

COASTAL GEOMORPHOLOGICAL AND ENVIRONMENTAL CHANGES AS DRIVERS OF HISTORICAL SHIFTS IN MARITIME ACTIVITIES

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Two leagues north from the village of Pederneira lay a big and well-suited port for fishing and trade; the King [D. Dinis] did not wish it to be empty and useless [...] and issued a settlement permit for thirty inhabitants, who would have six fishing caravels and hunt [...] This village, called Paredes, kept growing and growing until the time of King D. Manuel, when neighboring sands carried by the winds coming from all directions covered the houses and silted the port in such a way that it became uninhabited [...] This way does the weather change and, with it, all things, even ruining villages.

Francisco Brandão (1650)

1. INTRODUCTION: GEOMORPHOLOGICAL SETTINGS AND HISTORICAL CHANGES

Humans have been taking advantage of shores' natural features for millennia, but just a small proportion of the coast offered safe harbour conditions¹. There are several factors for humans to settle in coastal areas, but the most important is the relationship

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¹ GILLIS, 2012.

with the surrounding marine and coastal environment, both in terms of accessibility, transport and defence, and exploitation and trading of marine resources. Shores are, and always have been, important frontiers, and places of contacts and interactions. Consequently, changes in the coastline dynamics did influence both communities and activities dependent on the sea and shores². And particularly rapid changes did happen in these sandy coasts, which were highly dynamic in time and space.

In mainland Portugal, over time, several villages were settled and developed in distinct coastal settings, such as estuaries, lagoons and sheltered bays. The central coastal region of Portugal has been a very important one since ancient times. Here, *Eburobritium* (Óbidos) connected to the mouth of old Pederneira lagoon, as the capital of a large territory with strong relevance to local and Lusitanian trade, both through land and sea routes. This region connected *Collipo* (Leiria) in the north to *Olisipo* (Lisbon) in the south³. These towns and many others were, since the beginning of the Portuguese nation to the 16th century, part of the Estremadura port system, ranging exactly from Pederneira in the north to Atouguia in the south⁴. These small urban centres benefitted, from its establishment, of privileged natural conditions to develop and expand as fishing and trading villages. They were geographically safe in a nearshore hinterland, with a navigable water body that allowed a quick contact between sea and land⁵.

But, during the last millennium, the expansion of agriculture and deforestation, using technological innovations, motivated an increasingly significant impact of human activities in the coastal zone, from the 15th century onwards⁶. Several studies conducted in alluvial plains and estuaries along the Portuguese coast established a correlation between the sedimentary record, geomorphology and environmental changes⁷. These rapid changes overtime in the maritime areas due to geomorphological, environmental and human factors are well-documented for Portugal, commonly mentioned in written historical sources⁸ and easily verified through cartographical analysis⁹. Between the 14th and 16th centuries, several locations in the Portuguese west coast suffered from a fast silting process and, consequently, coastal lagoons and estuaries had reduced in area or, in some cases, completely disappeared¹⁰: «The kingdom's inlets are suffering major damages due to the sands of the rivers that flow into them».

² BLOT, 2003.

³ GRAÇA, 2013.

⁴ RIBEIRO, 1977.

⁵ BLOT, 2003.

⁶ DINIS *et al.*, 2006.

⁷ *E.g.* BAO *et al.*, 1999; BOSKI *et al.*, 2002; FREITAS *et al.*, 2002; RAMOS-PEREIRA *et al.*, 2002; HENRIQUES *et al.*, 2002; DRAGO *et al.*, 2004; DIAS, 2009; RAMOS-PEREIRA *et al.*, 2011.

⁸ *E.g.* BRANDÃO, 1650.

⁹ CORTESÃO & MOTA, 1987.

¹⁰ BRANDÃO, 1650.

