia/enchimento-praias-travar-erosao-costeira-custa-milhoes-estado-1680355>

The costs involved in this defence, of approximately **196 million euros between 1995 and 2014** (being 23 million applied to repair the damage caused by the storms that occurred in Costa da Caparica, between January and March of 2014 [GTL, *Management of the Coastal Zone: The Challenge of Change, Executive Summary and Recommendations, 2014*]), show the magnitude of the expenses incurred and the high costs, expected in the near future, associated with the storms that will have in the public purse, if the accepted forecasts with climate change take place.

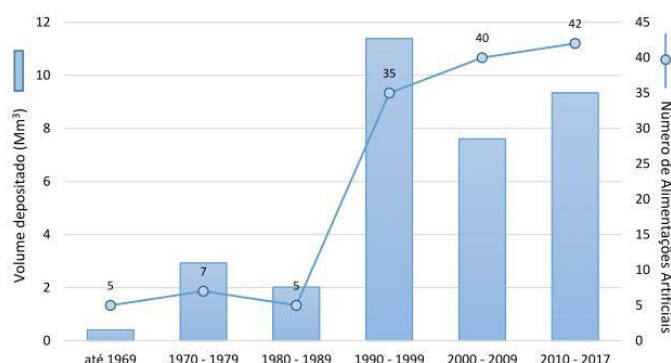


Location and magnitude of artificial beach nourishment in the coastal strip of mainland Portugal between 1950 and 2017. Boxes with details of the most relevant intervention locations (greater number and greater magnitude).

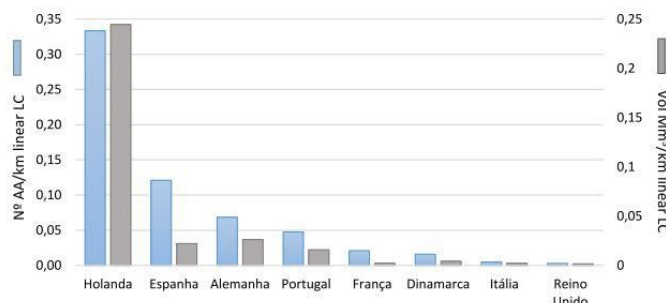
Source: Pinto et al., 2018 Alimentação artificial de praias na faixa costeira de Portugal continental: enquadramento e retrospectiva das intervenções realizadas (1950-2017). Agência Portuguesa do Ambiente



Costa da Caparica: artificial beach nourishment.



Evolution in the number of interventions for artificial beach nourishments in mainland Portugal since 1950, at 10-year intervals, to the present. Inside the bars is shown the number of artificial beach nourishments.



Number of artificial feeds (blue bars) and volumes in Mm³ (grey bars) per linear kilometer of coastline (LC) in several European countries, until 1998. Data source: Hanson et al. (2002) in Pinto et al 2018.

Risk Mitigation and its costs ...

Need to defend: **Villages, ports, bathing areas, natural areas ...**

To avoid the occurrence of **land loss** and maintain, if possible, the **environmental quality** of the coastal zone

- 196 million euros spent between 1995 and 2014
- Due to the storms in 2014, 23 million euros were spent

Costs likely to rise due to the scarcity of sediment and to the expected climate change effects.





Geological and Hazardous Mapping Program at 1:3000 scale, as a contribution to the promotion of sustainability, defence and enhancement of the Portuguese coast

In such a scenario, and as the **national entity that performs permanent functions of the State in the development of geoscientific knowledge** of the Portuguese territory, reorienting the knowledge production on the Coastal Geology field to mitigate the problems that affect society and the economy, LNEG started a programme on a national scale, which aims to contribute to the knowledge of the coastal zone from a point of view of **sustainability, defence and enhancement of the coastal zone**, with the study of the Vila Real de Santo António - Faro and Figueira da Foz - Nazaré sectors under progress.

The knowledge increase on geology of the coastal strip as a result of a detailed cartography, and the assessment of hazard information based on the historical evolution of the coastline, expressed in a digital cartographic basis, besides constituting an important contribution to the development of regional geology, is a vital support to the correct use and sustainable development of the coastal zone at a local scale.

This project aims to generate and integrate a set of useful information for decision makers (at national and regional level), researchers and the general public, in a single digital platform available to the community. The information will be available in different layers, being aggregated into three domains: Geology, Hazard and Physical characterization of the environment (sedimentological and morphological).

