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Is the Sea the Enemy? Occupation and Anthropogenic Impacts at Costa da Caparica (Portugal)

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Abstract: This article explores the development of human occupation and the anthropogenic impacts at Costa da Caparica, a Portuguese coastal town that faces several challenges concerning coastal erosion processes. A historical long-term analysis was made, mainly through medieval and modern writing sources, crossing such textual data with geology, geography, and other related scientific disciplines studies regarding the coastal erosion problems of the study area. Therefore, from the Middle Ages to the present, human actions concerning this area were examined. The sea was first seen as an income, due to tourism, and later seen as a danger. It is argued that human behaviors were the main cause of historical problems and also the present vulnerabilities and risks associated with this coastal stretch of the Portuguese littoral. We must search the past for answers to understand present problems and think about the future. This is the main purpose of this paper: to contribute to a better knowledge concerning coastal sustainability based on the results of past human actions, as a way to avoid such mistakes in the future.

Keywords: Portuguese littoral; historical analysis; human settlement; coastal risk; coastal vulnerability; coastal erosion; coastal management

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1. Introduction

Coastal areas are densely populated regions with significant economic value. Anthropogenic actions and climate change impacts are increasing the vulnerability of their social and ecological systems. Events such as coastal erosion, land flooding or submergence, soil salinization, and loss of ecosystems, among others, are expected to become more frequent. This scenario results in negative impacts on biodiversity and human life in coastal areas, especially in the low-lying coasts, estuaries, and lagoons [1–6]. In Portugal, the literature shows that extreme events in coastal areas are becoming frequent, enhancing historical problems related to human occupation and uses of such areas [7–13]. It is argued that the combination between the impacts of climate change and human-made actions will intensify these problems along the Portuguese coast [7,13]. Therefore, ecological systems and communities established in coastal areas are very vulnerable as they are exposed to several natural and human risks.

The Caparica-Espichel sandy coastal plain section, on the south bank of the Tagus estuary (Figure 1), is one of the Portuguese littoral areas where this phenomenon can be observed [13].

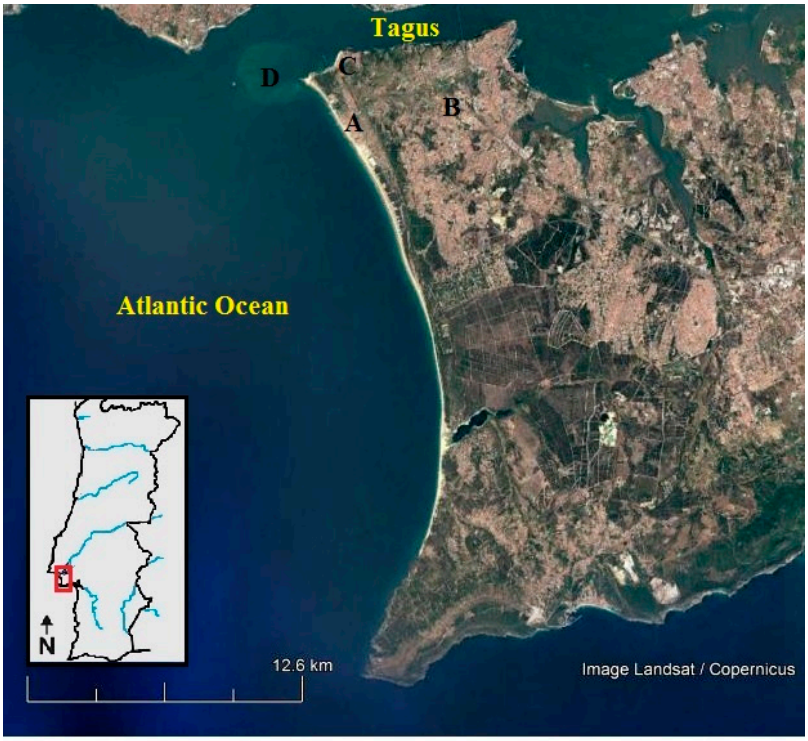

Figure 1. Study area. A) Costa da Caparica; B) Sobreda; C) Trafaria; D) Tagus mouth.

This coastal stretch faces several problems, including at Costa da Caparica, a coastal community in the Municipality of Almada (Figure 1A). At least since the second half of the 19th century and with more intensity in the 20th and 21st centuries, this area has suffered intense erosive processes, beach profile retraction, overtopping, and flood events on the urban front. This has resulted in damage to ecological and urban systems, and also to coastal protection infrastructures [14–19]. In order to protect such social and ecological systems or to delineate interventions that could reverse their vulnerable situation, scientifically informed decisions concerning governance for the future must be made [6]. It is our conviction that such steps can only be attempted based on a profound knowledge of the socioenvironmental evolution of such areas. As present problems result from a co-evolution between human and natural features, historical perspectives are necessary to understand the full consequences of human interventions over time and to develop appropriate management policies [20–24].

However, the analyses of the impacts on coastal systems are frequently within the scope of the natural sciences. The contextualization of human practices and behaviors to achieve holistic approaches concerning these issues is needed. This is the novel contribution of this study, since it integrates history to the discussion, disclosing the human actions that have led to the present problems of the study area. A literature review reveals the lack of long-term analysis which considers such dynamics. Studies that discuss coastal erosion or other related problems usually consider recent chronologies, namely after the 19th century, when such problems became more frequent [13,14,16,18,25], but what triggered them? How does the sea, once seen as an economic asset, become an enemy in the sense that it now represents a danger to human populations? To answer these questions, we need to trace the origins of the problems and contextualize them. Nevertheless, historical studies considering this area are usually restrained in chronological terms or do not focus on coastal landscape changes and their implications regarding the present [26]. On the other hand, local historiography does not offer any data about such matters [27–34]. The only historical analysis that could help to identify such matters concerns the occupation of this area after the 19th century, explaining the human-made landscape changes and problems concerning such dynamics [35]. Therefore, there is a research gap in the larger chronological approach

that needs to be addressed. First, what happened before the 19th century? How was this littoral occupied? Are there any reports of coastal-related problems? When was the turning point that led to any coastal-related problems and what were the causes? Considering such questions, this is a relevant case study since, even at a small scale, it shows how long-term historical analysis can provide knowledge about the human dynamics that lead to the present challenges concerning coastal management. Therefore, although it has a very specific geographical focus on the Caparica-Espichel sandy coastal plain, this study can be applied to other coastlines with similar characteristics: those with an historical occupation that goes back to medieval times and with an intensification of human settlement from the 19th century onwards which implies geodynamic changes that would not happen without human intervention.