These coastal areas — estuaries, estuarine-lagoonal systems or coastal lagoons — previously navigable and home to large numbers of boats, and very important for the local and national economy, became silted and unable to function as seaports. Several coastal complexes of small seaports in the west coast of Portugal are a good example of this¹¹. This fact led historically to changes in locations and activities of maritime communities. These communities, despite being active actors with impact over coastal ecosystems and resources, have sometimes also been able to adapt to environmental changes. Adaptations included the creation of new village locations and displacement of typical coastal villages to nearby areas, in a short time-frame, as well as long-time changes in local activities, from medieval to modern times. Typically, these are areas of temporal continuity, and geological and environmental discontinuity, in the accessibility to the sea front and transformation of port activities¹².

Both in Pederneira (Nazaré) and Atouguia (Peniche), a quick process of silting occurred since medieval to early modern times. Pederneira changed from a river/estuary system to an estuary/lagoon and became totally disconnected from the sea (a flooding flat land can still be identified)¹³. Atouguia became an inland village with the modification of its large estuary into a sand peninsula (or tombolo) connecting the island of Peniche to mainland. Moreover, Pederneira was historically favoured by the existence of this lagoon, which had been for years connected to the sea, being fishing both in the lagoon and in the coastal adjacent marine area very important to the villagers and the Alcobça Monastery¹⁴. Whaling is also documented in the region¹⁵, as discussed below. Atouguia da Baleia, since its setting as a village, paid duties and taxes on its local fisheries¹⁶. Its charter, dated from 1206, contains a detailed description of taxes to be paid on goods' transactions, including the trade of whale products (meat and fat). Whale products were by then set apart from other fisheries, as they were a much highly valued merchandise¹⁷.

Some of these geomorphological changes have been reported in the literature¹⁸, archaeology studies¹⁹, and in cartographic analysis²⁰. However, similar studies to the current one are not very common for the Portuguese coastline, even though Polónia analysed the history of Vila do Conde port system also in the perspective of its

¹¹ *E.g.* BLOT, 2003; FREITAS & ANDRADE, 2005.

¹² BLOT, 2003.

¹³ LOPES *et al.*, 2013.

¹⁴ GUINCHO, 2013.

¹⁵ GONÇALVES, 1989.

¹⁶ CALADO, 1994; PEREIRA, 2006.

¹⁷ TEIXEIRA *et al.*, 2014.

¹⁸ *E.g.* BLOT, 2003; GUINCHO, 2013.

¹⁹ *E.g.* ALVES *et al.*, 1989; MOREIRA, 2002; ALARCÃO, 2010.

²⁰ *E.g.* DIAS & BASTOS, 2017.

geomorphological evolution²¹. Some research about the formation and development of the tombolo that converted the ancient island of Peniche into a peninsula has also been published²². However, an integrated approach to relate geomorphological and environmental changes with shifts in human activities and practices is yet to be fully addressed.

Our main goal is to document the geomorphologic evolution of Pederneira (Nazaré) and Atouguia da Baleia (Peniche) coastlines, located in the central coast of mainland Portugal (Fig. 1). The analysis spans from medieval to modern times (ranging from the 12th to the 18th century) and is based on written sources and cartographic evidence. This study relies on a review of published and unpublished bibliography related to recent historical changes in the Portuguese landscape and its geomorphological characterization. First, we aim at showing visually the modifications operated in the coastline over the centuries. Second, we aim at addressing changes in maritime activities, such as fishing, whaling and trading, which occurred as a consequence of these short-term environmental changes.



Fig. 1. Map of Portugal, showing the study area with present day geographical locations of the mentioned villages

²¹ POLÓNIA, 1999; POLÓNIA, 2017.

²² E.g. DIAS & BASTOS, 2017.

2. PEDERNEIRA AND ATOUGUIA FROM THE HISTORICAL CARTOGRAPHY VIEWPOINT

We intended to further document and discuss the geomorphological changes in Pederneira (Nazaré) and Atouguia da Baleia (Peniche) as they appear in the cartography of Portugal's mainland from the 16th to the 18th centuries. With that purpose, we analysed over 50 cartographic elements and from a list of selected maps we chose three maps to be georeferenced and to perform a GIS analysis (see Table I in Annex 1).

