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IT'S NOT ONLY THE SEA: A HISTORY OF HUMAN INTERVENTION IN THE BEACH-DUNE ECOSYSTEM OF COSTA DA CAPARICA (PORTUGAL)

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ABSTRACT: Costa da Caparica, located south of Lisbon, has been since the 1960s the favourite beach of the population of the Portuguese capital. The bridge over the Tagus river (1966), connecting the two margins, has facilitated the access to that wide beach of sand and dunes. Due to its natural features and proximity to Lisbon, Caparica become a highly populated area, where different social and economic activities compete for the use of the available space, increasing pressure upon the local ecosystems. The situation is even more problematic, because that littoral has been deeply affected by coastal erosion from the 1950s onwards. Authorities have been dealing with the issue using groynes and artificial beach nourishments. Since 2015, the Municipality of Almada is investing in the rehabilitation of the dunes of the beach of S. João, placing fences to retain the sand and planting vegetation. This programme is particularly interesting from a coastal management history point of view, because these dunes have been the object of many interventions with different purposes, but what was done and why is not very well known. The aim of this article is therefore to present the results of a historical research about human intervention in Costa da Caparica and, particularly at S. João beach, starting in the 19th century, with the first dunes' survey, the afforestation experiences and the construction of a drainage system. This paper offers a long-term perspective on the socio-evolution of these hybrid environments. Results and discussion show how dunes were trimmed by the works carried out and the reasons that laid beneath these. Revealing the ideas and values, the social, economic and political pressures, that across the years and within the same time period, shaped management strategies and landscapes.

Keywords: Environmental History; Dunes Rehabilitation; Afforestation; Wetlands; Coastal Erosion.

RESUMO: *A Costa da Caparica, a sul de Lisboa, é desde os anos 60, a praia favorita dos habitantes da capital portuguesa. A ponte sobre o Rio Tejo (1966), que une as duas margens, tornou fácil e rápido o acesso àquela extensa praia de areia e dunas. As suas características naturais e a proximidade de Lisboa transformaram a Caparica numa zona densamente ocupada, onde diferentes actividades sociais e económicas competem pelo espaço, fazendo grande pressão sobre os ecossistemas locais. A situação é ainda mais complexa, porque este litoral tem sido muito afectado pela erosão costeira desde a década de 1950. As autoridades têm procurado resolver o problema utilizando esporões e recorrendo à alimentação artificial das praias. Desde 2015, a Câmara Municipal de Almada tem investido na reabilitação das dunas da praia de S. João, colocando paliçadas para reter a areia e plantando vegetação. Esta estratégia é particularmente interessante do ponto de vista da história da gestão costeira, uma vez que estas dunas têm sido sujeitas, desde há muito, a diferentes intervenções, mas o que foi feito e porquê não é muito conhecido. O objectivo deste trabalho é então apresentar os resultados de uma investigação histórica sobre as intervenções nas dunas da Costa da Caparica e na praia de S. João, desde o século XIX, começando pelas primeiras avaliações dos problemas existentes, as experiências de florestação e a construção do sistema de drenagem. Este artigo oferece uma perspectiva da evolução destes sistemas híbridos, a longo prazo. Os resultados e discussão mostram como as dunas foram moldadas pelos trabalhos realizados e as razões que os determinaram, revelando como diferentes formas de pensar, ao longo dos anos e num mesmo período, definem e marcam as estratégias de gestão e as paisagens.*

Palavras-chave: *História Ambiental; Reabilitação de Dunas; Florestação; Zonas húmidas; Erosão Costeira.*

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1. INTRODUCTION

In 1953, the newspaper *Praia do Sol* (1953-02-15) published an article about the sand dunes of Costa da Caparica. The purpose was to reassure the readers that the beach was not at danger, since everything had been taken care by the authorities. The article tells the story of Manuel Matias: a negative man, too cautious and nit-picking. A fellow that had the perfect job for him: he owned an insurance company. One day his friends met him at Costa da Caparica, Matias was paying special attention to a building, so they thought he was working on a new insurance. But, Matias was trying to understand how such big hotel could stand on the sand without falling apart. The insurance man was looking for a place to build his own home, but he was afraid. He feared the sea! For the others, his apprehension was foolish. The Forestry Services had built an artificial dune in 1953, a sand barrier against the sea to protect the infrastructures, so the area was perfectly safe. The dune established the limit between the daring ocean and the human domains. There was no reason for concern. Matias' friends had faith in the solution: dune afforestation and the drainage ditch had solved the old local problems. However, as time would show, they were wrong.

This story offers the perfect set to introduce the case of the dunes of Costa da Caparica (Figure 1). In the 20th century, the 30 km-long coastline broadly called Costa da Caparica was, for economical and leisure purposes, administratively divided in more than 20 small beaches, each one having its own name. Their limits and designations changed over the years. S. João, the one on which this article focuses, only acquire such label in 1960 (*Praia do Sol*, 1960-12-01), before that it has called *Lisboa-Praia* and *Praia da FNAT* or mentioned under the general name of Costa da Caparica.

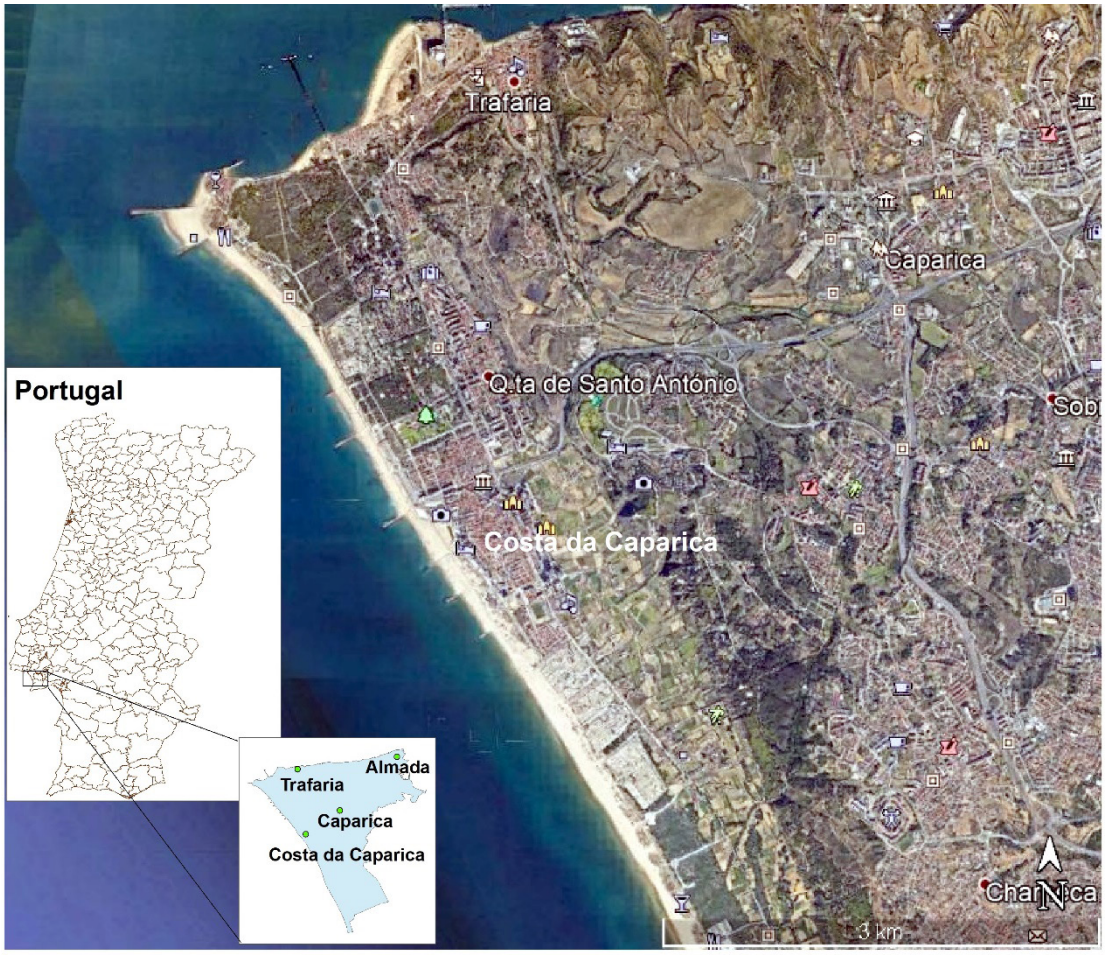

Figure 1. Location of Costa da Caparica, in the Portuguese western coast (Adapted from GoogleMaps).

In 2014, the dune system of S. João suffered a significant retreat - about 20 m - during a winter storm (Soares, 2014). Given the relevance of dunes as barriers against the ocean, the Municipality of Almada made a request to the Portuguese Environment Agency to activate the local rehabilitation program. ReDuna project, created in this context, aims to recover the ecological functions of the dunes, with the installation of fences and vegetation, to increase their capacity to retain sediments (Figure 2). This program also includes the setting of boardwalks to reduce trampling and information signs to explain the measures implemented (Câmara Municipal de Almada, 2015). ReDuna is very interesting from an environmental history and coastal management point of views, because these dunes have been the object of many concerns and interventions in the past, but not much is known about them and there are no long-term studies on the issue. This paper tries to fill that gap.