2. Study Area

Costa da Caparica (Figure 1) is located in the Municipality of Almada, west of the Lisbon Metropolitan Area, in Portugal. It is a sandy and low coastal plain that is part of the Caparica-Espichel coastal section, which is located on the south bank of the Tagus estuary in the Setúbal Peninsula. In geomorphological terms, Costa da Caparica coastal plain is characterized by beach, beach-dune, and fossil cliff systems [18,19]. These fossil cliff systems are parallel to the coastline and are located between Costa da Caparica and the Albufeira lagoon. Here, the beaches extend about 13 km and are considered the most important bathing zone of the Lisbon Metropolitan Area; therefore, they contribute to high-value tourism [36]. Dunes are also notorious in this area and the dune coastline is constituted by diverse vegetation for this type of ecosystem; namely, *Elymus farctus V.*, *Eryngium maritimum L.*, *Euphorbia paralias L.* and *Ammophyla arenaria L.* An extensive zone of inland coastal dunes also includes vegetation such as *Acacia* and *Pinus*, which were planted between the late 19th century and the first half of the 20th century. This beach-dune system, which is the natural defense against the sea, has been affected by diverse anthropic actions, such as illegal building, sand extraction, and urban growth, among others [35,36]. Climatic conditions of this area are marked by dry and hot summers with temperatures that can reach between 23 and 29 degrees Celsius near the ocean and between 29 and 32 degrees Celsius near the Tagus River. In winter, temperatures are moderate and in the coldest month, decrease to about 6 degrees Celsius [18,19,26].

3. Materials and Methods

Although in recent years an effort has been made to achieve a better perspective in the human–environment relationship affecting the oceans [23,37–39], such effort is lacking when it comes to coastal areas. As we mentioned before, historical studies concerning a long-term analysis of human impacts in these areas are globally scarce [20–24]. Coastal history comprehend several issues that demand a systematic approach from environmental historians. In a way, we believe that as this historiographical field develops, encompassing new subjects of study, applying new methodologies, broadening the thematic scope, and refining its conceptual apparatus, the analysis of certain ecosystems or themes will emerge.

This study considers the possibility of new approaches and results that can be obtained through an analysis of the scope of environmental history, considering the methodologies defined by several authors that have contributed to the emergence and development of this scientific area [40–46]. Therefore, this discipline provides long-term analysis concerning human–environment relationships with an interdisciplinary focus, using mainly historical sources, but also proxies obtained from various disciplinary areas.

The influence of anthropic actions in this coastal area has been observed through historical sources from which data was compiled. As Marc Bloch has noted, we must search in the past for answers to understand the present and think about the future [47]. For such analysis of the historical documents, the history method "tout court" was used. First, we applied an heuristic operation, by which the sources of information necessary for the historical analysis were collected. Afterwards, the documents were submitted to internal and external criticism

so that it was possible to verify the validity and veracity of these sources and proceed to data validation. Last, we applied an hermeneutics operation, by which documents were interpreted to understand how the information provided responded to the initial questions.

We analyzed the human occupation as far back as there are historical documents for the study zone. Medieval and modern historical documents were gathered mainly in the Arquivo Nacional da Torre do Tombo (Portuguese National Archive, henceforth ANTT), namely in the *Chancelaria Régia* (royal chancellery) [48–52], *Ministério do Reino* (kingdom ministry) [53], *Feitos da Coroa* (deeds of the crown) [54], *Gavetas* (drawers) [55], archival funds, and also from *Leitura Nova* (new reading) [56] and *Memórias Paroquiais* (parish memoirs) [57,58] collections. These documents were analyzed to collect information related to the problems addressed in this study. Document collections alluding to the royal chancellery of some reigns (D. Afonso III, D. Pedro I, D. Afonso IV, D. João I) were also analyzed [59–61]. Other document collections, such as *Portugalliae Monumenta Historica* [62], documents on the history of Portuguese discoveries [63] and documents related to [64–69] were also examined.

At a local level, data were collected in the city's municipal archives of Sesimbra (Arquivo Municipal de Sesimbra) and Almada (Arquivo Histórico Municipal de Almada). In the first, we analyzed mainly the *Book of Tombo* from the 15th century to 1728 [70]. In the second, we examined documents related to the administrative services [71,72], local legislation [73,74], and periodic publications [75–77]. Data were also collected from newsletters, mainly from the 19th and 20th centuries in the Portuguese National Library [78,79]. Some data were also collected online, mainly related to the government diary [80,81] and the republic's legislation [82]. Additionally, an interdisciplinary effort was made to combine historical methods with data and methodological proceedings from other academic fields, namely that gathered in geography and geology studies related to the study area (e.g., [13,14,16,18,25]), mostly from 19th century onwards.

4. Results and Discussion

4.1. Human Occupation and Administrative Evolution (12th–21st Centuries)

The chronological limits of this study were the period between the 12th and 21st centuries because these were the extreme dates of the primary written sources consulted. Despite that, the human occupation of the Setúbal Peninsula dates to prehistoric times. During the Paleolithic period, human settlement was near the coast and along river Tagus margins. In the Almada area, instruments attributed to the Epipaleolithic were found on the Caparica fossil cliff. Other archaeological remains from the Neolithic period were found inland, where more productive soils could be exploited [26,83,84]. This occupation dynamic continued through protohistoric times, and researchers have found several remains of sedentary groups from that era in the Almada area, particularly on land with higher elevations, where natural conditions allowed the defense of population agglomerates [26,84]. The area of the Setúbal Peninsula was then occupied by the Celtic people, and later conquered by the Roman Empire. The archeologic remains of the Roman occupation in the Almada area demonstrate the use of the region's natural resources, namely fish, salt, and clay, with evidence of industries dedicated to the exploitation of these products [26,85]. After the fall of the Roman Empire, this same area was occupied by the Visigoths. In 711, with the conquest of the Iberian Peninsula by the Muslims, there are several testimonies of the occupation of people in the Almada region, with particular evidence for the toponymy coming from Arab influences. The Muslim occupation occurred until the Christian conquest of Lisbon [26,28].