Three criteria were used to select the maps that represent the shoreline for each century: (1) sufficient topographic details of the coast (in this case, at least the Peniche tombolo formation and the Pederneira lagoon features should be portrayed); (2) maps displaying approximately N45W Peniche-Nazaré coastal angle, a ridged geomorphological feature; (3) highest possible spatial resolution obtained through the available digitalization. To analyse the coastal changes between time periods, historical maps were georeferenced (ETRS89-TM06 datum), using about 10 control points (features with no or few morphological variations along the last 500 years, such as administrative boundaries, landscape and architecture points), vectorised and compared the present coastline with the one in Portuguese cartography²³ (Fig. 2).

This analysis allowed a qualitative interpretation of the shoreline. Coastal features have been addressed and interpreted as independent parts given that a morphological resemblance between the same features in the cartography from different centuries is almost indistinguishable (Fig. 2). Generally, it seems that historical maps for Portugal made by Portuguese authors present a higher level of detail and accuracy than maps produced by other European cartographers, independently of the map-making intention. In addition, a positive evolution towards more complete maps is expectable along the centuries, featuring more detailed coastal morphologies. But, right on the contrary, the most detailed coastal map dates from the 17th century, although the toponymy is not fully correct. This can bias the interpretation, as it cannot be distinguished whether the map representation is due to a reduction in its detail or a representation of the silting up process of coastal lowlands as a consequence of sea-level rise deceleration²⁴. Moreover, the coastline between S. Martinho do Porto and Pederneira is over-represented in the 18th-century map, showing incongruences with the geological record and the written sources, as stated above, and also when compared to other maps from that period. Different maps, however, do show the different coastal features in terms of its temporal and local changes that may eventually represent the geomorphological and environmental historical modification (Figs. 3 and 4). But again, they do not offer sufficient quality to be analysed using GIS. Thus, in future approaches, a comprehensive study of the evolution

²³ CAOP, 2015.

²⁴ E.g. BAO *et al.*, 1999; DINIS *et al.*, 2006.

of these historical maps and its features' reconstruction should be considered. Further analysis should also comprise the design of the map and its purpose, with a high level of detail given to individual features. For our purpose, however, it is possible to conduct a qualitative interpretation of the historical cartography in comparison to present day geography and aerial photography information (Fig. 5 and Annex 3).