In the last decades, many scientific works were produced about Costa da Caparica and S. João beach, specially from the middle of the 20th century onwards (e.g. FEUP/IHRH, 2000, 2001, 2003; Veloso-Gomes *et al*., 2006, 2007; Diogo *et al*., 2013; Neves *et al*., 2013; Pinto *et al*., 2015, 2013, 2007; Rato, 2017). Since this literature is well-known by those working in coastal issues, and this paper focuses in a previous time period, only some of the works are highlighted. For instance, Rato (2017), focused on the monitoring of the seasonal morphological changes of the frontal dune, between 2015 and 2016, analyzing the evolution of the rehabilitation project. She has concluded that, during the 21 months of the evaluation, a new primary frontal dune was formed and there was a sedimentary budget increase of 5000 m^3. Neves *et al*. (2013) discussed a methodology for the evaluation of the risk level associated with the action of the waves at the foreshore of S. João da Caparica. This is an important issue since, between 1999-2007, this coastline has suffered a retreat of 26 m (3.3 m/year). In the same period, between Cova do Vapor and S. João da Caparica, 27000 m2 of dune area were lost (Pinto *et al*. 2007). In the winter of 2006-2007, the dunes were severely affected and the camping parks nearby almost flooded by the sea (Veloso-Gomes *et al*., 2007). Pinto *et al*. (2007, 2013) studied the evolution of the coast, stressing the risks upon it and proposing measures for the future. The authors also organized a chronology of major events related to storms, retreat/accretion episodes and hard engineering protection structures, since the 19th century. Earlier, Freire (1986) had analyzed the evolution of Costa da Caparica's morphology using the cartography available since the 16th century. Her study emphasized human intervention and its effects, listing the relevant events connected to the transformation of this landscape since the 19th century. Freire (1986) mentioned the dune afforestation, the drainage of the

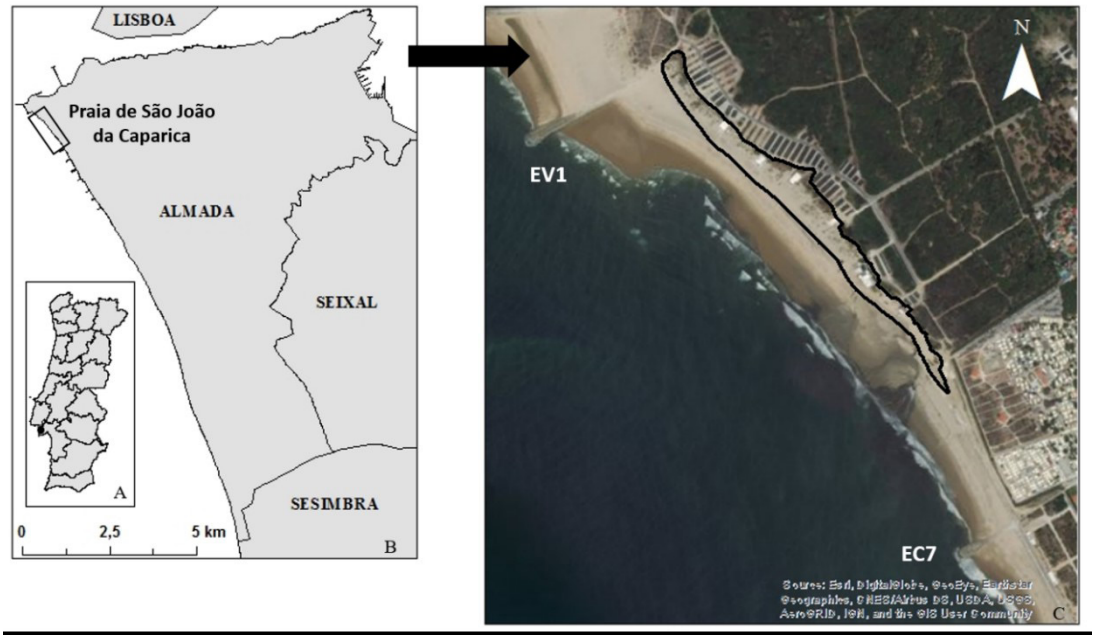

Figure 2. Location of S. João da Caparica Beach and the dunes under ReDuna project (Source: Rato, 2017).

wetlands and the changes made in land use that turned this almost empty beach into a busy seaside resort. However, her references to interventions on dunes and wetlands were quite superficial. Meanwhile, this coast has also been addressed, from a different perspective, by authors interested in the fishing communities (Pereira *et al*., 2015; Martins, 2000), its history and local heritage (Sousa, 2003) and the urban growth (Oliveira, 2015; Câmara Municipal de Almada, 2008; Correia, 1976), which is deeply connected with the development of Costa da Caparica as touristic place (Carvalho e Pacheco, 2010; Arcos, 1974; Ramalho, 1934). Yet this literature, beside some scattered references (e.g. Sousa, 2003; Ortigão, 1876), does not say much about the dunes.

The purpose of this paper is to present the results of a historical research on the dunes of Costa da Caparica, especially the ones from S. João. These dunes have put many management challenges since the 19th century, when the shifting sands were perceived as an annoyance and a trouble that had to be solved. Afforestation and the drainage of the wetlands associated to these sands were the solutions found at the time. These works had effects that are important to understand the development of Costa da Caparica as a seaside resort. A critical historical analysis is not a collection of dates, people and events. It aims to disentangle the intertwined strands of beliefs, powers, tensions, continuities, fractures and flows that make meanings and define actions within society. This article, covering a period from 19th to the 21st century, wants to shed a light on those issues, making experts, coastal managers and the general public to understand that landscapes are constructions that depend on many key-factors. Perceptions, ideas and policies are modeling agents of dunes as much as the wind, the ocean and the sand. Considering the uses given and the strategies for the dunes, this paper addresses the following issues: 1) the origins and evolution of settlement in Costa da Caparica; 2) the sands and wetlands as a problem, afforestation and drainage as the solution; 3) the shaping of ecosystems and communities: challenges of managing hybrid coasts.

2. MATERIALS AND METHODS

Much is known about Costa da Caparica. There are many scientific works about this subject, as mentioned above. What is less noted are the ideas and powers that, embedded in the political, economic, social and institutional structures, determined the guidelines for human intervention in that area and on the dunes. This paper is based in a research that offers a more complete and multifaceted perspective about that stretch of the Portuguese coast, by critically analyzing a documental corpus that holds for a plurality of actors, institutions, discourses and interests setting the dunes' agenda. This corpus is composed of monographies, newspapers articles, legal documents, technical reports, urbanization plans and cartography. These have been collected in several institutions, such as Portugal National Library, the Historical Archive of Almada, the Historical Archive of Economy, the Archive of the Institute for the Conservation of Nature and Forests and the personal archive of the Forestier José Neiva Vieira. Following the historical method of document analysis, all the data was carefully checked for its accuracy, being placed in time and place of its production and interpreted according to the context that let to its creation. The information was crossed with other literature to build an interdisciplinary long-term approach to the dunes of Caparica.

3. RESULTS AND DISCUSSION

3.1. The case-study area

Costa da Caparica, understood as the oceanic coast immediately south of the mouth of the Tagus River, is a dynamic complex area. The sediments existing here came originally from the Tagus, which over time has been constituting an extensive underwater delta. On the Portuguese West coast, the dominant offshore wave comes from the Northwest quadrant, which induces a littoral drift yearly resultant from North to South. However, in practically all river mouths there is a reversal of the direction of the littoral drift, which is directed North. The consequence is the growth of sandspits rooted to the South. In Costa da Caparica something similar has occurred. Here, the dominant wave of Northwest is diffracted in Cape Raso, to the North, which causes the rotation of the incident wave that hits the coast to the South (Costa da Caparica) with the attack angle directed to the North, being this the local direction of the littoral drift. This rotation is amplified by refraction in the Tagus submarine delta. On the coast between the mouth of the Tagus River and Cape Espichel the littoral drift is running North, in the Northern part, and South, in the Southern one. The drift reversal zone is located roughly in the vicinity of the Lagoa de Albufeira, although it depends on the direction of the offshore dominant wave. If this one is more oriented to the North, the drift inversion zone is more to the South; if it is more turned to the West, this inversion is more to the North. During Southwest storms, the littoral drift in the whole sector is to the North.

These conditions provided an accumulation of sediment in the Northern sector, that lead to the formation of wider beaches defended by the groins, whose finer sands, transported by the wind, created a vast dune field, limited to the East by the fossil cliff of Costa da Caparica. The alluded sedimentary accumulation also induced the growth of a sandspit that extended greatly into the mouth of the Tagus River. Between late-16th and mid-17th century, a defense tower – the Fortress of São Lourenço do Bugio - was built there (Figure 3). This sandspit, rooted in Costa da Caparica, always had a high morphological dynamism, depending on the amount of the sedimentary supply, the frequency and intensity of the storms and the occurrence of floods in the Tagus. Sometimes, it was possible to walk on foot to the Fortress of S. Lourenço do Bugio; other times parts of the sandspit were submerged, as it happens nowadays.