After establishing this historical framework, we focused on the highlight of this study, through the analysis of the oldest written documents that were the basis of our characterization of the anthropic occupation of the territory. For specific historical periods, we went beyond the strict study area since we still could not talk about Costa da Caparica as a municipality. Therefore, we will begin by referring to Almada as a whole, narrowing

the geographic focus as we approach the present and Costa da Caparica is evident as a toponym.

The concession of land to a private entity (individual or collective) was, in Portugal, the way the kings rewarded those who had helped them in the Portuguese crusades. By definition, all the territory conquered from the Muslims established the *tout-court* feudal state of the medieval kingdom and belonged to the king, who disposed of it as he wished. It is an ultimate affirmation of the Portuguese monarchs as supreme army chiefs and lords of Portuguese conquered villages [86]. Here, the king was more than a primus inter pares and always ceded full ownership to a landlord—full domain—on a precarious basis (i.e., to an individual or collective person) and, therefore, there is a need to confirm the granting of the privilege that we always face with the change of reign. This is not to be confused with the concession of possession of the useful domain made to peasants, who use the land for their cultivation and rentier valorization [87]. This is the same way, nowadays, we speak of landlords (with full domain) and tenants (with useful domain or usufruct of the good). We will here only focus on the protagonists of the full domain of the territory: those who were in possession of the area that is our subject of study from D. Sancho I to the present. From administrative, economic, fiscal, and legal points of view, this coastal segment is generically known today as "Costa da Caparica" in a broad chronology.

In the year 1147, Lisbon was conquered during the reign of D. Afonso Henriques, the first Portuguese king. Although some hypotheses suggest that Almada was conquered before Lisbon by the crusaders, who helped the monarch in the military undertaking of Lisbon, it was around this time that the Christians regained control of the Almada castle [26,27,32,33,88]. To keep the territory under Christian jurisdiction, it was necessary to populate and organize its administration. Such a task was achieved through the Christian population that came to the region, to help with the governance of Muslim people and the administrative and military grant to the newly founded religious and military order of Santiago de Espada [26,88]. It is from this date that we have access to a document that reveals that the king handed over the castle of Almada to the order of Santiago de Espada, to guarantee the defense of the Tagus line (Figure 2A), recently conquered by the Christians with the seizure of Lisbon from the Muslims in 1147. So, supposedly Almada was granted to this order in the year of 1175 [89] (p. 67 and p. 533). However, Almeida [90] contends that such a historical document is not authentic.

Beyond any doubt, it is certain that in 1186, D. Sancho I, the second Portuguese king, redefined the territory possession of the Santiago order, granting the Setúbal peninsula extended territory, including Almada [48,61] (fls. 151v–152, pp. 274–275). It seems, however, that the constant battles of the reconquest that occurred in this territory explains these changes of its possession [88]. The order could not control the territory administration, so the king took upon himself this obligation and the order was mainly dedicated to military defense [26]. As such, the king granted a charter to Almada in 1190 [54,62,63] (charter 341, pp. 475–477, p. 368). Nevertheless, the military order possessed all the territory of Setúbal Peninsula, including the Caparica-Espichel sandy coastal plain section, but excluding the Adiça (Figure 2A or Figure 2C), a gold mine near the coast that was maintained under the king's administration since the Lisbon conquest [91].

Documents confirm that the Adiça has been maintained under royal jurisdiction. According to a transcript dated from 1357, but referring to a document of 1262, the king confirmed the privileges that the Santiago order had obtained over all products imported or exported to Almada, as it was the "landowner" of all that region, but underlining that Adiça did not come under the order's jurisdiction [70] (fl. 14 v.). Posterior documents maintained this premise [61] (pp. 301–302). Adiça was an important gold mine, considered the most profitable medieval gold mine in Portugal, therefore, it was important to keep it under royal jurisdiction. Several privileges were granted to miners and other stakeholders in gold exploration, resulting in constant complaints from neighboring municipalities, such as Almada and Sesimbra [26,91].

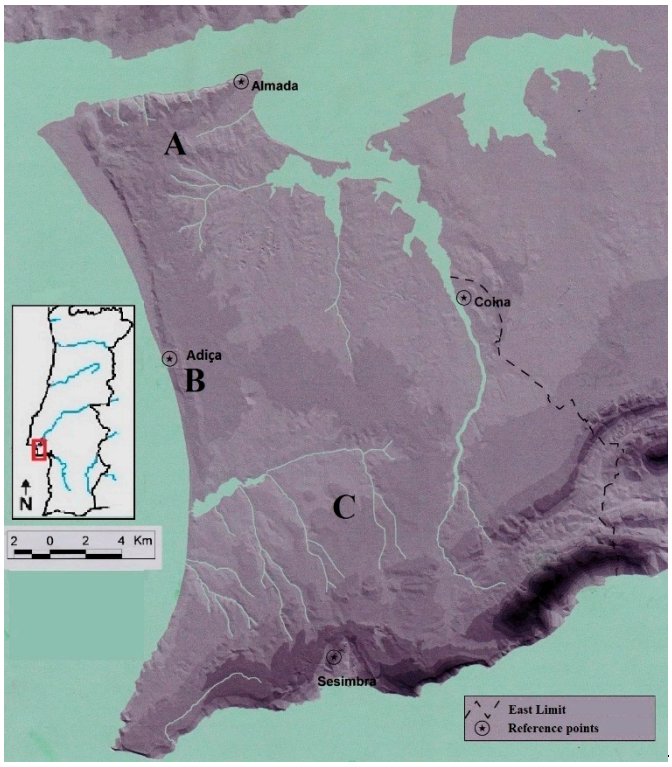

Figure 2. Territory administration. A) Setúbal Peninsula northern territory; B) Adiça gold mine; C) Setúbal Peninsula Southern territory.

