

# Coastal Erosion: from Coastal Natural Resources Loss to Territorial Imbalances



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## Abstract

This mini-review addresses the Coastal erosion dilemma with which governments seek to deal. The problem stems from coastal attractiveness to society since coastal regions are rich in biodiversity, provide food, transportation, and recreation, appealing to people and economic activities. Consequently, they are becoming densely populated areas which is determinant to the coastal erosion escalation. The growth and diversity of activities located in coastal regions that directly or indirectly depend on them have led to increasing pressures with damaging ecosystems and accelerating coastal erosion. Damming, dredging, inert extraction, fluvial and marine engineering works, and coastal zones' urbanization have all caused profound imbalances in the natural systems. Among other things, these imbalances have reduced the number of sediments arriving at the littoral, contributing to coastal ecosystems' degradation and diminishing their resilience in extreme weather events. On the other hand, if some of those pressures result from societies' development and highly urbanized coastal areas, others are directly related to natural processes potentiated by global warming. In any of these situations, the path drawn is that of leading to degradation and over-utilization, jeopardising coastal natural resources. This paper aims to present some results and details of an ongoing research project on the social-economic and environmental impact of coastal erosion in a Portuguese coastal urban area.

**Keywords:** Coastal erosion; Risk perception; Environmental conflicts; Natural resources loss; Territorial Imbalances

## Introduction

### Perception of coastal erosion risk and loss of coastal natural resources

The sociological approach to the exhaustion of natural resources and increased environmental risks seems to have progressively abandoned a holistic and anthropologically negative perspective, derived from Ulrich Beck's theory of risk society [1]. To Beck, a collective political drift and individual impotence (in the face of the damaging course of climate change) accentuated the character of uncertainty and the indeterminate future of human societies. Human societies would be exposed and extraordinarily vulnerable to irreversible and progressive environmental aggression on a global scale. Thus, human societies could barely manage not fully anticipated and unwanted urbanization and industrialization consequences. However, somehow, and still in the field of theoretical production, the gigantic nature of the

damage and its radicalized character gave way to the plurality of local responses and to a multifaceted adaptive capacity that translates into public policies and environmental infrastructures [2,3].

Thus, adaptive solutions would be expressed in environmental policies, in applying various resolutions and developing prevention and protection measures. Adaptive and mitigating policies and solutions are becoming more and more needed, and the predictive models must incorporate human subjectivity and common perception of environmental risks, together with more objective elements on calculating probabilities and the magnitude of potential damage [4]. This incorporation of subjectivity reinforced the attention to local aspects and cultural differences, the patterns of occupation and land use, and populations' confidence in scientific evaluations and political institutions.

It is consensual to consider that the common perception of environmental risks is conditioned by familiarity with them and by factors related to individual control and exposure, the space-time of the development of harmful processes, and an understanding of its close or remote social, natural, or mixed causes [5].

The public and even the technicians involved in coastal management often forget or are not fully aware that coastal areas are marine resources. Although this is obvious, many of the mismanagement is because many politicians and decision-makers are not aware of it. It is natural that the ordinary citizen, when looking at a beach, interprets the concept in the light of what he sees, that is, that internalizes the beach as (only) the sand that extends as far as the waves arrive or, at best, as far as they break. However, as scientists have known for a long time, this is only one part of the beach, usually called the emerged beach. Another part, often more extensive than the one with sub-aerial expression, is not visible by ordinary citizens since it is in an underwater environment. It is the submerged beach. Consequently, all environments integrated into the coastal areas are marine resources. Moreover, this was recognized intrinsically since 1992 by Agenda 21<sup>1</sup>, which begins chapter 17 by stating that “the marine environment, including the oceans and all adjacent seas and coastal areas, forms an integrated whole that constitutes an essential component of the life-support system and a resource that has opportunities for sustainable development”, and reinforced by SDGs<sup>2</sup>, a UN blueprint to achieve a better and more sustainable future for all.

Consider that, in the specific case of coastal erosion, the coastline retreat’s visibility generally requires a time scale based on several years of observation, if not a large time series. Still, the social acceptance of such risks is particularly weak due both to the involuntary exposure to them and a to feeling of lack of personal control. In addition to this, it is relatively difficult to establish direct and immediate causal relations between regional patterns of occupation and land use vs territories’ susceptibility to recording harmful events. It is also the case where the option for heavy protection infrastructures reinforces the rights of humanization and occupation of coastal areas, contributing to an illusory sense of security of the population or the demand for more protection. These heavy infrastructures (spurs, dykes, breakwaters, groynes) weaken the search of other more flexible and collaborative solutions (reconstitution of vegetation cover and dune lines, or interventions with perishable barriers for the natural retention of sand) [5]. Thus, adaptation by intrusive measures of a heavy and hard nature fosters an immobilist conception of land-use planning. It makes coercive action face the coastal anthropic pressures unnecessary, at least for a long time [6].

Protective coastal measures using heavy infrastructure and fixed interventions appear to express the anthropological pessimism of the first perspectives of analysis on involuntary exposure to risks. The main concern is that this exposure is still unpredictable regarding the exact indeterminate moments of harmful occurrences considered potentially catastrophic and disruptive [7]. This dimension of uncertainty and catastrophe on the risks arising from climate change goes hand in hand with the sense of the inevitability of social and ecosystem damage that is already occurring and becoming accentuated, up to the limit of (im)possible or absurd, with heavy protective interventions. These successively adaptive and protective interventions are developed to the detriment of mitigating measures and other types of collaborative solutions, rarely considered due to the implicit social conflict (such as the retreat of coastal populations and the de-urbanization or demolition of buildings) [5,8].