Throughout the 20th century, a cascade of dams was built along the Tagus River basin, which resulted in the regularization of the water flow, with a strong reduction in flood intensity. As such, there was a diminishing of the river sediment transport and, with the drastic reduction of flood peaks, the episodes of sand transfer from the estuarine domain to the adjacent ocean were also strongly diminished. At the same time, in order to improve port activities in the Tagus estuary, large dredging operations began to take place periodically, inclusively in the sandspit area. This way, the sand volume that used to reach Costa da Caparica was drastically reduced and this coast began to be affected by erosion. The sandspit itself was progressively weakening and migrating to the East, being now more than 3 km inland compared to its position at the beginning of the 20th century. Nowadays, the vast dune field that existed here once is quite reduced: the frontal part was eroded and most of it was afforested and occupied by urban equipments. The only remaining dunes are in a Southern narrow space and to the North in the rooting area of the sandspit.

3.2. From an empty territory to an idyllic seaside resort

The territory now under the administration of the Municipality of Almada has very old historical roots. This article, however, focuses on recent times and in a particular sector of this region: the seashore now known as Costa da Caparica. The parish of Nossa Senhora do Monte da Caparica, in the 18th century, covered a triangular area running from Cacilhas to Trafaria in the North, the ocean coast in the West until Poço do Mouro (near Fonte da Telha) and, to the South and East, up to the

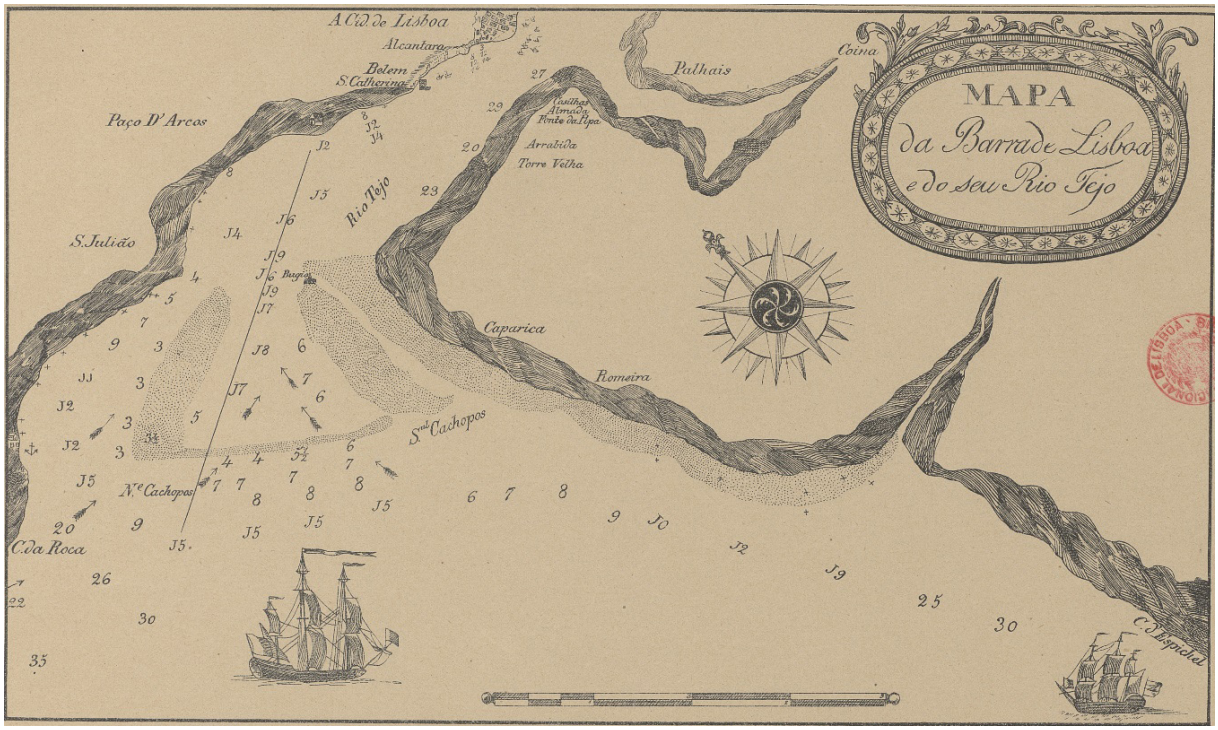

Figure 3. Map of the port of Lisbon and Tagus River mouth, by W. Burgis, in 1765 (Adapted from Silva, 1893. Source: Biblioteca Nacional de Portugal).

limits of the parishes of Sesimbra and Almada (Figures 1 and 2). It was formed by five main villages (Fonte Santa, Murfacem, Pêra Ribeiro, Funchal and Sobreda), hamlets and farmlands, located predominantly in the Northern and central part of the parish, in the highlands of the fossil cliff platform. The vineyards were the main farming activity. There were also six riverine ports: Banática, Porto Brandão, Paulina, Portinho da Costa, Portinho de Buxos e Trafaria. On the lowlands of the seacoast, at the base of the cliff, there was nothing but a sandy area and the beach called Costa (Memórias Paroquiais, 1758) (Figure 4).

This was an empty territory, as Corbin (1990) defined it to other European maritime coasts. It was only used by the fishing communities that travelled along the littoral. Fishers from Ílhavo and Algarve were the first to colonize the seashore of Caparica (Ferreira, 1936). They roam along the coast looking for beaches with suitable features for xávega (Madureira e Amorim, 2001), a fishing art, based in bottom trawling, in which the nets are pulled and gathered at the beach, that requires sandy coasts with no rocks and a broad open space for maneuvering (Pereira *et al*., 2015). In the summer, the fishermen lived at the shore and at the end of the season they moved out, returning to their original places, to work in sheltered waters or to find a job inland (Freitas *et al*., 2018). Most historical sources put them in Costa da Caparica, forming the village with the same name, around 1770 (Brochura de divulgação, 2019[1930]). But, a transcript from the Archive of Almada (Depoimentos de testemunhas, 2019) shows that, in 1761, there was already a thriving community living at the beach. The document also reveals that this population was quite diverse, as there were fishers, grocers, rural workers and tavern keepers amongst it. There are many examples along the Portuguese coast of the co-existence of temporary settlements on the shore with inland villages, like Furadouro/Ovar, Palheiros de Mira/Mira, Costa de Lavos/Lavos and Praia da Vieira/Vieira, showing that these were clearly different territories, but interconnected communities (Freitas, 2016, 2010). This must have been the case of Costa da Caparica and other interior villages of Caparica. In common also the fact that these coastal communities lived in houses perfectly suited to their sandy environment: the *palheiros* were simple wooden huts, easy to build and, moveable according to coastline changes (Figure 5). If the sea got too close or the dunes threaten to cover them, they could be transferred to a safer area (Peixoto, 1899; Oliveira e Galhano, 1964). Something that was still being done in Cova do Vapor, in the 1960s (Oliveira, 2015).

In the 19th century, when population growth and the development of fish canning industries increased the demand for fish, bringing more stability to the activity, the fishing communities become more sedentary. In 1885-1886, there were 68 boats and 780 fishermen at Costa da Caparica (Silva, 1991 [1892]). Their families still lived in *palheiros*, but since part of them had been destroyed by fires, they were slowly being replaced by regular houses (*Diário do Governo*, 1885-07-15; Brochura de Divulgação, 2019). In the 1920s, some were rented to bathers during the summer (Ortigão, 1876). Transport development, by boat, connecting Belém (Lisbon) to Trafaria and, by road, linking Trafaria to Costa da Caparica, contributed to increase the number of houses in that beach (Duarte & Lamas, 1978). The newcomers constructed their own homes next to the already build area (Brochura de divulgação, 2019). Population varied according to the seasons: in August 1944, there were around 5000 people; in February 1945, only 1800. This means that in the summer there was a significant growth of the ones living there (Gröer, 2004-2005 [1946]). In the 1930 and 1940s, urbanization plans were made for the area, under the 1934 Law, on the General Plans of Urbanization, that stipulated the need for the municipalities to rearrange and requalify the urban structures of the towns with potential as leisure and touristic destinations. Many seaside places had their first urbanization plans drawn then. The projects for Costa da Caparica intended to transform the fishing village into a touristic and leisure centre, to properly install the growing number of people arriving each year. But, as in most places, these plans were only partially put into practice (Lobo, 1993).

The natural characteristics of this coast made it an excellent location for sea and sun bathing. The place was famous for its therapeutic benefits. The local newspaper, *Praia do Sol* (1951-01-01, 1953-05-15, 1955-09-01), publicized it as being good for children and athletes and to cure lymphatics diseases, rickets, scrofula and tuberculosis. Doctors, like Pinto da Silva, in "It is not only the sea", considered it a healing station: the geological nature of the sands, the extension and width of the shore were believed to have curative properties (Brochura de divulgação, 2019). The beach and the green surrounding forest were appraised as an idyllic place (*Praia do Sol*, 1970-03-15) (Figure 6). But, it hadn´t always been like this. The blissful idealized Costa da Caparica was physically and metaphorically built on sand. This element, its abundance, scarcity, fixing and drainage, is key to understand the evolution and dynamic of this hybrid coast.