When King D. Dinis assumed the Portuguese throne, Almada and its surroundings were once again taken under royal jurisdiction, in the year 1297. A barter was made with the military order to exchange the area for the villages of Almodôvar and Ourique, the castles of Aljezur and Marachique with their churches, as well as the church of São Clemente de Loulé. Adiça was described in this new division of the territory as the southern section of the royal land of Almada [49,55] (fl. 2 v., gaveta 5, maço 4, doc. 1). It was also in this reign that we observed, for the first time, a document mentioning the toponym Caparica (year 1299), locating it inside the crown lands of Almada [50] (fl. 7 v.). The large extensive territory once occupied by the military order was reduced while a new administrative area emerged at the north of Setúbal península under the king's jurisdiction. As one document details [70] (fls. 8v.–9v.), the Albufeira lagoon was now the natural frontier between the king's possessions at the north and the Santiago de Espada military order possessions in the south (Figure 2A or Figure 2C). As crown's land, Almada was given to D. Leonor Teles by her husband, King D. Fernando I, in the year of 1372 [52] (fls. 107–108). The Adiça gold mine was also under royal jurisdiction in 1375 [70] (fls. 8v.–9v.), however, still with the privileges concerning the Almada jurisdiction [91].

Due to the support provided by D. Nuno Álvares Pereira to the future Portuguese King D. João I, during the civil war that occurred between 1383 and 1385, after the death of King D. Fernando I, Almada was donated to that noble in the year 1385 [59] (pp. 33–34). This donation included full legal possession of the territory; that is, the *mero et mixto imperio*, which allowed the exercise of criminal and civil jurisdiction, which was very rarely granted by the Portuguese kings [92] (pp. 241–242). Therefore, it included subjection of persons and goods, high and low landlords, all income, jurisdiction, taxes, belongings, real and bodily and non-corporeal rights, as were the rights of the king [59] (pp. 33–34). While D. Nuno Álvares Pereira had such jurisdiction under Almada, Adiça was never given by D. João I. In fact, in the year 1416, the king was offering privileges to the miners, so the mine was still under the crown jurisdiction [60] (pp. 234–235). Excluding the mine, this territory was maintained in the family, since in 1422, D. Nuno Álvares Pereira donated Almada to

his granddaughter D. Isabel [51] (fl. 26 v.). Almada became once again a possession of the Portuguese crown, through marriage dowries. A document dated from 1496 confirms that Almada was under king D. Manuel I's jurisdiction when D. Beatriz, the monarch mother and great-granddaughter of D. Nuno Álvares Pereira, asked about the tax status of some products [56] (fl. 24). Therefore, all that territory once again became royal land (Figure 2A). These possession changes can be observed in a summarized way in Table 1.

Table 1. Territory full domain.

Date	Place	King	Domain	Source
5 July 1175	Almada	D. Afonso Henriques	Santiago	[89]
28 October 1186	Almada castle	D. Sancho I	Santiago	[61]
3 February 1262	Adiça	D. Afonso III	Royal	[70]
5 January 1272	Adiça mine	D. Afonso III	Royal	[61]
1 December 1297	Almada (1)/Sesimbra (2)	D. Dinis	Royal (1)/Santiago (2)	[55]
4 December 1297	Adiça (1)/Sesimbra (2)	D. Dinis	Royal (1)/Santiago (2)	[49,55]
26 February 1299	Caparica and Sesimbra	D. Dinis	Royal	[50]
11 April 1328	Albufeira lagoon	D. Dinis	Santiago	[70]
5 January 1372	Almada	D. Fernando I	D. Leonor Teles	[52]
19 July 1375	Adiça and Alpena	D. Fernando I	Royal	[70]
22 August 1385	Almada with its lands	D. João I	D. Nuno Álvares Pereira	[59]
7 January 1416	Adiça mine	D. João I	Royal	[60]
4 April 1422	Almada	D. João I	D. Isabel	[51]
5 July 1496	Almada	D. Manuel I	D. Beatriz	[56]

Meanwhile, according to Arcos [28], Caparica's parish was created in 1472 by Sixto IV. Although this author transcribes the alleged papal bull of concession, it does not refer to the historical source, so we could not find it, to confirm such information. Assuming such a text exists, permission was given in it for the construction of a chapel, where there was a baptismal font and all the divine services could be celebrated, and where the rector called the parishioners of the church (and only here is the parish mentioned!). The same concession was mentioned in the parish records of 1758, in which the priest of Monte da Caparica parish described its limits [57] (fls. 769, 771).

Between the end of the 15th century and the end of the 17th century (1677), there is nothing in the historical sources that allows us to affirm that there was a reorganization of the administrative possession of the territory under study. Only in 1677, we have a reference to the monastery of the Agostinhos Descalços located in Sobreda [93] (Figure 1B). Like the other religious orders in the kingdom, this monastery also had full use of the property attached to it. This is stated by Costa in his text "Coreografia Portugueza", when indicating the existence of the monastery in the place of Sobreda in 1712 [66,94] (pp. 31–32, p. 317). So far, we have not noted references to Costa da Caparica. It is reasonable to assume that this coastal territory was in the parish of Monte da Caparica. This description is made by Luiz Cardoso in his geographic dictionary of 1747–1751, when after describing the fluvial ports in the Tagus mouth that belonged to the Monte da Caparica parish, he referred to the possibility of more ports in the "(. . .) entire length of the sea that touches this parish" [67] (p. 15).

In 1747 the existence of a tailor "(. . .) resident in Costa de Caparica neighborhood of the villa of Almada (. . .)"is reported [65,71] (p. 10–11, reg. 1708-fls. 20–20v.), demonstrating that this area already had permanent occupation, contrary to what is usually stated [27,31,32,34]. In fact, the 1758 parish memoirs of Monte da Caparica make explicit mention of the Costa as a place, referring to the coast and the beach south of the Tagus River mouth, in which the fishermen's boats were adapted to face the waves when they arrived at the beach or departed out to the sea. There is also mention of the existence of rocks next to the beach with a fountain called "Adissa" [57] (fl. 769), which seems to be a reference to the medieval mine previously mentioned.