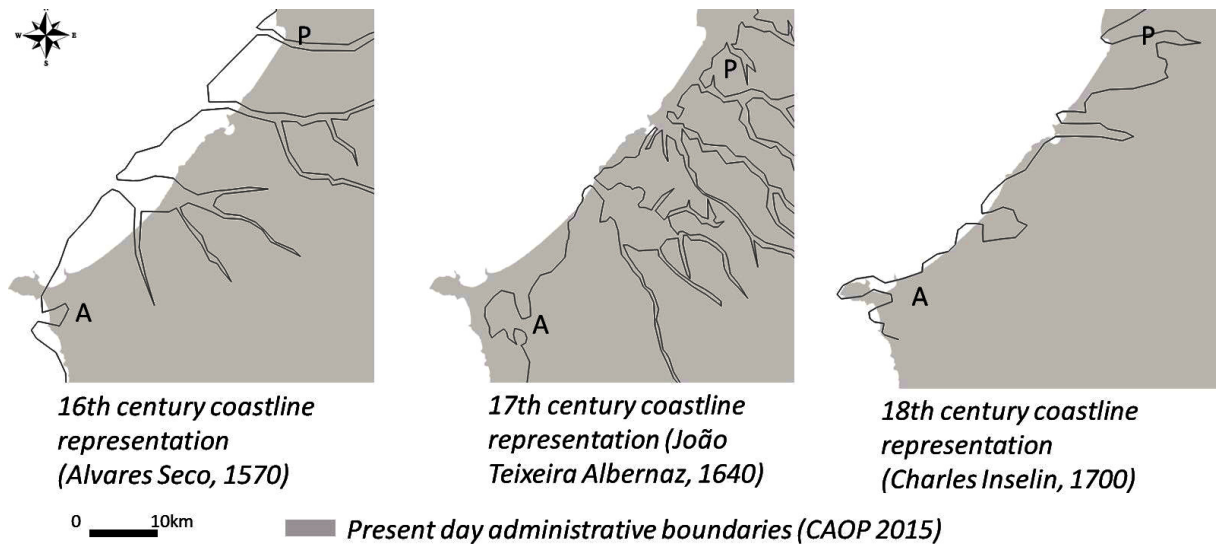


Fig. 2. Coastline comparison showing cartographic representations from the 16th to the 18th century (see Annex 1): (A) Atouguia da Baleia estuary and (P) Pederneira lagoon in the past



Fig. 3. The coast of Pederneira (Nazaré) and Atouguia da Baleia (Peniche) in the 16th century, shown as a detail from Alvares Seco's map (see Annex 1 and 2)

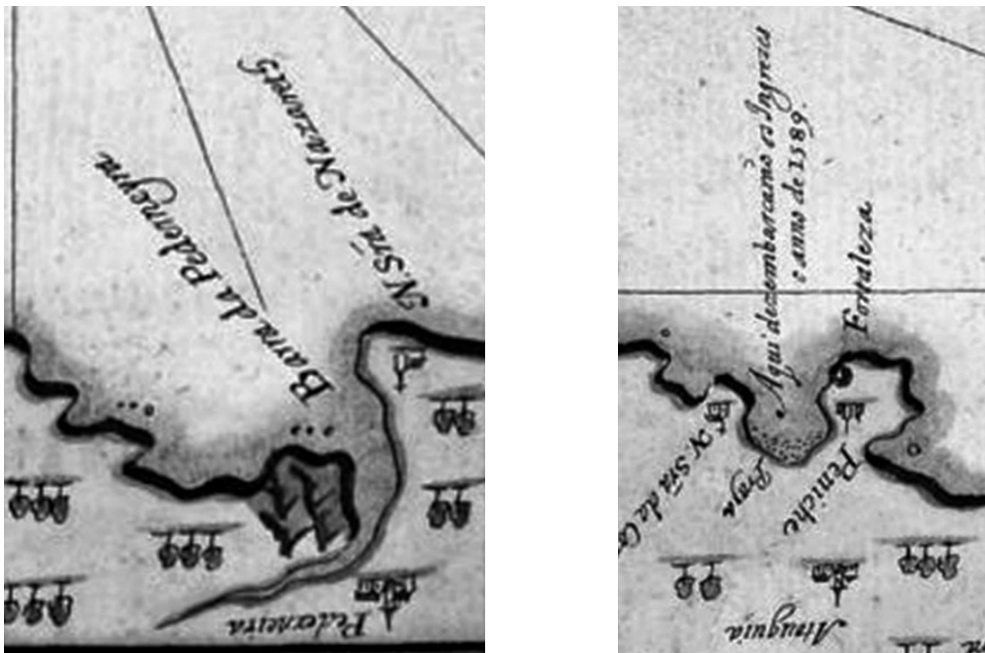


Fig. 4. The coast of Pederneira (Nazaré) and Atougua da Baleia (Peniche) in the 17th century, shown as a detail of João Albernaz Teixeira's map (see Annex 1)



Fig. 5. The coast of Nazaré and Peniche in current days; images from Google Maps

3. MEDIEVAL AND EARLY MODERN ESTABLISHMENT AND REPLACEMENT OF MARITIME ACTIVITIES

Medieval port systems in Portugal were places of great vitality, with large populations and a variety of crafts and activities related to fishing, whaling and salt exploitation²⁵, as well as maritime transport and trade. Different types of coastal related activities