Figure 4. Detail of the Plan of the Lisbon Port, by Jacques-Nicolas Bellin, 1764 (Source: Gallica. Bibliothèque Nationale de France, https://gallica.bnf.fr/ark:/12148/btv1b530570096). The picture shows the south margin of the Tagus River, presenting some of the main places at the time, from Cacilhas (Cassile) and Almada to Trafaria (Trefferie), Fonte Santa (Fontaine) and Murfacem (Morfacem). The parish center – Caparica (Taparica) – is also represented. Some of the riverine ports are mentionned: Banática (Banate), Porto Brandão (Port Brandan), Portinho da Costa (Port de Coste) and Portinho de Buxos (Bouche). The fossil cliff is represented as well as the sandy beach.

Figure 5. Postcard representing a palheiro of Costa da Caparica, by A. Rocha Gameiro, early-20th century (Source: Private Collection of the Family Arriaga Corrêa Guedes).

3.3. Solving the sand problem: greening the dunes

In the early-1800s, Marino Franzini, major of the Portuguese Royal Corps of Engineers, drawn the entrance of the Tagus River, including Caparica's area (Figure 7). His representation of the beach and the fossil cliff is remarkable and he offers some quite interesting information. Franzini mentions the existence of a *medo*. *Medo*, *medos* or *medões* were the old designations used to name the dunes of the Portuguese coast. The dune identified by Franzini as *Medo Ingles* it was probably a detached landscape feature in the base of the sandspit used as a reference for navigation. He also refers the *igreja da Costa*, the church, the main building in any inhabited place at the time.

Some decades later, in 1857, another map presents the study area with amazing detail, showing the small hamlet of Costa, the farmed fields at the base of the fossil cliff, the wetlands and the dunes. *Medo Inglez* is also there (Figure 8).

In the 19th century, the extensive shifting dunes seen in Figure 8 were considered sterile, worthless and a concern, as the sand blown by the wind caused damages to fertile fields. This problem affected many countries and other stretches of the Portuguese coast. At the end of the 18th century, following the example of the French state that had promoted the afforestation of the dunes of Gascogne, efforts were made to fix the sands of Aveiro, Vieira and Lavos (Portugal). The idea was to prevent sand drifting, by trapping it with fences, vegetation and trees, turning the useless dunes into profitable forests. In 1802, Andrada e Silva, Head-Chief of Forest and Mines, was put in charge of sowing the seashore sands (Silva, 1815). Later, some interventions were made to protect agricultural fields (e.g. Leiria and Nazaré) and stop the silting of rivers and ports (e.g. S. Martinho do Porto) (*Diário do Governo*, 1823-04-04, 1824-11-22). The dunes issue would draw much more attention in the second half of the 19th century, as complains about the need for safeguarding people and assets reached the Parliament, compelling the authorities to take measures (Melo, 2017:50-51; *Diário da Câmara dos Senhores Deputados* - DCSD, 1866-03-05; 1867-06-15; 1868-08-06; 1896-03-27). By then the Government was aware that to fully know and manage national resources more information was necessary. So, an inventory was ordered on the location and size of the public forests and barren lands that should be afforested, which included the coastal dunes. The survey was made in 1868. According to it, the dunes of Costa da Caparica had no vegetation and were running freely. Its authors recommended their fixation and conversion into productive soil (Ribeiro e Delgado, 1868).

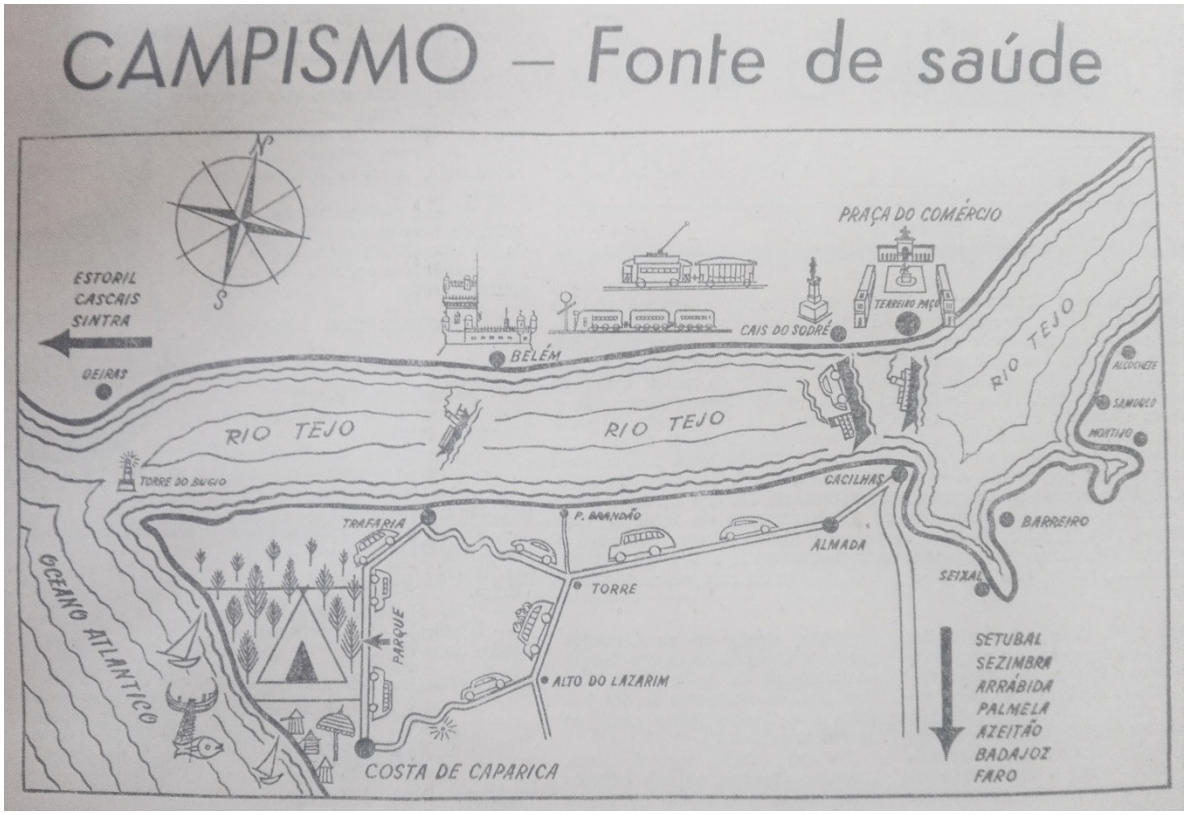

Figure 6. Propaganda to Costa da Caparica as a healthy place (Praia do Sol, 1951-07-01). (Source: Archive of the Municipality of Almada). Notice the references to the transports between Lisbon and the south margin, the car access to Costa da Caparica, the forest, the camping park and the beach itself.

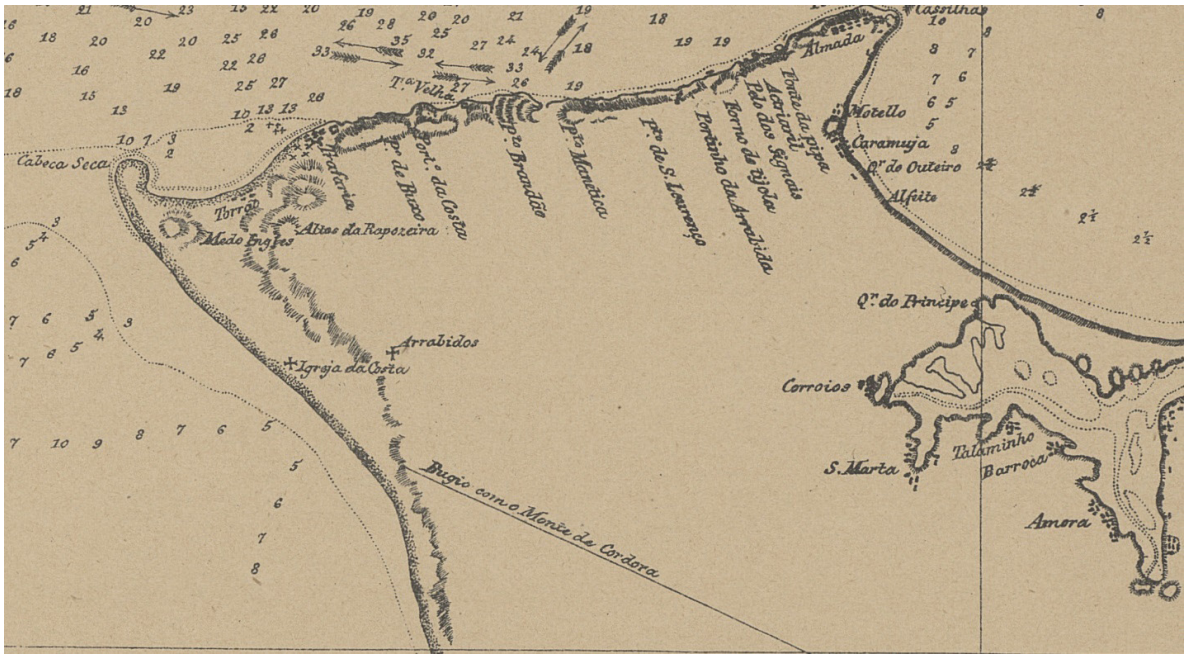

Figure 7. Detail of the Plan of the Port of Lisbon, by Marino Franzini, in 1811 (Adapted from Silva, 1893. Source: Biblioteca Nacional de Portugal).