This area was occupied when in the year 1761 there were reports of a fire in some wooden huts (called "palheiros"), one of them the local grocery store. The witnesses in the inquiry's process were all Costa de Caparica residents [65,73] (pp. 14–16, fls. 58.–60v. reg. 6018). The legislation concerning the commerce and transport of the fish captured by the fishermen of Costa da Caparica, imposed in the year 1774, shows the dynamism of the place. It is interesting to note that regulations were imposed to restrain the construction of wooden houses or other kinds of uses of the Costa da Caparica beach, which confirms that not only were people settled there, but that human occupation was growing [68] (p. 49). Mainly dedicated to fishing, the village grew and expanded in the following centuries [27,28,31,32,34,35]. Costa da Caparica belonged to Monte da Caparica parish until the year 1926 when it was integrated into the parish of Trafaria (Figure 1C). On 12 February of 1949 it was elevated to the status of parish seat [81]. In the year of 1984, the population was already claiming the elevation of this locality to village status [75] (ano I, nº 3, janeiro 1984, pp. 1–2 and ano I, nº5, Março 1984, p. 1). Such category was achieved on 26 September 1985 [34]. With 12.200 permanent residents and 40.000 residents in the summer season, Costa da Caparica was elevated to the category of city in the year 2004 [82]. This brief history of the administrative/judicial landlord of the study area shows the intensification of the human settlement. It is now time to analyze the effect of natural and anthropic actions on such territory.

4.2. Tourism and Coastal Occupation: A Recipe for Disaster

As mentioned, Costa da Caparica is located in the Caparica-Espichel coastal section of the south bank of the Tagus estuary in the Setúbal Peninsula (Figure 1). This is an area that includes beaches, beach dunes, and fossil cliff systems [18,19]. In the mid-19th century, even if the extension of the beaches situated in the Caparica-Espichel coastal section was appealing due to bathing tourism, it seems that this area was not very popular. That may be the reason why in 1876, Ramalho Ortigão in his *Bather's and Traveler's Guidebook*, described the beaches located at the south bank of the Tagus estuary as quiet places with poor houses at affordable prices and a lower cost of living than in Lisbon. He only mentions Porto Brandão, located to the north and bathed by the Tagus River, and the Albufeira lagoon located at the south. However, he does not mention specifically Costa da Caparica, which suggests that it was not a very popular area for bathing [95]. In 1882, this was a poor area mainly populated by fishermen, where the existence of swampy areas could result in diseases, and also a region where there was a lack of infrastructures and connecting routes for tourists [78] (nº 5892, 26 de Junho de 1882, p. 1; nº 5958, 31 de Agosto de 1882, p. 2), so it is understandable that it was not very popular. Only in 1885 did this situation change after the wetland's drainage, the construction of a road to Costa da Caparica, and the dunes' afforestation. It was also when the first fishermen's houses were rebuilt with brick and tile roofs, after a violent fire that consumed the typical "palheiros" (Figure 3) that were simple wooden huts [78] (nº 6998, 15 de Julho de 1885, p. 1).

In this region security was also a problem, and only in 1887 was the creation of maritime police in this littoral proposed [80] (nº 050, 10 de Junho de 1887, pp. 1135–1136). Such changes would provide better facilities to eventual travelers. What is certain is that in 1901, Queen D. Amélia visited Trafaria, northern Costa da Caparica, where she founded and inaugurated the first children's bathing colony of the country [27,96]. Therefore, at the beginning of the 20th century, the area was already important from the perspective of bathing tourism, which was developing there since the late 19th century, when the Lisbon bourgeoisie started to frequent the beaches due to the facilitated access by boat with departures in Belém [96].

Figure 3. Image of the Caparica's wooden huts available in Lisbon municipal archive (PT/AMLSB/EAT/000083-84-85).

In this epoch, but especially after 1925 when the village was considered a tourist resort, Costa da Caparica emerged as a new beach tourism destination and important changes led to growth in visitors, who came mainly from Lisbon and Alentejo. Several urban developments occurred, the transport connections to the beach increased, and construction began of the first establishments, including the first hotel named "Hotel Praia do Sol". The village was electrified, piped water and basic sanitation installed, and in the fishermen's district a road was built connecting it to Fonte da Telha [18,96]. In 1939, during the Salazar regime, the Portuguese Dictatorship known as "Estado Novo", the National Foundation for Joy at Work vacation camp—FNAT—was created in the public forest of Costa da Caparica [27,96]. Soon other institutions asked permission from the government to build resorts and nursing homes in this area [35]. Roads near the beach began to be paved [64]. Meanwhile, an urbanization plan in Costa da Caparica was urgently needed to put an end to the disorderly construction that this tourism boom was creating [96]. In 1946, there appeared the "Report on the Urbanization Plan of the Municipality of Almada". This work refers to the number of residents in Costa da Caparica, revealing that in the winter there were 1800 inhabitants and in the summer 5000 residents, excluding about 13,000 persons that crossed the Tagus by boat, arrived by bus or car every Sunday. New roads were projected to bring even more people, and infrastructure projects were executed or planned [72]. Caparica grew to be seen in the 1950s as a seaside resort; however, this increased the illegal construction in sensitive areas such as the dunes and the forest, destroying the natural protections of the beaches [35].

In the following years, the tourist demand in this region increased, especially after the construction of the Tagus bridge in the late 1960s, which promoted a more efficient, fast and safe way of crossing the river. The increased public transport connections promoted the campsites that would become very popular and increased the supply of accommodation, especially the wooden huts or palheiros. There were about 120 of these constructions in the dunes by this time, most of them transferred from the Trafaria area where the effects of erosion were already being felt, forcing their owners to move such structures. In the 1970s and 1980s, Costa da Caparica was a mass tourism destination, not only drawing Portuguese tourists but also foreigners, who were particularly attracted by the campsites and the natural beauty of the area. The proximity of Lisbon airport and the international boom of tourism after the Second World War [18,96] were also attractions. Illegal construction, however, continued [75] (ano I, nº 1, Novembro 1983 and ano I, nº2, Dezembro 1983). The village was facing a complete change as new hotels, pavement roads, and housing districts consisting of high-rise buildings were built not only in town but also along the coastline. This changes brought an ideal of progress to the local population who aspired to see in the locality the archetype of development that had taken place in the resorts of Biarritz, France, or in Torre de Molinos, Spain, which implied construction in height and on the seafront [75,76]

(ano I, nº 7–8, Maio/Junho 1984; nº 11, Maio 1986; nº 16, Junho/Julho/Agosto 1987 and ano XXIV-326, 05/01/1973). Towers with more than 10 floors and avenues such as Avenue General Humberto Delgado were built on the seafront, destroying the dune system that defended the interior from overtopping. This process of increasing and densifying spaces with more urban functions was continuous until the present and Costa da Caparica became an urban plain with a sharp decline in agricultural areas, dunes, and beaches [18].

