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Coastal risk perception: a case study in Aveiro District, Portugal

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Abstract

As a result of a combination of natural processes (e.g. strong littoral drift) and anthropogenic action (e.g. groins), coastal erosion is rapid in some areas of the western Portuguese coast. These factors together contribute to high coastline retreat rates and an increased erosion risk, despite the adoption of mitigation measures. This research investigates the perception criteria and risk assessment of the key actors affecting the coastal zone and demonstrates that those who live at the coast have a low perception of the urban occupation risk in susceptible areas and consider that engineering structures should be used to protect the coastline.

Keywords: Coastal erosion; Risk; Perception; Key-actors; Portugal

1. Introduction

The central part of the western Portuguese coast is low-lying, with sand dunes and narrow beaches. These coastal areas are exposed to the Atlantic west and north–west winds of cyclonic origin, which can create waves exceeding 8 m in height. The coastline is highly vulnerable to natural processes like strong winds, strong tidal currents and flooding [1].

In general, the main causes of coastal erosion along the Portuguese coastline have been identified as a response to the reduced sediment supply from rivers (due to dam construction), sea-level rise, human occupation, coastal and harbour structures. The attraction of the coast has led to an intensive use of the shoreline, namely urban

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development in high risk areas, which affects local population, through flooding, and the stability of coastal sediment systems (beaches, dunes and coastal cliffs) [2]. The combination of these factors are causing the degradation of the coastal landscape and the intensification of the erosion risk, despite the adoption of mitigation measures. Several examples of intense urban development on unstable and environmental sensitive areas, can be found on the Portuguese coast.

To study the perception and evaluation criteria of erosion risk and erosion management in coastal areas, key actors in the coastal zone of Aveiro District were asked to complete a questionnaire: local residents, coastal municipal authorities, property speculators and non-residents (people living inland).

2. Study area

A section of coastline was selected near Aveiro (Fig. 1). This section is characterised by a narrow sand beach, bordered by a sand dune system. Until the 1970s, the

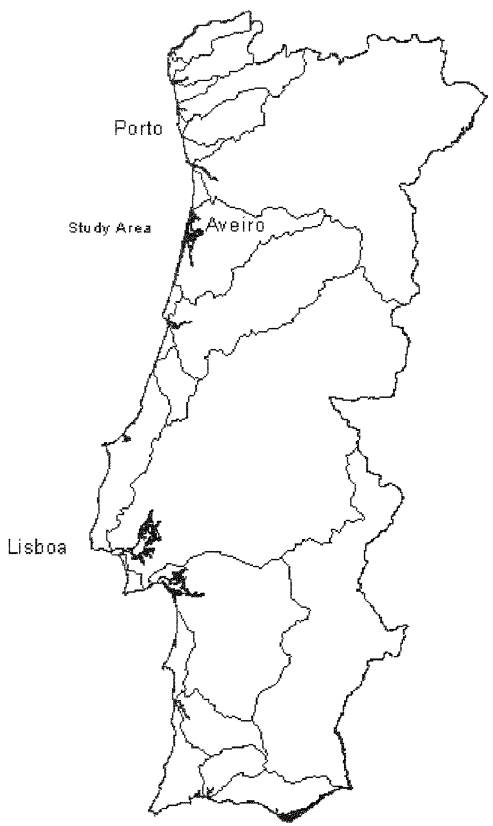

Fig. 1. Location of study sites within Portugal.

Table 1
Coastline change for locations near Aveiro

	S. Jacinto (m/yr)	Barra (m/yr)	Costa Nova (m/yr)	Vagueira (m/yr)
1947–1954	–	−16	−15	–
1954–1984	+48	+0.7	−5.2	−3
1984–1990	0	−5	−8	−16

Adapted from [3].

beach–dune system was well developed with very low human occupation, but is now being destroyed due to natural changes in their dynamic and also by anthropogenic modification. During the 1980s, a decrease in winter storm frequency led to the notion of a 'stable' coast which gave rise to an increased use of the coastline. Buildings, parking areas and camp sites were established in the dunes and close to the beaches, which contributed to changes in coastal configuration. In turn this led to enhanced risk of damage.

Previous studies of the coastline [3] demonstrated that the beach was unstable, with coastal retreat being up to 15 m/yr (Table 1).

There is a strong north–south littoral drift down the whole of the Portuguese Atlantic coastline (Fig. 2).

Coastal erosion risk has increased due to: (i) occupation and degradation of sand dune barrier; (ii) erosion of the beach and consequently shoreline retreat as a result of the low sediment exchange between the dunes and the beach, as well as the incompatibility of the beach profile with a steadily rising sea level; and (iii) the increase of potential flood risk during storms.

3. Results and discussion

The survey demonstrated that risks directly dependent on coastal erosion (sea level rise, erosion and depletion of beach sediments, sand dune destruction and sea encroachment) are well understood by those who live near the coast. In contrast, in areas a few kilometres inland from the coast, the most readily perceived risks are those related to anthropogenic causes (e.g. sand exploitation, proximity of buildings to the coastline) (Table 2).

Risk frequency and magnitude are criteria that could influence risk perception; on natural shorelines prone to active retreat, people who live at the coast have a clear and fatalistic view of coastal erosion, regarding it as a serious and direct threat. On the other hand, despite their awareness, non-residents do not perceive it as a real threat, [4]. As individual's personality, socio-economic level and profession also affects his or her erosion risk perception [5]. The survey shows that property speculators and local politician's perception tends to be mainly influenced by socio-economic and political motivations; a typical response from such a person would be that ''... coastal erosion exists, but does not cause negative impacts in the short run.''

Fig. 2. Location of the study sites.