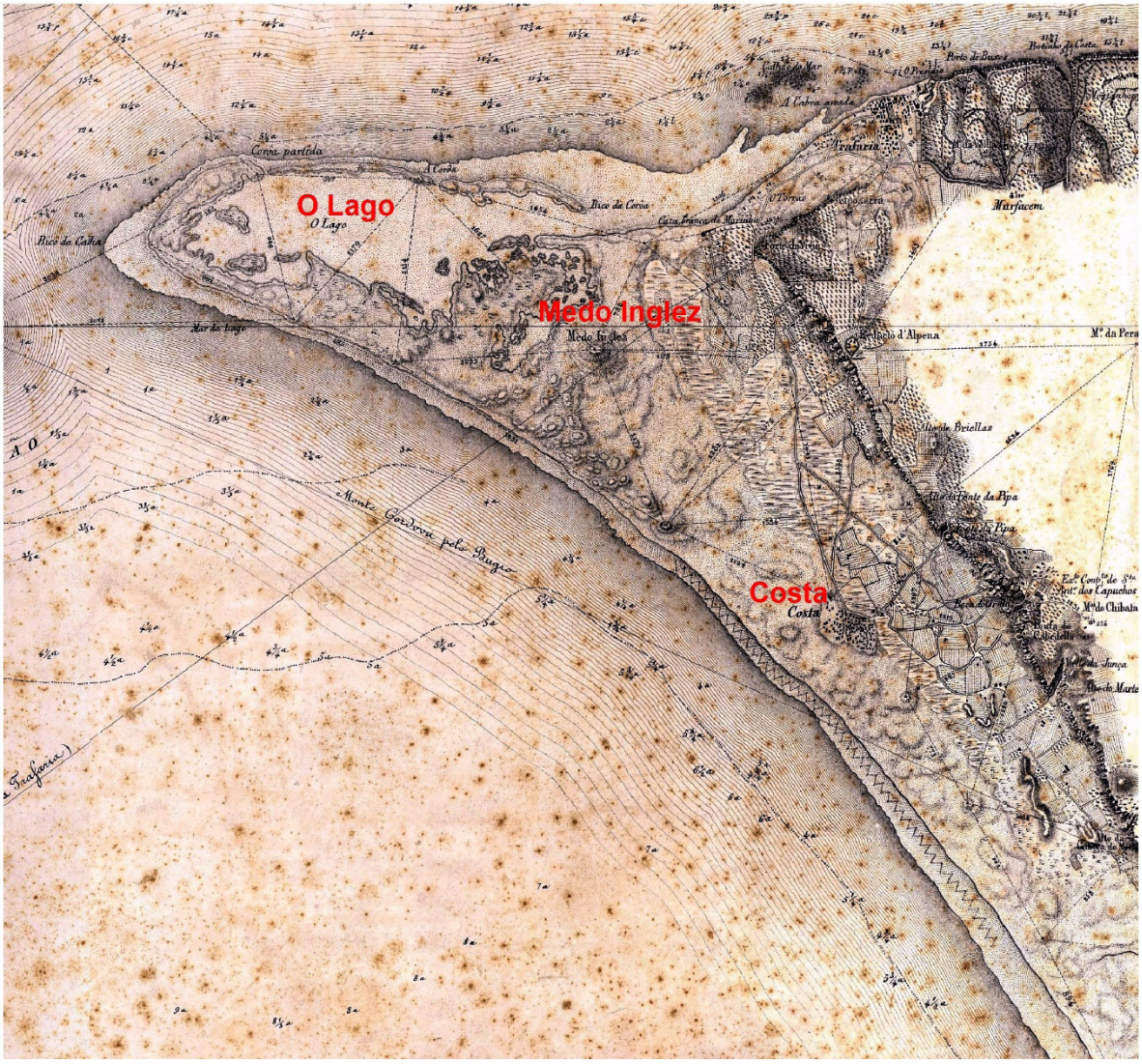

Figure 8. Detail of the Hydrographic plan of the Port of Lisbon, made by the Naval Officers Lieutenants F.M.P. Silva, C.M. Batalha and C.F. B. Vasconcellos. Field work in 1842, 1843 and 1845. Drawings in 1857 (Source: Biblioteca Nacional de Portugal). Notice the sand dunes near the coastline and the wetlands extending from the village of Costa to the sandspit in the north. Between the cliff and the wetlands, patches of agricultural fields.

In the 1880s, the engineers Henrique de Mendia and José Alegro were put in charge of mapping the dunes of Costa da Caparica and proposing a plan for the drainage of the wetlands, the afforestation of the sands and the construction of a road to the village. These interventions aimed to guarantee the safeguard of the population, since many souls lived bedeviled by the sands, suffered from frequent fevers due to the stagnant waters nearby and, had no proper access to other villages (*Diário de Notícias*, 1882-08-31). In 1883, the newspaper *Diário de Notícias* announced that the government has putting forward the afforestation and drainage of Costa da Caparica (*Diário de Notícias*, 1883-02-10). The Municipality of Almada decided then to sell to the state, for a low price, all the worthless shore lands, from Trafaria to the Southern end of the municipal boundaries. Out of the bargain, were the settlements' grounds; an extension of 200 m, to the North and to the South of the village of Costa da Caparica, reserved to the development of new dwellings. And, a 400 m wide strip of drifting sands from the high tide mark, from Costa to Fonte da Telha, to ensure space of the fishing activities. The government – through the

Forestry Services - assumed the responsibility of creating and maintaining a forest in those dunes to fix the sands, protect the riverbank and prevent silting (Termo do contrato, 2013 [1883]). The works started in 1883-84, at Trafaria and, in 1885-86, at Costa da Caparica (Borges, 1897).

At the time, Viana (1885) appraised the benefits of dune afforestation, pointing that it set the right humidity, protected the soils and plantations, provided jobs and resources. According to him, two years after the first sowings in Trafaria there were 36 ha of fixed dunes. The method used was based in setting fences to stop the sands, sowing vegetation and pine seeds, covering all with bushes for protection, and later, planting small pines. The technique had been introduced in Portugal, by Andrada e Silva, who had learned it in France and Prussia, during his travels in Europe (Silva, 1815; Freitas, 2004). The works at Caparica were not a specific local matter, but part of a bigger scheme implemented in Portugal and other countries (e.g. France, Spain, Italy), to turn the barren dunes into green profitable forests. The task was also a way for governments to reinforce their powers over public lands and resources, by assuming the responsibility for soil improvement and the protection of local communities against the sands (Melo, 2017).

In 1897, the Ministry of Public Works published a report on the situation of sand afforestation in Portugal and the aims for the years to come. This document presents a good picture of dune management at the time and the ambitious goal of fixing the country's mobile sands. Concerning the case-study area, it is said that the interventions done between 1883-86, in Trafaria and Costa da Caparica, had immobilized 35,6 and 38,8 ha of dunes, respectively. The works in Trafaria were given as finished in 1891. In Costa da Caparica, the total area of dunes to fix was 175 ha, so there was still 137 hectares to work out. The next step was the setting of a 1400 m long fence, to protect the plants from the sand. But, no more sowing and seeding were proposed for the following years, so it is not clear from this document if the Forestry Services were thinking of expanding the forest area. The financial support provided then to Costa da Caparica perimeter seems to have been only for the maintenance of the existing plantations (Borges, 1897).

Figure 9 shows that the works proceeded in the 20th century, including new sowings, but they were not linear in progress. Costa Pinto, deputy and former president of the Municipality of Almada, described how difficult it had been to convince his peers and even the press of the advantages of dune afforestation. Revealing that the process had had opponents and it was not as consensual as some enthusiastic speeches made it sound (DCSD, 1901-03-03). Also, the report written by the Head-Forester Magalhães Mesquita, in 1908, explains how hard the works were in practice, with unsuccessful plantings - pines dying because of droughts - and the need to do successive