4.3. Coastal Evolution: Natural and Anthropic Actions

The Costa da Caparica littoral faces serious problems of coastline retreat and coastal erosion, which assumed greater relevance after the mid-20th century and on the coastal front of Costa da Caparica [13–18,25], but are these modern-day issues? What actions triggered these events? Some authors point out that this coastal area has faced minor variations on this theme since the Middle Ages [97–99]. That seems the case, except for the Albufeira lagoon area, where the situation was quite different. Loureiro [97] states that historical cartography shows changes in this lagoon, namely a wider representation of it and the intermittent opening of its bar. Martins [98] says this lagoon inlet was not silted and there was a regular connection with the ocean. However, medieval documents reveal that siltation was occurring in this water body. The lagoon was frequented by Almada fishermen, as is confirmed by a document of the year 1328. However, fishing began in earlier times, and one document states that it was a tradition that went "back to his parents and grandparents" [70] (fl. 9). It seems a mistake to think that these men went to the lagoon by land, as is said [26]. Even with the siltation problems in the lagoon inlet, it is more credible that fishermen went there by sea, as there are earlier documents that show they used to fish and to sail in the Atlantic [48,61,63] (fl. 151, pp. 305–307 and pp. 11–12). On the other hand, even if we know that this lagoon was facing siltation before the 15th century, it is also stated that measures were made to open its bar and promote water exchanges with the ocean, and thereby the fishing boats could access the lagoon by the sea. A document dated from 1415 states that it was the ancient usage and custom for farmers to open the lagoon inlet and avoid the flooding of productive lands that extended around it. This task was one the kings used to impose on the councils of Almada, Sesimbra, and Adiça [48] (fls. 112 v.–113 v.). This silting problem was not uncommon. The same process happened in several coastal lagoons along the Portuguese coast during the medieval period. Referring to some examples, similar processes are also known in the cases of Pederneira, Alfeizerão, and Óbidos [100–102]. As occurred in other Portuguese coastal areas such as Aveiro [103], the combination of reconquest and the consequent pacification of the territory, along with the medieval climatic optimum that allowed population growth and the expansion of agriculture, increased the sediment deposits in lagoon bodies. In the Albufeira lagoon, the advances of agricultural lands around it [26] must have had contributed to increasing discharges of sediments that silted up the inlet.

In the year 1758, there was still the need to open the lagoon bar, revealing that the siltation process was still occurring [58] (fl. 1952). This is curious and seems to confirm that the tsunami that followed the 1755 Lisbon earthquake may have made small changes in the Tagus River mouth and the surrounding coastlines as argued by Loureiro [97]. Except for this extreme event, we could not find any other historical reports concerning large floodings or coastal retraction events. Nevertheless, this area appears to have suffered some episodes of coastal inundation, namely through storm surges that have been detected at the beginning of the 19th century. Nearby the coast where there are changes in the direction of sediment transport (cf. [17,25,99]), in the coastal area of the Adiça mine, a storm occurred on the Saturday afternoon of 15 February 1821. Three mine water suction wood pumps, which were placed on the beach, were lost to the sea. Of those, only one was later recovered by Costa da Caparica fishermen. This episode cost the interim mine inspector his job. Despite his reports of the storm, his superiors attributed the loss of the pumps to the usual rise of the tide and his lack of zeal by leaving them on the beach [53] (fls. 2–5v.). However, his account seems not completely false, because it happened during a storm that

probably had caused coastal erosion, and uncovered some veins of gold in the Adiça [53] (fl. 12).

These cases are an exception to what is known concerning coastal change processes in this coastline. According to some authors, the geomorphological changes here only started in the mid-19th century, namely due to anthropic actions in the Tagus River mouth that have contributed to coastal retraction and erosion processes. Until then, the fundamental morphodynamic elements that constituted the outer estuary of the Tagus were stable [15–17,25,99]. Sediment supply is very important to maintain the balance of this littoral. There are several hypotheses concerning the explanation of the predominant direction of sediment transport on the Caparica-Cabo Espichel coast. The south of the Costa da Caparica beaches, Fonte da Telha or the area nearby Albufeira lagoon, are stated as the possible point where there are changes in the direction of sediment transport. Nevertheless, it is affirmed that the prevalent direction is from south to north due to refraction and diffraction complex patterns that occur in this littoral [15,25,99]. The Tagus River is the main sediment source for this area [16,25]. Once the interventions in this river mouth began, the natural processes changed (Table 2).

Table 2. Coastal changes—literature synthesis.

Date	Place	Damage or Recovery Data	Sources
1845–1879	Cova do Vapor	Sandspit coastal retreat of 750 m.	[15,17]
1879–1893	Cova do Vapor	Sandspit coastal retreat of 400 m.	[15,17]
1929–1939	Cova do Vapor	750 m advance in the direction of Bugio Fortress.	[15,17]
1947–1953	Cova do Vapor	Considerable reduction of the sandspit.	[17]
1947–1951	Cova do Vapor	Disappearance of the sand field supporting the sandspit and 500 m retreat at the edge of the coastal plain (average of 125 m per year).	[15]
1953–1954	The western front of the sandspit	General retreat, reaching 100 m at some points.	[15]
1954–1957	The western front of the sandspit	200 m wide retreat.	[15]
1957–1963	Beach and dunes at Cova do Vapor and Costa da Caparica	Intense erosion of the beach and dunes with the back of the dune retreat of 100 m.	[15,17]
1966–1974	The western front of the sandspit	Sandspit retreat of 150 m.	[15]
1995/1996 Winter	Costa da Caparica (São João da Caparica)	Beach and frontal dune erosion with the generation of escarpment and overtopping on the main accesses to the beach.	[16–18]
1998/1999 Winter	Costa da Caparica (São João da Caparica)	Beach and frontal dune erosion with the generation of escarpment and partial destruction of beach support establishments.	[17,18]
2000/2001	Cova do Vapor, S. João da Caparica and Costa da Caparica	Considerable erosion of the beaches and frontal dune, with total or partial destruction of beach support establishments. Damage to the spurs.	[17,18]
2002/2003 Winter	S. João da Caparica	Destruction of the crest of the frontal dune, leaving campsites and other buildings at risk; dune reinforcement.	[17,18]
2003/2004	Costa da Caparica	Small emergency works executed.	[16,17]
2006	Costa da Caparica and Cova do Vapor	Completion of repair work on the coastal defense structures.	[16,17]
2006/2007 Winter	Cova do Vapor—S. João da Caparica Sector	Intense erosion, frontal dune retreat and width loss of the emerged beach. Imminent rupture of the dune cord and risk of overtopping. Destruction of a beach support establishment.	[17]
January–March 2007	Cova do Vapor—S. João da Caparica Sector	Emergency works to prevent the dune cord rupture and ocean overtopping with camping park (Inatel) flooding.	[17]
2007–2009	Cova do Vapor—S. João da Caparica Sector	Beaches and dunes artificially built up with 3 million m^3 of sand dredged from the Tagus navigation channel.	[16,17]
2013/2014Winter: Hércules, Brigid and Stephanie storms	Cova do Vapor—S. João da Caparica Sector	Beach profile and dune retreat, coastal erosion, overtopping with floodings on the urban front, damages in the coastal protection and urban infrastructures.	[13,18]
2014	Cova do Vapor—S. João da Caparica Sector	Beaches artificially built up with about 1 million m^3 of sand.	[17]