Table 2
Questionnaires responses to perceived coastal zone risks

	Residents (%)	Non-residents (%)	Municipal authorities (%)	Property speculators (%)
Sea level rise	23	10	22	13
Storms	12	6	15	14
Beach erosion	15	10	15	21
Sand dune destruction	19	20	17	17
Sand exploitation	19	26	18	26
High urban density	8	16	8	6
Proximity of buildings to the sea	4	12	5	3
Number of respondents	150	190	33	25

Adapted from [4].

As far as erosion risk factors are concerned, municipal authorities together with property speculators agree that the main causes are natural processes whilst the population in general assumes that the main cause is human action (Table 3).

Along most of the Portuguese coast, various types of coastal development will probably sooner or later experience coastal retreat, due to the exposure to high-energy destructive waves. Some settlements are currently under threat and it is clear that several policy strategies must be adopted in order to manage development of the coastal strip. As most people do not want to lose their homes as a result of erosion they ask for sea defences paid by the Government. These sea defences (groins, associated adherent works and jetties built to improve navigation at estuary inlets) are often added to other man-made structures (e.g. equipment, multi-store buildings) which because of a poor understanding of coastal processes can cause unwanted coastal changes, as they tend to induce or aggravate other erosion problems downdrift of the obstruction on the Portuguese coast [6].

In order to mitigate against coastal erosion a set of management strategies should be implemented. According to Cooke and Doornkamp [8] and Gomes [7], three possible alternative strategies can be identified to manage coastal risks: these can be termed retreat, relocate and protect.

(a) The *retreat* strategy argues for no action in risk areas. It can be a result of an enforced situation due to technical or economic inability or a positive response adopted

Table 3
Perceived causes of coastal erosion risk

	Residents (%)	Non-residents (%)	Municipal authorities (%)	Property speculators (%)
Natural processes	37	19	67	59
Human action	63	81	33	41

Adapted from [4].

following an environmental impact assessment and a consideration of the large economic costs which would be involved. The infrastructures and buildings affected would be progressively reconstructed at inland sites and non-building land would be defined according to coastal retreat rates.

(b) The *relocate* strategy involves acceptance of the risk without carrying out any remedial construction work. Relocation just of the population living in high risk areas would be carried out. This measure assumes a tolerance of property damage and involves high economic costs when new homes have to be built.

(c) The *protection* strategy is a high cost one, involving the adoption of hard and soft engineering measures to maintain the present coastal configuration and to conserve and when necessary improve the coastal environment. It involves: (i) sustainable land use management; (ii) reduction in anthropogenic impact; and (iii) coastline maintenance.

This topic of attitudes to these strategies was also addressed in the questionnaire (Table 4).

Considering the first strategy, the results show that none of the key-actors mentions this as an important measure to mitigate against erosion risk. Relocation has only a low acceptance by residents and municipal authorities, as a consequence of the high costs involved in this process, the fear of giving up their possessions or the view that this would be brought about by political motives.

Considering the last strategy, protection, three measures were defined: engineering works, dune system reconstruction and land use planning. Taking all the mitigation options together, engineering works are perceived, especially by residents and property speculators, as an efficient and worthwhile measure, helping shoreline stabilization, the protection of people and property and acting as an important defence against sea level rise. Not surprisingly, the population living on the coast considers that coastal defences are totally indispensable. Apart from coastal engineering works, dune stabilization is perceived as an important risk mitigation measure.

Urban development at the coast has introduced some landscape changes in the absence of land use planning, in terms of waterfront density and quality criteria (high building density, buildings of poor quality and little or no attention to the surroundings). Despite the clear need for land use planning measures to reduce coastal risks [9], the survey has shown that it has a low acceptance by the local municipalities and speculators who are directly involved in the development of the coastal areas. In

Table 4
Attitudes towards the coastal mitigation measures defined by Gomes [7]

	Residents (%)	Non-residents (%)	Municipal authorities (%)	Property speculators (%)	Total (%)
Retreat	0	2	0	1	1
Relocation	2	12	0	16	7
Engineering works	52	24	33	57	41
Dune reconstruction	27	32	47	20	32
Land use planning	19	30	20	6	19

Adapted from [4].

contrast, land use planning is perceived by non-residents as the most desirable mitigation measure. The former view stems almost from the fact that economic and political interests are inextricably linked with coastal risk assessment.

The survey shows that coastal erosion risk is understood by the population in general in spite of the apparently low concern shown by those living in high risk areas (Table 2). This perception derives from: (i) the diversity of reasons making up an individual's perception (e.g. the desirability of living at the coast but the recognition of its risks); (ii) the lack of assessment of risk potential; (iii) the priority given to socio-economic interests (particularly by property speculators), political interests (i.e. local authorities) and recreational and social interests (residents and non-residents); and (iv) the conviction that coastal engineering works will be able to prevent and minimise coastal risk.

4. Conclusions

The heavy bias in favour of protection measures by the decision makers (property speculators and local government authorities) has influenced planning along the Aveiro District part of the Portuguese coast. Instead, the perceptions of different key-actors as well as the potential risk of those areas should be taken into account, so that development according to the potential risk involved and to the need for coastline conservation can be undertaken rather than always adopting high cost option of protection [10].

Integrated coastal planning and management in Portugal is now being implemented. Some coastal zone management plans have been draw up at a national level, during the 1990s. The aims of these plans are land use planning, beach classification, regulation of beach recreation, improving the beaches from an environmental perspective, controlling the development of activities in the coastal zone and nature conservation. The success of the planning policies in the coastal zone are dependent also on perception of the population and assessment of the risk, since risk knowledge is a prerequisite for risk reduction and for the acceptance of the mitigation measures [11].

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