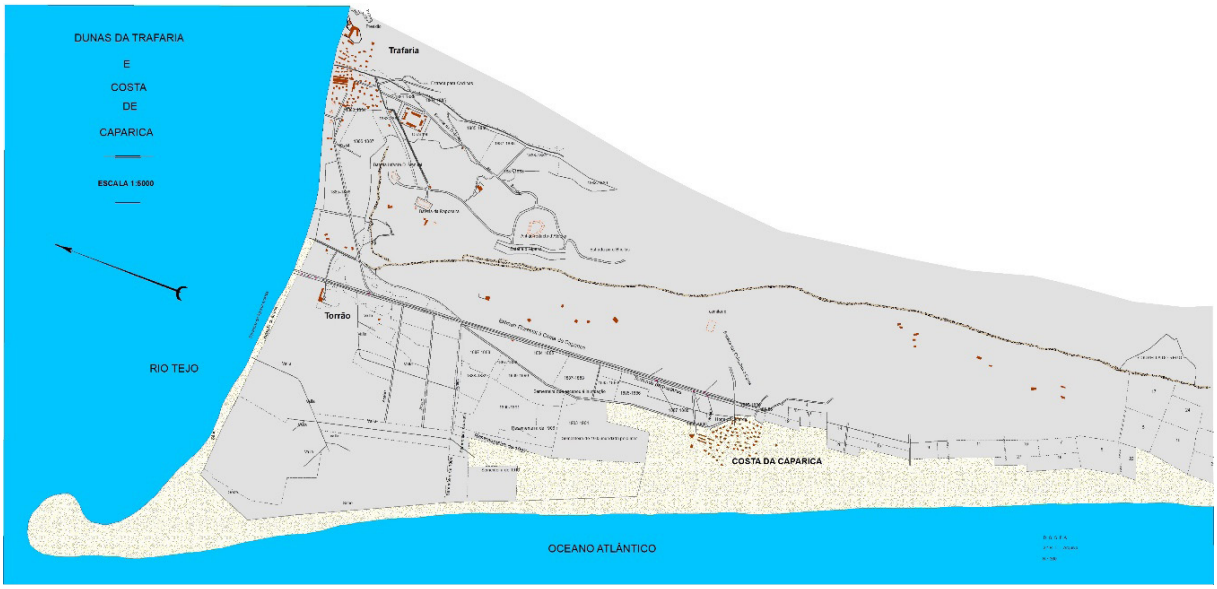

Figure 9. Dunes of Trafaria and Costa da Caparica (Adaptation from original by Dissanayake M. Ruwan Sampath. Source: Archive from Instituto para a Conservação da Natureza e Florestas). Representation of the works made by the Forestry Services between 1884 and 1910. Reference to an area flooded by the ocean in 1905 [sementeira de 1905 inundada pelo mar] and areas where new sowings had to be done [resementeiras]. Notice the drainage systems [valla] and the fences [sébe] near the coastline to protect the plants.

vegetation seeding to fill the blanks in some areas. Meanwhile, the Forestry Services had built a frontal dune using a double fence (see Figure 9) made of pine branches, running North to South, parallel to the coastline, 80 m from the high tide mark. And, another one, up North, running East to West, to protect the plants from the sea, the sand and the winds (Mesquita, 1912; Almeida, 1912). The method had been proposed by the forester Mendes de Almeida, in 1905, to improve the efficacy of the plantings and reduce the afforestation costs. The Forestry Services staff was clearly conducting experiments, adapting foreign knowledge to local conditions and testing different strategies and species along the Portuguese coast. Mendes de Almeida applied in Costa da Caparica his learnings from Peniche, up north, where he combined practices used in Germany and Chile. He set to build a frontal dune to protect plants using pine branches hedges. The creation of a frontal dune – one of the first steps in dune afforestation according to the French and German methods – had been tried before, using a fence of wood planks, but the structure had been destroyed by the waves. The fences and plantations being so close to the ocean were often damaged by storms and overwashes (Figure 9). Sheltered by the frontal dune, Mendes de Almeida established smaller square areas – the German approach – where he seeded rye and pine (the rye was an influence from Chile) and planted pine, acacias, casuarinas and eucalyptus. There he tested different combinations of plant species and manure to find the most suited for Caparica (Almeida, 1912; Teixeira, 2016). Years later, in a plan of the port of Lisbon, done by Portuguese Naval Officers, it is still possible to see in Caparica some free mobile sands. But, the forest is already visible between Trafaria and what is now the S. João beach (Figure 10).

The dunes of Trafaria and Costa da Caparica were afforested in three different phases – from 1883 to 1896, 1903 to 1910 and 1926 to 1938 (Rego, 2001). The first two periods correspond to the times of the Monarchy, when the first attempts were made to stop the drifting sands. Between 1911 and 1926, the Republican regime kept the previous policy of afforestation, promoting interventions in many dune perimeters along the Portuguese coast. But, according to Rego (2001), there were no new plantations between 1911 and 1926 in the case-study area. One hypothesis is that they were not needed and only maintenance was done. Other, quite plausible, is that in the turmoil of the Republican revolution, political instability, bankruptcy and the Great War, dunes were a minor issue. After 1926, the Portuguese Dictatorship, known as *Estado Novo*, made a big investment in what the authorities considered to be a highly relevant economic task: finishing dune fixing. The *Estado Novo* propaganda transformed it into a huge national campaign: the terrible danger of the moving sands had to be stopped (Secretariado Propaganda Nacional, 1941a). The official speech put it as a way of preventing the silting of rivers and harbours, the protection of fertile fields and the rending of new areas to agriculture. But, this had also a political meaning, the dictatorship was presenting itself as a paternalist institution taking care of the welfare of its people (Secretariado Propaganda Nacional, 1941b). And, it was a manner for the regime to consolidate its power over the territory, resources, local authorities and communities (Freitas, 2004). The expansion of the afforestation works to the South of Costa da Caparica, in mid-20th century, was part of this scheme (Figure 11). The Afforestation Development Plan (*Plano de Povoamento Florestal*, 1939), did not include Caparica. This may mean that no further interventions were needed in this coast and from then on it was only necessary to ensure the maintenance of the existing forest.

3.4. Solving health issues: desiccating the wetlands

The afforestation of the dunes of Costa da Caparica had another aim beside the stabilization of the sands. The task was also a public health and disease control issue. The wetlands around the village of Costa promoted the proliferation of mosquitos, responsible for fevers (known as "sezões") that made casualties among the local population. These wetlands were quite common in sandspits and dunes areas. Here sea flooding was recurrent, invading the village and the adjacent fields (*Diário de Notícias*, 1885-02-14; 1895-02-12; 1905-12-29; 1910-12-12; 1912-02-03). At the time, doctors and authorities associated stagnant waters to endemic diseases and many efforts were done to desiccate and drain marshy areas considered dangerous and worthless (Morera, 2012; Sousa, 2009). It was not known then that the mosquitos were the spreading vectors of the pathogens. Andrada e Silva (1815), for instance, attributed the dissemination of some illnesses to deforestation and the lack of vegetation to absorb the malign waters and the bad odours associated to them. The miasmas were considered to be the carriers of the diseases and trees believed to purify air and eliminate them.

The decades of 1850-60 were particularly rainy in Portugal (Melo, 2017). This led to floods and water accumulation in the lowlands, that during warm season held the optimum conditions to the development of mosquitos. Those were years of famine and sickness as the crops were destroyed by the rain

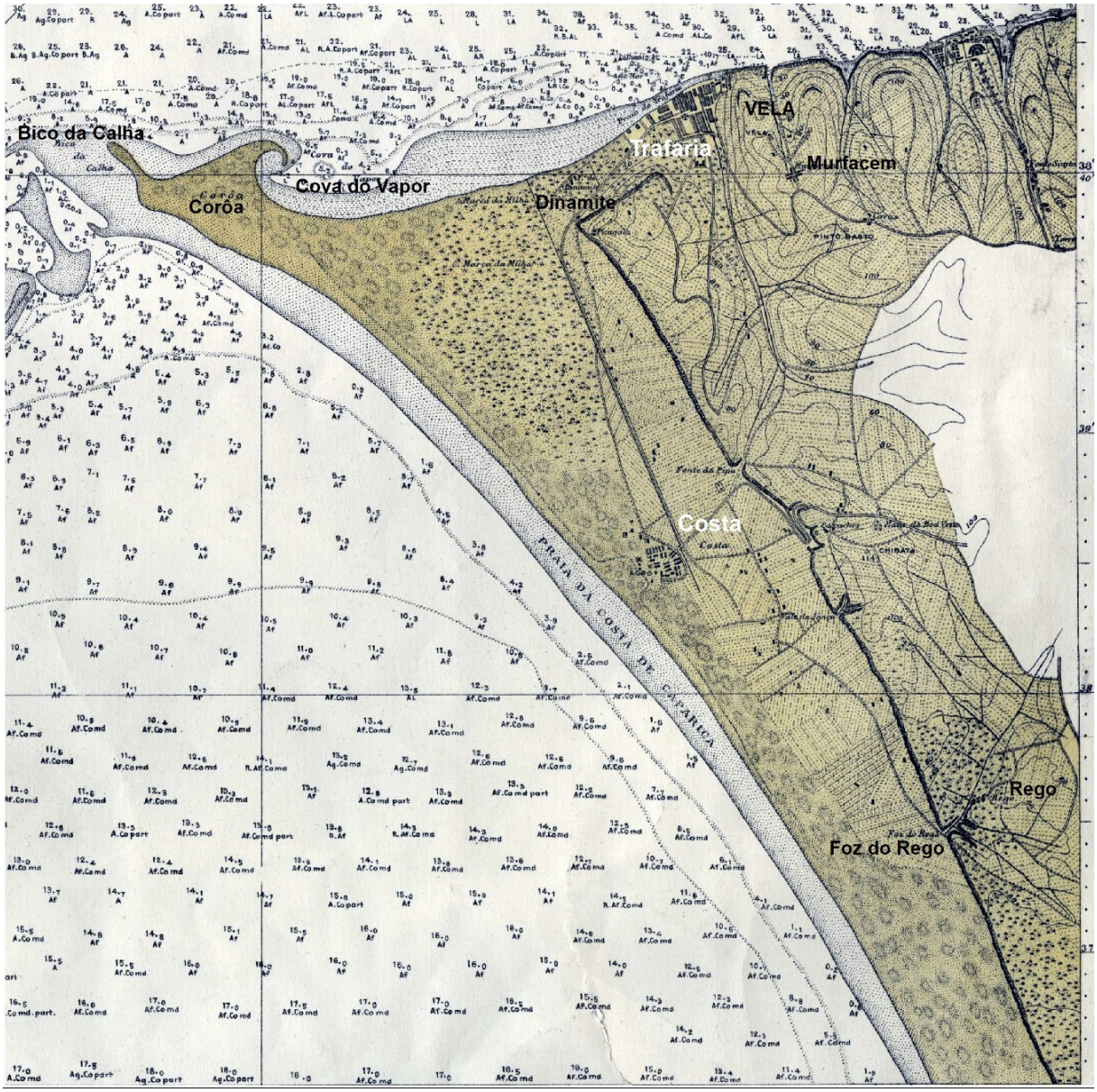

Figure 10. Detail of the Hydrographic plan of the port of Lisbon, made by the Officers of the Hydrographic Mission for the Portuguese Coast, in 1929 (Source: Biblioteca Nacional de Portugal). The plan shows the dunes, the afforestated area and the drainage system. No wetlands are represented. They seem to have been converted into agricultural fields.