²⁵ BASTOS, 2009.

have always been developed along the Portuguese shoreline. The fastest, safest and most efficient means of transportation of people and goods between the urban centres was by sea²⁶. Although the Iberian Peninsula had inherited a complex and efficient Roman road communication system, much of which was used during all Medieval Times and later, the importance of the fluvial and maritime communications is attested by all historical and archaeological evidence. Both Pederneira and Atouguia da Baleia are examples of such coastal areas; they were integrated in a vast littoral region connecting main kingdom castles and monasteries with small countryside and littoral villages²⁷. Here we will be discussing particularly whaling activities, their development and evolution in the referred coastal villages, also as a consequence of their coastal geomorphological changes.

According to Gonçalves, in medieval and early modern times, whales came frequently ashore in Pederneira coast and only dead whales were due to the Alcobaça Monastery²⁸. Castro mentioned, referring to the 13th century, that merchants were trading the black whale from Pederneira, alongside with other sea species²⁹. Also, villagers from Pederneira knew how to cut and salt a whale, and their sailors payed duties as whalers in the nearby royal whaling ground of Atouguia da Baleia («Baleal»)³⁰. At the end of the 12th century, the seaport of Atouguia da Baleia was very important to the Portuguese economy. For this region, we found in grey bibliography³¹ indications that during the 13th century, «whales came ashore and stranded so frequently that the right to the “sea spoils” included ship, boat or anything with its merchandise, or a whale and everything else the sea throws away». It is not evident, however, if an active hunting was taking place or only scavenging of dead whales coming ashore³². During the 14th century, while the whale’s hunting was developing in Atouguia, many fishermen and whalers also settled down in Baleal. By then, whaling was a common business, but most importantly it was a king’s business as the Portuguese crown would hold to itself all the rights of the whaling in its coast — «royal whaling». For instance, during the 14th century, the king ordered the payment of a convent’s debt with the incomes «*from the whale’s oil and other parts processed in Salir and Atouguia seaports*»³³. Whaling in Atouguia was rather important and the fishermen had a royal decree issuing the cancellation of the previously paid tax, together with the right not to serve on the royal whaling. Another indicator of this activity economic growth, and of its value, is that all royal rights on Atouguia were given away except whaling rights, which remained in the hands of the crown.

²⁶ LOPES, 2018.

²⁷ MONTEIRO & PINHEIRO, 2011.

²⁸ GONÇALVES, 1989.

²⁹ CASTRO, 1966.

³⁰ GONÇALVES, 1989.

³¹ PEDROSA, 2000.

³² BRITO, 2011.

³³ BRITO, 2011; BRITO & JORDÃO, 2014.

Apparently by the mid-15th century, whaling was no longer an important activity because as stated for Baleal³⁴: «some houses were rebuilt over the last 30 to 40 years which are old ruined facilities previously used for whale's processing». It was said that by then, whales have gone far away from the coast³⁵, which means that the resource availability was decreasing³⁶. In the historiography, it is mentioned that the Portuguese maritime expansion from the mid-15th century onwards changed the kingdom interests to far ocean waters instead of coastal ones, as well as to the fauna and marine resources from the Atlantic islands and the African and Brazilian coasts³⁷. But this may have also been due to a local resources depletion or to the documented geomorphological changes in the coastlines (eventually changing nearshore whales' migration routes)³⁸.