Geology at detailed scale (1:3000) with identification of artificial deposits



Hazard represented by the coastline retreat in the last 65 years



Coastal zone mapping at scale 1:3K

- **Geology**
 - Natural deposits
 - Artificial deposits
- **Hazard Indicator**
 - Coastline retreat (NSM, SCE, LRR)
- **Physical characterization of the environment**
 - Beach profiles
 - Sediment grain size
 - Outcrop photographs
 - Sediment color

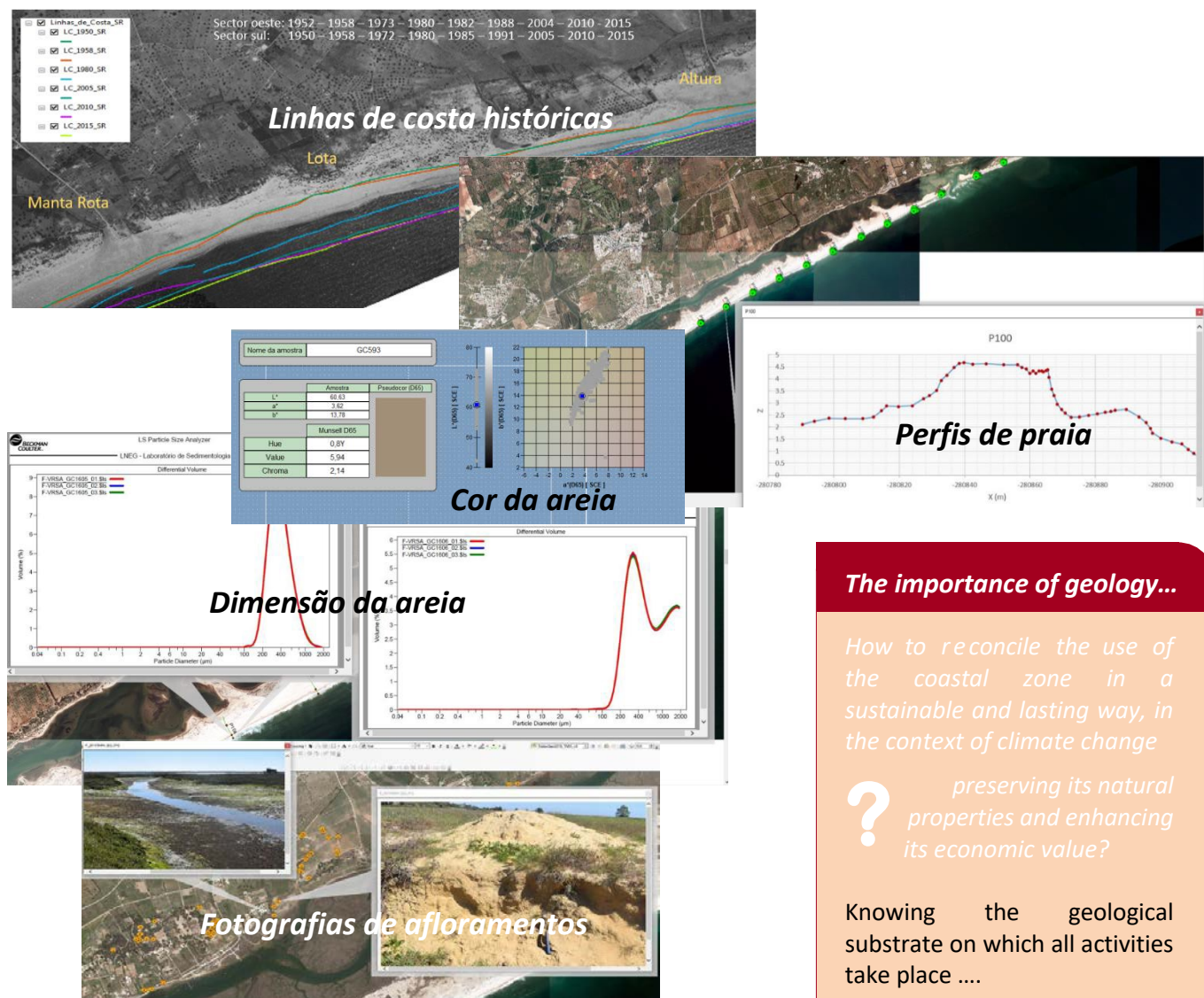


The incorrect infrastructures implementation in the coastal zone, which, in addition to the continuous financial effort for its maintenance, generates landscape degradation, loss of value and quality of the national territory, being sometimes the cause of the increase in the land loss by coastal erosion, can be avoided. The increase of knowledge on geology and geological processes associated with the coastal zone, an aspect in which this project is relevant, is decisive to mitigate past mistakes and contribute to promoting good coastal management in the future.

Geology, as a science that studies not only the substrate, but also its evolution over time, is, in this project, approached in an innovative way on a human scale, both spatially and temporally. This is a critical factor for its applicability to the correct management of the coastal space.

In this project, and in order to streamline processes, enable updated information and **generate easily accessible products to users**, data acquisition, storage and processing and the resulting products are preferably developed on digital platforms.

Complementary layers



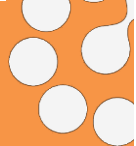
The importance of geology...