### Environmental risks, the sustainability in question

In this century, environmental issues and the risks arising from climate change pose one of the most severe human sustainability challenges. In the case of coastal erosion and the possible rise in sea levels, the risk of oceanic overtopping and coastal flooding are plausible scenarios requiring the development of measures to safeguard economic activities and populations’ safety. Portugal, with about 950km of continental coastline, a large part of it made up of beach areas, or low-lying cliffs, presents itself as a case study susceptible to erosion and coastal floods. Besides, these coastal zones represent a very significant demographic and economic importance, captivating about  $\frac{3}{4}$  of the resident population and accounting for 85% of wealth production [5]. It should also be noted that the urban development model has privileged, not only in Portugal but also in other European countries with a maritime coast, the occupation of coastal areas and the resulting concentration of people, activities, and property on the seafont. While there is a greater collective sensitivity to environmental issues and the development of new planning policies with a specific focus on coastal areas, critical erosion situations prevail, especially on sandy coasts of greater urban density as in the Portuguese continental case north coast [8]. The problem is not more favorable in other European countries. Today, more than 70 million Europeans live in coastal municipalities, a figure that has more than doubled compared to the middle of the last century<sup>3</sup>. An estimated loss of European territory on the coastline is due to coastal erosion of approximately 15 square kilometers per year<sup>4</sup>. These phenomena of coast loss and flood susceptibility may, in the present century, represent progressive and widespread social and ecosystem damage, which is difficult to reverse; southern

<sup>1</sup><https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>

<sup>2</sup><https://sdgs.un.org/goals>

<sup>3</sup>[https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/2020\\_06\\_blueeconomy-2020-ld\\_final.pdf](https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/2020_06_blueeconomy-2020-ld_final.pdf)

<sup>4</sup><https://www.climatechangepost.com/europe/coastal-erosion/>

European countries, are most vulnerable to the effects of climate change [9].

Today, more than 50% of the world's population lives less than 60km from the coast, and it is expected that this percentage will reach 75% within two decades. This narrow strip of land corresponds only to less than 10% of the habitable space on Earth. On the other hand, around two-thirds of the world's largest cities (with more than 6 million inhabitants) are currently located in coastal areas [9]. It can thus be seen that in the last two centuries, there has been an intense process of littoralization of human societies, whose development is exponential. The coastal area in question is based, directly and indirectly, on the exploitation of marine resources, especially those from coastal areas [10].

In Portugal, the shoreline retreat rates of more than 1m/year are recorded for more than 50% of the sand shores, with locally maximum rates up to 5-10m/year [11]. Examples of areas under threat and facing serious problems are: Ofir, south of Espinho, south of Aveiro and Costa da Caparica on the west coast, and Quarteira-Vale do Lobo and Ria Formosa National Park on the south coast. Erosion of the Portuguese coastline became an important problem due to

- (i) lack of continuous and systematic monitoring of the coastline,
- (ii) unarticulated management strategy by local, regional, and national authorities, and
- (iii) underestimation of erosion complexity [5].

Sediment starvation at coastal areas is amplified by mining activities at the river basins, estuaries, and harbors, for navigational and construction purposes [5,11]. Past and current sea level rise is a minor cause of shoreline retreat at sand shores, and probably only contributes 10-15% to actual shoreline retreat [10]. In the face of these pressures and the many activities that have arisen, coastal areas have become highly conflicting areas, where port interests compete with traditional activities (artisanal fishing, agriculture), where the economic interests associated with real estate compete with environmental conservation, where mass tourism competes with the maintenance of the cultural values of locals, where fixed coastal protection works compete with natural landscape values, where extreme sports compete with bathing practices, where industrial activities compete with nature tourism. Thus, superimposed on this complex plot, it is essential to consider the consequences of global climate change and the impacts of anthropic activities that often occur in remote areas but on which the coastline is dependent.

Everywhere solutions towards sustainability of coastal resources are sought through a groping process, often using the principle of trial and error; with the aggravating fact that each coastal zone has its specific features (oceanographic, economic, climatic, cultural, geological, social, sedimentological, landscape etc.) that distinguish it from all the others. As we know, one can

only manage well what is well known; the more knowledge of a system, the greater the effectiveness of management measures can be. Consequently, it is essential to increase the levels of awareness and experience of each coastal zone systems. In this context, the dissemination of new scientific knowledge, the innovative adoption of more efficient technologies, the systematization of factors affecting coastal areas' problems, and the exchange of experiences are particularly relevant.

### Discussion and Conclusion

The article takes account of the dynamics of land-use change and the increased human exposure to the risk of coastal erosion in critical areas at the earth-sea interface. Coastal erosion is not a recent phenomenon and partly results from the interaction between sea and land. But environmental policies of prevention and protection of coastal areas are relatively recent. These policies emerged following urban densification, increasing human pressures and increasing artificial areas along the coastline. Populations and activities are now exposed to risks arriving from coastal erosion and are becoming vulnerable communities. Building "walls" of protection becomes part of coastal landscapes of cities with the seafront. However, even recent extreme events of overtopping are not compromising the growth of artificial surfaces near the sea.

Furthermore, climate change increases the vulnerability of coastal populations. Climate change and the threat of coastal overtopping also question the development of tourism and economic activities and broad sectors of society which invested in the overcrowded coastal areas. Despite the pressure for public intervention, there is no consensus among the stakeholders on how to do it. Protecting people and activities at risk with soft or hard engineering infrastructures or relocate them. Protect or retreat; this is the dilemma of the authorities. In any case, urban communities' sustainability requires more determination to reverse the patterns of urban sprawl and requires greater attention to the weaknesses of the interdependence between natural and social systems.

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