and floods and, malnourished bodies were more susceptible to infirmities. Authorities tried to solve this calamity by passing the 1867 Law, that allowed the State to undertake wetlands drainage, for safeguarding public health. The afforestation of coastal areas and river plains (e.g., Tagus and Mondego) was also connected to this (Melo, 2017). The interventions at the dunes of Costa da Caparica were part of a bigger project to improve those lands, which included the drainage of the wetlands with the purpose of transforming that "insalubrious place in an appraise location with good health conditions" (*Diário de Notícias*, 1882-06-06). Mendia's report in 1882 set the plan to desiccate the Juncal marshes by building a network of ditches to drain the water directly into the Tagus River (*Diário de Notícias*, 1882-08-31). The selling of the coastal area of Caparica is also connected to this. The government was building the drainage ditches under the 1867 Law, so the Municipality

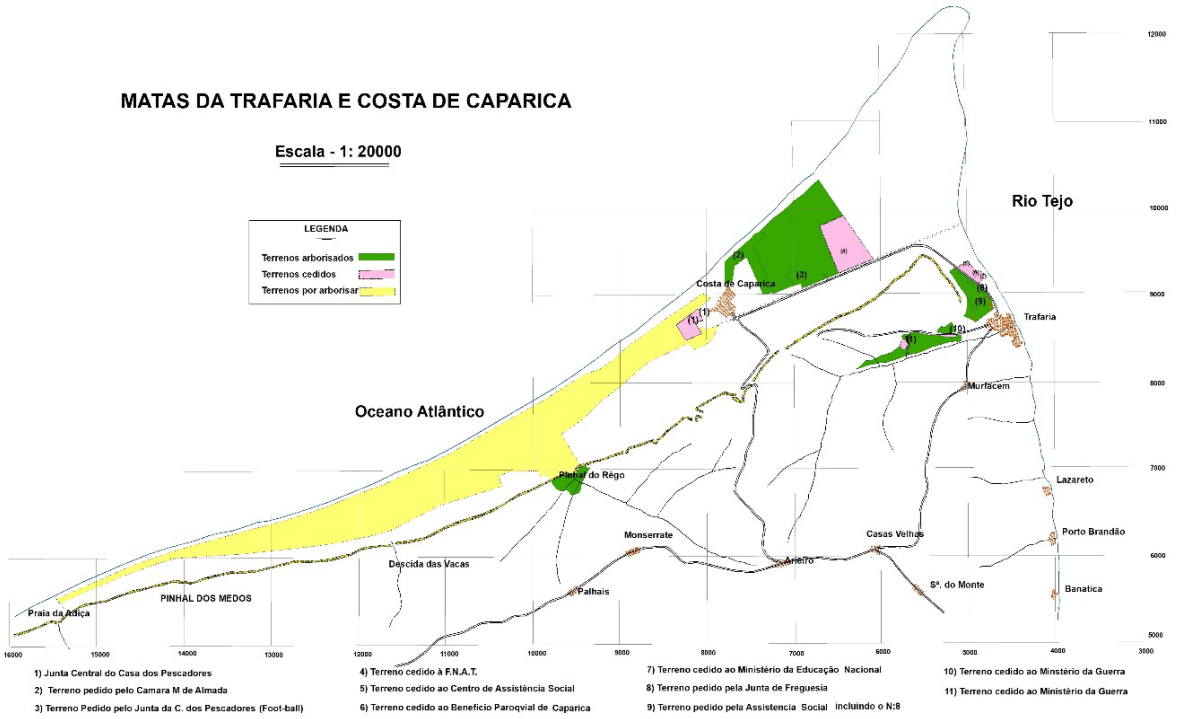

Figure 11. Forests of Trafaria and Costa da Caparica in the 1930s-1940s (Adaptation from the original by Dissanayake M. Ruwan Sampath. Source: Archive of Instituto para a Conservação da Natureza e Florestas). In green, the existing forests. In pink, the Forestry Services areas given to other institutions or services for public uses (the list can be seen below). In yellow, the dunes to be afforested.

of Almada got rid of those valueless lands passing to central authorities the responsibility for their improvement (Termo do contrato, 2013). The drainage works started in 1883 under the coordination of the Commission for Sanitary Improvements [Junta dos Melhoramentos Sanitários]. Two years later, they prove their efficacy when, during a storm, the sea waves invaded the village and the water run off through the existing channel (*Diário de Notícias*, 1885-02-14). According to Viana (1885), the engineering works were complemented with the planting of eucalyptus and acacias (Figure 12).

In 1923, the writer Raúl Brandão (1923) driving on the road from Trafaria to Costa da Caparica described the small pines and the water ditches furrowing the large plain. By then the forest and the drainage system had become part of the landscape. These were key-elements of late-19th /early-20th century strategic ideas for the coast. They were not the result of a linear structured plan, but more of a series of events, product of the agency of different actors, powers and institutions, driven by the firm believe that dunes and wetlands were of no value and improvements should be made for the common good.

3.5. Management paradigms: ruling the unruliness

The end of the 19th/mid-20th century was also the time when sea bathing for therapeutic (and later, leisure) reasons started spreading in Portugal, changing the way coasts were thought and bringing new uses and values to the seashore. Due to its location, the cheap boat trips between Lisboa and Trafaria, the health issues solved and the pine forest embellishing the place, Caparica become a much sought seaside resort. The paradisiacal image of this beach, mentioned earlier, had much to do with the drainage of the wetlands and control of the drifting sands. These would also be the ground for development as, over the years, houses, buildings and economic activities grew on the beach and dunes. The public forest of Costa da Caparica was such an attraction that several institutions asked the government for permission to install holiday resorts and nursing homes, following the example of FNAT's vacation camp (Gröer, 2004-2005), in 1938 (see Figure 11). Even before the Tagus River bridge, in the 1960s, illegal constructions, camping parks and leisure resorts, built on the dunes and green areas, start packing this coast (Figure 13). The pressure on those ecosystems increased with more buildings, new accesses, clearings and

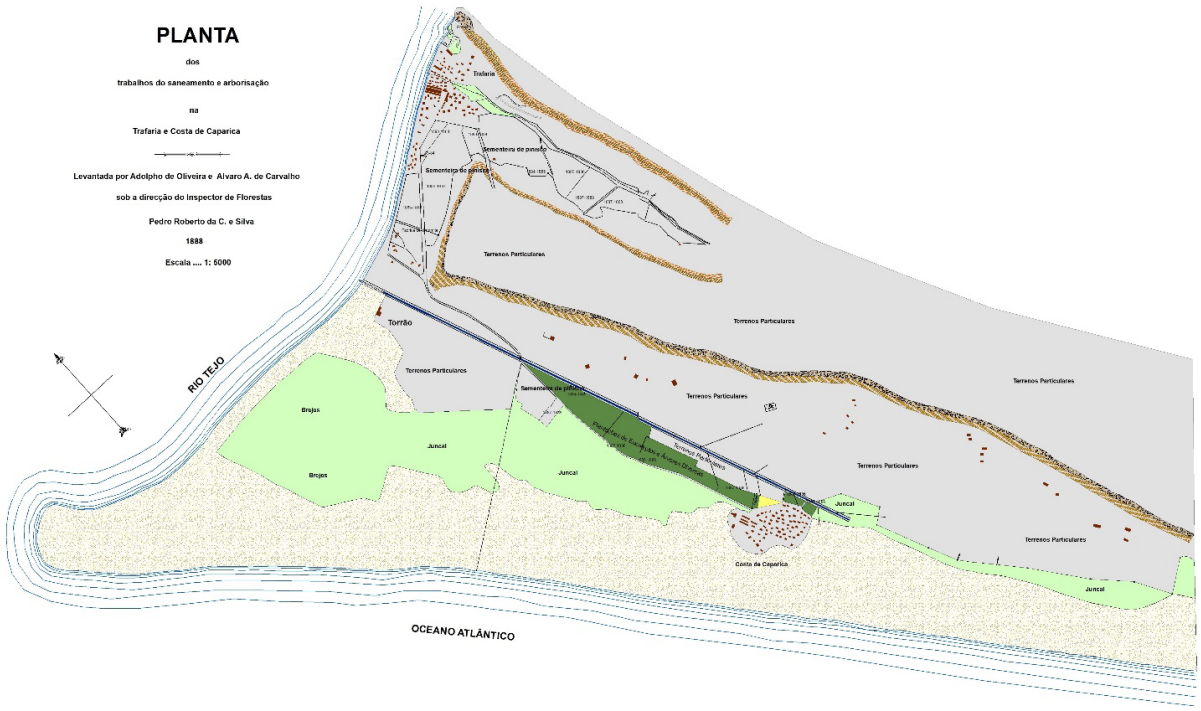

Figure 12. Plan for the drainage and afforestation works in Trafaria and Costa da Caparica, made by Adolpho de Oliveira and Álvaro de Carvalho, under the direction of the Forest Inspector Pedro Roberto de C. e Silva, 1888 (Adaptation from original by Dissanayake M. Ruwan Sampath. Source: Archive Instituto para a Conservação da Natureza e Florestas). The wetlands are the ones named "Juncal" and "Brejos". The drainage ditch runs from Costa da Caparica to the Tagus river. The sowings in the dunes are mentioned as "sementeira de penisco". Eucaliptus and some other trees were planted near the ditch [plantações de eucalyptus e árvores diversas]. Private lands are referred as "terrenos particulares".