Studies determine through historical cartography that there was a natural sandspit that used to exist immediately south of the Tagus mouth (Figure 1D) and that connected Trafaria to the Bugio fortress [15,97,99]. This was a vast and consolidated sandspit, although part emerged just at low tide [15,104]. This spit was like a natural barrier that restrained

the sediments and fed the coastline. According to Veloso-Gomes et al. [25], with 3 km in length, this spit had protected the Atlantic facade between Trafaria and Albufeira lagoon up to 1870 and even with some retreat, until 1929 (Table 2). It seems that important changes have occurred in the area between Trafaria and Costa da Caparica in such chronologies. Analysis of historical cartography shows that nearby Costa da Caparica started a process of coastal retraction and, in Trafaria, human interventions transformed swampy areas into agricultural land. In some areas north of Costa da Caparica there was a coastal retraction of about 1 km between the years of 1845 and 1893. South of Caparica and in Trafaria, there was sedimentary accumulation [15,17] (Table 2).

Historical sources support such analysis and prove the human changes of this area are a possible factor in the increasing impacts of storm surges and coastal retraction. This was the time when dune afforestation and the drainage of the wetlands began [35]. The first note of such interventions dates from 1882, when a commission in charge of raising the plan of the coastal lands, led by engineers António Alegro and Henrique de Mendia, travelled to the region to observe it and to intervene in the question concerning the health of such areas [78] (nº 5892, 26 de Junho de 1882, p. 1). The swamp in Trafaria corresponded to an area with 8 km, which was a source of disease for the nearby population but also Lisbon [80] (nº 043, sessão de 27 de Março de 1901, pp. 5–6). From the Henrique de Mendia report, it is possible to infer that the sandspit, constituted by mobile dunes, extended from Trafaria to the Albufeira lagoon. However, at the north, this sandspit was still connected from Trafaria to the Bugio fortress, although it was in this segment that it had the smallest width [78] (nº 5958, 31 de Agosto de 1882, p. 2). These descriptions are according to historical cartography observations that realize, in the late 19th century, this sandspit was facing morphological changes and variations in its location [15,99,104].

In 1883, the contract for the purchase of land in Trafaria and Costa da Caparica for the aforementioned purpose of dune afforestation and the drainage of the wetlands was made. All the land on the coast between Trafaria and the south limits of the municipality was sold. There were important exceptions, namely the lands within the villages and an area of 200 m on the north and south sides of the village of Costa da Caparica, which were destined for new buildings. This seems to reflect that growth was expected in the urbanization of this area. There was also reserved for fishing activity a coastal area of 400 m in width, counted from the high sea line, which extended along the coast from the chapel of Our Lady of Conceição, located in Costa da Caparica, to the area of Fonte da Telha, near the Albufeira lagoon [69,74,78] (pp. 32–33, nº 59–15 de março de 1883–p. 623 and nº 6119, 10 de Fevereiro de 1883, p. 1). In 1884, the works had begun and the dune afforestation in the area north of Trafaria was advancing. An important aspect was that afforestation was planned in a way that the shifting sands could still feed the coastal area of Costa da Caparica to protect the fishermen's houses [79] (nº 122, 30 de Maio de 1884, p. 1379). Could this be a sign that the engineers thought that the coast was retreating? It is possible, since there was such concern in maintaining the sand on the beaches. Meanwhile, a ditch was opened between Costa da Caparica and the left bank of the Tagus for the drainage of water of these marshy areas [79] (nº 122, 30 de Maio de 1884, p. 1379). In the following year, the ditch was put to the test. A coastal surge hit the beaches of Costa da Caparica in February, and the sea invaded the houses and the village infrastructure. The event was so extreme at one point that, according to reports, the episode gave the residents the appearance of inhabitants of an island on the high seas. If not for the ditch, the results could have been worse, because this structure provided an outflow for the rushing waters [78] (nº 6849, 14 de Fevereiro de 1885, p. 1). This engineering work was able to drain the wetlands of the area, which was considered a benefit to bathing tourism [78] (nº 6998, 15 de Julho de 1885, p. 1).

Yet at the same time that this coast was gaining importance in beach tourism, human actions combined with natural episodes led to several hazardous situations on the Costa da Caparica littoral. In 1888 was begun the construction of the Lisbon harbor. Although some authors argue that such enterprise did not influence the Tagus River mouth's natural features, others claimed that it interfered in the direction of currents, and in sediment

transport, among other consequences [15,97]. In any case, episodes of maritime invasion occurred in the years after. In 1895, a succession of bad weather events caused considerable destruction as the sea invaded the village, damaging some fisherman houses, especially the ones close to the beach that were in danger of collapsing [78] (nº 10444, 18 de Janeiro de 1895, pp. 1–2 and nº 10469, 12 de Fevereiro de 1895, p. 1.). In 1905, the sea invaded the land and destroyed several boats and six well-built wooden huts, reaching agricultural lands more than 600 m away from the beach [78] (nº 14400, 29 de Dezembro de 1905, p. 1). This kind of inundation by the rising tides continued to occur, for instance in 1910 [78] (nº 16194, 12 de Dezembro de 1910, p. 2) and 1912, in an episode in which many houses were surrounded by water [78] (nº 16603, 3 de Fevereiro de 1912, p. 2).