How to reconcile the use of the coastal zone in a sustainable and lasting way, in the context of climate change



preserving its natural properties and enhancing its economic value?

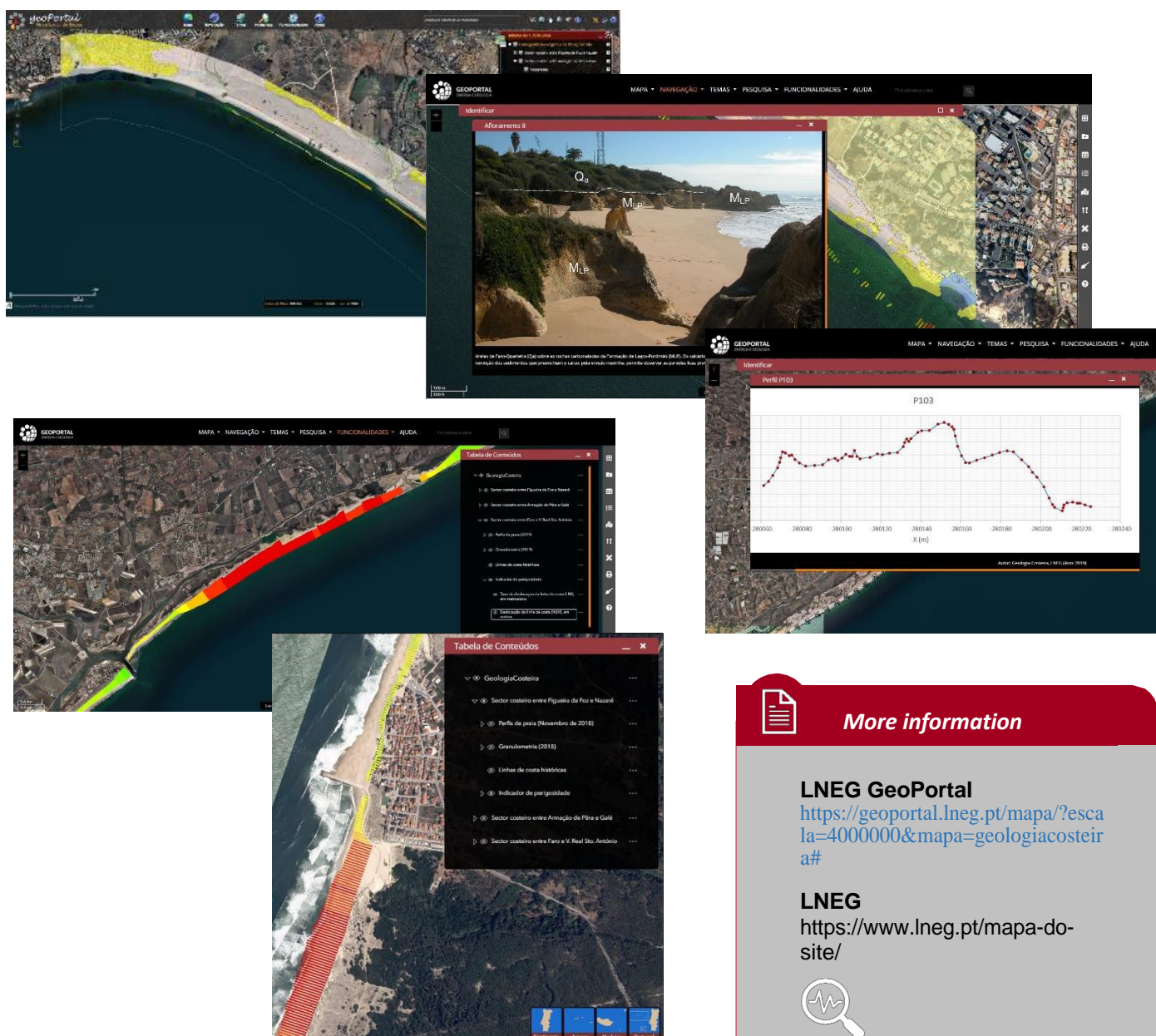
Knowing the geological substrate on which all activities take place



Continuous availability of data - LNEG GeoPortal

All information produced in the project is available to the public, in digital format, on the **LNEG's GeoPortal**. Using the potential of this platform, the various layers of information are easily consulted, either separately or in aggregated form. This form of data availability, as part of the public sector's digital transition strategy, aims to facilitate the access to citizens, enterprises and public entities.

Layers are being developed so that they can also be presented in APP for mobile devices, which associated with the scale used (1:3000) and the possibility of using an orthophotomap image as a background image, as well as the transparency of the geology layer, allows an easy location by the user in the surrounding environment.



More information

LNEG GeoPortal

<https://geoportal.lneg.pt/mapa/?escala=4000000&mapa=geologiacosteira#>

LNEG

<https://www.lneg.pt/mapa-do-site/>