Historically, Pederneira in Nazaré seems to be a case of discontinuity, where changes in local geomorphology also altered the conditions of accessibility, either by eliminating or strongly reducing previous settings. Atouguia da Baleia and Peniche, for their part, are a case of continuity, where the change in geomorphological and environmental conditions allowed for the transfer of maritime activities from one village to another one developing nearby³⁹. In both cases, however, fishing and whaling activities were displaced to nearby areas with the creation of new coastal villages (Figs. 3 and 4). In Peniche, for instance, archaeological remains attest the capture of whales up to the 17th century⁴⁰. It is not yet fully understood if historical whaling happened in Nazaré as a result of the activity displacement from Pederneira, or if it ceased completely. In modern times, coastal villages of Nazaré and Peniche (see Annex 3) are still important fishing towns, and since the early 20th century they became major places for summer recreation and beach use by local population and tourists. Pederneira and Atouguia da Baleia are nowadays small inland villages that suffered a modification in its main economic activities. We find almost no trace of their maritime past (fisheries) and economic activities are now supported on alluvial soils and sediments that have been filled due to the old water lines (agriculture).

4. DISCUSSION: THE LONG-TERM PERSPECTIVE

Both Pederneira and Atouguia da Baleia were very important medieval seaports, with a myriad of maritime activities taking place, ranging from commerce and salt exploitation to trade and fishing (including whale scavenging and whaling). We can only begin to understand local transformations, adaptations and activities if we bear in mind

³⁴ PEDROSA, 2000: 17.

³⁵ *E.g.* PEREIRA & RODRIGUES, 1906.

³⁶ BRITO, 2011; BRITO & JORDÃO, 2014.

³⁷ *E.g.* PEREIRA & RODRIGUES, 1906.

³⁸ BRITO & JORDÃO, 2014.

³⁹ BLOT, 2003.

⁴⁰ TEIXEIRA *et al.*, 2014.

that there was a long tradition of and a close relationship with maritime activities, much before medieval time. During the Middle Ages period and the beginning of the early modern age, the connection with interface areas such as lagoons or islands was rather important. Here, as in other Atlantic edges, we could find both seaboard and riverine populations that extended well back from the sea as far up river as the tides reached⁴¹. Small climate oscillations, ecosystem variations influencing resource availability and fisheries, demographic growth, deforestation related to increasing shipbuilding and agriculture needs, an increased technological capacity to change watercourses, and harbour improvements⁴², all contributed to local geomorphological changes. Thus, when known geomorphological features progressively disappeared — natural and human-induced phenomenon occurring very fast — it forced an adaptation to new accesses to the sea, including port structures and vessels, and also a shift to different commercial activities.

In the Late Middle Ages, trading and fishing alongshore intensified throughout Europe⁴³. By then, changes in land use, particularly the building of mill dams⁴⁴, alongside silting due to deforestation, and pollution of water caused by animal and human populations, altered the environment so deeply that Europeans turned from fresh to salt water for the supply of fish⁴⁵. These same impacts, which previously impacted riverine ecosystems, resulted in early modern changes in coastal morphology that once more would alter practices and uses of shorelines. As a consequence, a progressive disappearance of certain fishing and whaling activities in these seaports or their transfer to geographically nearshore new villages occurred⁴⁶.

Presently both Pederneira and Atouguia da Baleia are inland regions, with human communities mostly dependent on agriculture, apparently showing no visible memories of their past sea activities. In fact, when we look at these villages, we hardly associate them with old coastal settlements. In Nazaré, the regional Museum Dr. Joaquim Manso, dedicated to the culture of the sea, offers some information on the Pederneira lagoon. But its exhibitions about local maritime material and immaterial culture and traditions mostly refer to more recent times in the beach of Nazaré. And only a more curious or closer look will notice a lost reminiscence of past whaling traditions in Atouguia da Baleia, besides its toponomy. But visiting the Church of São Leonardo, where a whale bone lies leaning against a corner, or the Interpretation Centre that just opened in 2012 and where old whale bones are part of its assets, it is possible to grasp some pieces of its past environmental and cultural landscapes. These municipal institutions, nevertheless,

⁴¹ GILLIS, 2012.

⁴² DIAS *et al.*, 1997.

⁴³ AMORIM, 2004; GILLIS, 2012.

⁴⁴ *E.g.* POLÓNIA, 1999.