As was mentioned earlier, until the 1930s, the sandspit between Trafaria and Torre do Bugio (Figure 1D) helped to retain the sediments in this coastline. However, this natural defense was vanishing [15,17,25,99,104]. The growth in human occupation and urban construction happened when the process of coastal erosion and retreat also intensified due to human actions (Table 2). It is important to notice that until the mid-20th century, afforestation was maintained in this coastal area, namely among Trafaria and Costa da Caparica [35], a project that could have reduced the natural circulation of sediments between the dunes and the beaches, contributing to costal retraction [15]. Other anthropic causes reduced the sediment flow in the Tagus River basin. In the 1920s, there began the construction of hydroelectric power plants, contributing to sedimentary retention. This situation worsened in the second half of the 20th century when dam construction diminished even more the sediment flow to the coastline [8,15,35]. Besides these impacts, about 14.5 million cubic meters of sand was removed for landfills on the right bank of the Tagus [8,15,35,99,104]. All these anthropic triggers increased the coastal erosion processes in this littoral (Table 2). For instance, extreme natural events, such as the 1937 hurricane, caused great damage to the village. The waves that reached the dunes forced the evacuation of the southern part of the locality, flooding several areas, destroying houses and boats [78] (nº 25500, 2 de Fevereiro de 1937, p. 7). We believe that such damage could have been worse if the process of erosion that occurred in the sandspit between 1845 and 1893 had been maintained. Probably the 750 m advance that was registered between 1929 and 1939 [15,17,25] (Table 2) reduced this extreme event's impact.

At the beginning of the second half of the 20th century, the anthropic actions previously referred to had worsened the problems on this littoral. Between 1947 and 1957, extreme erosion processes were observed in the sand spit between Trafaria and Torre do Bugio (Table 2). In 1953, the appearance of dangerous openings in the north dune was reported by the local press, which complained that authorities should continue placing acacia branches on the southern dune to provide sand retention [76] (ano IV, nº 70). It was in this phase when the first destruction of houses occurred in Cova do Vapor, northern Costa da Caparica [15]. As a consequence of the retreat in Costa da Caparica beaches and dunes, erosion processes became more intense and frequent (Table 2). In 1957, there was an overtopping at high tide, flooding the forest and summer facilities. Two houses were destroyed and many others were damaged. In Cova do Vapor, 60 houses built on the dunes needed to be removed [77] (nº 26, 23/02/1957, pp. 5–6). Local news reported that in 3 years there was the almost total disappearance of the Cova do Vapor beach and the dune up to Costa da Caparica [77] (nº 33, 15/04/1957, p. 6). These problems led to the visit of a technical commission [76] (ano VIII, nº 126). There was also assembled a local stakeholder's commission to ask the government for support [76] (ano VIII, nº 129). In response, still in 1957, government authorities set up a commission to study and propose the rules and procedures to be adopted for this coastline protection and its defense [79] (nº 182/II, 6 de Agosto de 1957, p. 6031). Interventions to repair dunes began at the end of the year [76] (ano VIII, nº 136, 137). In 1958, a commission was established to analyze the problem of coastal erosion in the area [76] (ano IX, nº 150) and in 1959 the Portuguese army began the construction of three spurs and longitudinal defenses in the Cova do Vapor-Costa da Caparica sector [76] (ano IX, nº 154, 155, 160, 172), as mentioned in other studies [14,17]. These interventions brought some comfort to

inhabitants that the sea would no longer be a threat [76] (ano IX, nº 180, 194). However, in 1965 concerns returned when the sea ruined one beach establishment [76] (ano XVI, nº 230).

Meanwhile, more coastal defenses were built to protect the coastline and between 1968 and 1974 the expansion of the Cova do Vapor spur field began along with the construction of the spurs of Costa da Caparica and the first artificial additions to the beaches [76] (ano XX, nº 229, 279; ano XXI, 297; ano XXII 300; ano XXXIII 317). Until 1996 the intervening segments became relatively stabilized, although there was progressive loss of beach width and volume [17]. In the following years, some episodes led to infrastructure damage, coastal retreat, and erosion, leading to interventions between 2002 and 2006 [16–18] (Table 2). In that year's winter, erosion increased and led to the need for new interventions between 2007 and 2009, namely beaches and dunes being artificially supplemented. This kind of intervention was repeated after the 2013–2014 winter when the Hercules, Brigid, and Stephanie storms wrought considerable damage on this coastline (Table 2). Analysis indicates that even with such interventions, this coastline is highly vulnerable to hazards and risks of coastal erosion, overtopping, and coastal flooding events, requiring strategies of defense/protection, accommodation, and/or relocation [18,19].

5. Conclusions

This work aimed to provide a long-term historical analysis that could enhance our comprehension of human occupation on this coastal stretch and its implications to present and future challenges concerning coastal management. History can help us to understand past mistakes and try to avoid them in future decisions. The principal remarks of this study are:

1. The Setúbal Peninsula occupation by the Santiago military order was very important in the Christian reconquest scenario;
2. In the first half of the 18th century, Costa da Caparica was already inhabited and a dynamic human community already occupied that region;
3. In the late 19th century, tourism started to appear in the region and at the same time the first human actions took place in northern Costa da Caparica, driving the first anthropic impacts;
4. In the 20th century, there was the construction of the Tagus bridge and the Lisbon airport. Costa da Caparica became a tourism destination and human occupation increased. At the same time, human actions such as the interventions on the Tagus River and dam construction, among others, changed the natural features of the region. Since then, the results of human impacts have become more evident through coastal erosion, overtopping, and coastal flooding events.

Costa da Caparica has become a very vulnerable coast, being a practical example of how through historical analysis the impacts of human actions can be perceived and perhaps avoided. This kind of analysis may be applied in similar coastal stretches with ancient human occupation and a lack of natural morphodynamics; i.e., where the geomorphological evolution is mainly due to anthropogenic actions.

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