unruly car parking, after the bridge was built (Duarte e Lamas, 1978). Along the maritime front, from S. João to Fonte da Telha, urbanization extended in size and height (Pires *et al*., 2017). Meanwhile, another phenomenon was putting more tension upon this territory: from the 1950s onwards, coastal erosion became a major problem (Pinto *et al*., 2007). This coast was always a prone sea flooding area, but the diminishing of the sedimentary budget to the shore associated with urban growth in such highly dynamic system made human settings extremely vulnerable.

The issue was then the lack of sand. When the population saw it disappearing from the beach in S. João, they turned to the dunes for a protective barrier. Many worried that even these could not hold the sea and the local newspaper *Praia do Sol* (1953-02-15; 1953-04-15) asked for some faith in the works of the Forestry Services, which had been reinforcing the dunes (the ones mentioned by Matias's friends). However, from Cova do Vapor to Costa da Caparica village, during high tide, the waters often overwashed the dunes and invaded the woodlands and the FNAT's installations (Marés-cheias, 2006 [1957]). In 1957, a group representing local elites and authorities paid a visit the Public Works Minister to pressure him to find a solution for the problem of the dunes (*Praia do Sol*, 1957-06-01; *Diário do Governo*, 1957-08-06). Just after, the Forestry Services built a second frontal dune near FNAT to defend the vacation camp (*Praia do Sol*, 1957-10-15). Nevertheless, in December 1958, S. João beach almost disappeared, with the sea water reaching the forest (Freire, 1986). The dune breeches were filled later, but the main response - following coastal management practices at the time - was to invest in hard engineering structures: the groynes and the seawall that still exist today. In the 1960s, *Praia do Sol* (1967-04-01) published an article saying "we need more stone": stone to build a barrier against the sea that each year is taking more sand from the beach. Later, the newspaper appraised those protection works, considering the groynes and the seawall an attraction for recreational fishing and for allowing people to bring their cars closer to the beach, through the parallel road that it was going to be build. The seawall, it stated, would help Costa da Caparica to keep up with progress. It was believed that the huge stones being unloaded at the moment would stall out the dangers of the ocean and that the sand would return to the beach (*Praia do Sol*, 1971-09-11).

Figure 13. Representation of the dunes of Trafaria and Costa da Caparica in the Military Chart of Portugal, probably in the 1960s (Adaptation from the original by Dissanayake M. Ruwan Sampath. Source: Archive of Instituto de Conservação da Natureza e Florestas). This representation shows the afforested areas in this region and the urban growth in the coast, specially near the town of Costa da Caparica.

In spite of the severe coastal erosion and the degraded dunes, Costa da Caparica was a vital recreational area for the Lisbon's population. The economic value of this coast increased exponentially in late-20th century. This is absolutely clear in a letter circulating within the Forestry Services about the interest of the Municipality of Almada in getting back the dunes sold in 1883. "A century ago, when the sell was made, those beaches had no one and the sand worth nothing" (Ramos, 1981). But, meanwhile, the situation had changed and the touristic pressure was huge. The Municipality wanted to recover the land between INATEL (old FNAT) and Ribeira do Rego, to set hotels, restaurants, pools and sports infrastructures. From Ribeira do Rego to Fonte da Telha, on the other hand, the idea was to put a halt to the dunes and forest's degradation, leaving the area for the ones who were looking for a closer contact with nature (Ramos, 1981).

In mid-20th century, increasing urban development and protect it were the chosen options and they still define the present

managing policies, since the safeguard of the built area has to be maintained. Like Hodder (2012) pointed, there is an "unwillingness to abandon a path of action if a great deal has been invested in it, even if future prospects are not good". Decisions are often taken based in past investments and humans tend to keep fixing things that go wrong within the existing entanglements. The costs of changing a particular route are normally considered prohibitive because of all the interlinked relationships and their domino effect. As such, the strategy at Caparica has been marked by successive emergency interventions, like the ones in the 2000s, which included groynes repairing and sand beach nourishments, to hold the destruction of infrastructures, rather than a long-term approach considering retreat (Schmidt *et al*., 2011).

Pinto *et al*. (2007, 2015) have shown how dynamic the evolution of this coastal stretch has been. Some of the intricate natural processes responsible for such morphological changes are still not very well known, especially because many direct and indirect human activities have contributed to make these coastal settings even more inextricable and unpredictable, by multiplying the unexpected spin offs. Societies are often thought as coherent units changing and adapting through time in an orderly way. But, what a long-term approach reveal is that there is a large degree of uncertainty and contingency even within the same human group, so responses are always "provisional, worked out in practice, temporary and partial" (Hodder, 2012: 110). For this reason, it is possible to find examples of different and contradictory ways of dealing with coastal issues along the years, but also within the same time and society. For instance, the sand mining in Torrão/Trafaria, in the 1950s, and dredging in Cova do Vapor, in the 1990s, while groynes were being built to safeguard the adjacent beaches (Freire, 1986: 29; Delicado *et al*., 2012). The approval of new concessions for setting camping parks on the dunes (*Diário do Governo*, 1962-03-02) when a few years earlier 60 houses were removed from the shore by their owners to avoid being damaged by the sea (As marés-cheias, 2006 [1957]). The intensification of urban settlement upon a shore, in the 1990s (Pires *et al*., 2012: 286), when the same was being affected by coastal erosion. The implementation of an urban management plan (Programa Polis), in the 2000s, to deal with the maritime front problems, which did not take into consideration future climate change scenarios (Schmidt *et al*., 2011). And, the recent decision of the Municipality of Almada, the institution supporting dune rehabilitation in S. João, to build a highly contested road parallel to the sands, in Fonte da Telha (Moutinho e Pescada, 2020).

What was said makes clear that thinking, planning, managing and solving problems are always historical and specific, depending on the environmental conditions, the tools that can be used, the knowledge and skills that are held, the available financial and human resources, the social relationships, the balance between powers, laws and wills, and the mental structures of each society within its own time (Hodder, 2012; Pires *et al*., 2012). This is why human activities should not be reduced to their materialities – dams, groynes, dredgings and beach nourishments -, but need to be put into their right context.

4. CONCLUSIONS

Sand is a key piece to understand the evolution of Costa da Caparica. The strategies for sand dunes management are connected to perceptions and political and economic interests regarding the coast. Today, as in the past, the interventions in the dunes have to do with the protection of assets. But, before, dunes were considered a danger from which human property had to be protected. Now, dunes have a value of their own for the ecosystem services they provide. They are being watch over to secure humans and their properties on the shore.

In the case of Costa da Caparica stabilizing the dunes and draining the wetlands was the way to reduce damages and turn worthless things into profitable lands. Later, ideas about the shore changed, the beach and the afforested dunes become appraisable healthy places and people started visiting and building on them. So, when coastal erosion menaced one of Lisbon's favorite seaside resorts, dunes turned into valuable natural barriers against the sea. But, since they could not hold it, armoring the coast was the next step. The optimistic believe in groynes and seawalls is, however, disappearing as their maintenance has shown to be an endless task. Setting hard engineering structures is not the predominant option anymore and "building with nature" techniques, like sand beach nourishment and dune rehabilitation (ReDuna project), are being implemented. But, since the main problem is the lack of sand, dune recovery is not effective if the littoral sedimentary budget is not assured (and it is not) and human settling is not properly fit to this highly dynamic environment. So, it is clear that this is not the solution also, only a way of buying time. The fact is that there aren't definitive fixing solutions for the littoral, as nothing is or should be fixed in an ephemeral territory.

This paper shows that dune intervention is driven by believes, intentions, powers, politics, money, emotions, knowledge and

creativity. Things that are as fluid as the coasts themselves, changing through the years, across societies and within the same society and time. This means that coastal management is not about ruling coasts, but making decisions about individual and collective behavior concerning beaches and dunes. So, any long-term adaptation plans for these environments have to consider not only the natural processes, but also the socio-political pressures, the historical and cultural contexts, the discrepancies, the aims and the cravings for the future. In other words, humans in all their complexity.

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