⁴⁵ GILLIS, 2012.

⁴⁶ BRITO, 2011; BRITO & JORDÃO, 2014.

may provide a chance for the local community to engage with its maritime past and reflect on its heritage and long forgotten traditions⁴⁷.

Today, their contemporary counterparts, i.e. nearby coastal towns with sea-related activities such as fishing and tourism, are, respectively, the villages of Nazaré and Peniche. Following the decay of Pederneira and Atouguia da Baleia, Nazaré and Peniche respectively began to develop with fishing and trading expanding since the 16th century up to the present day. Nowadays, Peniche's fishing port built in 1981 is the westernmost seaport of continental Europe and one of the largest in the country⁴⁸.

Since the early 20th century these fishing villages became also important recreational areas, with their beaches being populated by summer tourists besides fishermen and fishmongers⁴⁹. New experiences and uses of the shoreline emerged and new traditions started to characterize these coastal villages. Naturalist and impressionist painters, poets and writers began to show the Portuguese society all the romance and beauty in the appreciation of the shoreline and the sea, even if sometimes criticizing aspects of the environmental and landscape degradation⁵⁰. And just very recently, new opportunities arose from the sea with important socio-economic impacts in these coastal villages. The sea and waves' power of Nazaré and Peniche started to be seen as a potential important source for renewable energy production, with different devices being tested in the last decade. These are the same waves that fuel a whole new industry — surf — inscribing both towns in world circuits of sports and tourism⁵¹.

The human use of the coastal environment for commercial profit, leisure and sports, or simply for aesthetic appreciation, has always been edged by the negative impacts of these same activities. A paradoxical appropriation and interpretation of seascapes is shown by history and repeated throughout the times up to the present. Research in the oceans' humanities can be a strong contributor to inform current stakeholders and to help in the construction of local memories and the renovation of cultural heritage.

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⁴⁷ E.g. FERREIRA, 2012.

⁴⁸ INE, 2011.

⁴⁹ E.g. SANTOS, 2010.

⁵⁰ E.g. BRANDÃO, 1923.

⁵¹ *World surf league Peniche/Nazaré Challenge* 2016, 2016.

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ANNEX 1

Table 1. List of consulted historical maps and selected historical maps (highlighted in bold) forte cartographical analysis of the coast line

Cartographer	Title	Date / Place	Reference	Digital repository
Fernando Álvares Seco	Portugalliae que olim Lusitania	1560 Rome	Portugal National Library (CC-803-V)	http://purl.pt/5901/3/
Abraham Ortelius	<i>Regni hispaniae</i>	1603	Portugal National Library (CC-843-V)	http://purl.pt/3766/3/
Fernando Álvares Seco	<i>Portugalliae que olim Lusitania</i>	1606? Amsterdam	Portugal National Library (C.C. 812 V.)	http://purl.pt/3393/3/
Pedro Teixeira Albernaz	<i>Atlas</i>	1634	Albernaz (2002)	
Pedro Teixeira Albernaz	<i>Atlas</i>	1634	Albernaz (2002)	
João Teixeira Albernaz	Reino de Portugal	1640	Portugal National Library (il-239)	http://purl.pt/23505/2/
Joan Blaeu	<i>Regnorvm Hispaniæ nova descriptio</i>	1662 Amsterdam	The National Library of Scotland (EMW.X.017)	http://maps.nls.uk/atlas/blaeu-maior/browse/9/page/6
Joan Blaeu	<i>Portvgallia et Algarbia...</i>	1662 Amsterdam	The National Library of Scotland (EMW.X.017)	http://maps.nls.uk/atlas/blaeu-maior/browse/9/page/78
Danckerts Theodorum	<i>Novissima regnorum Portugalliae et Algarbiae descriptio</i>	1685-1727 Amsterdam	Portugal National Library (CC-1665-A)	http://purl.pt/3905/3/
Cornelis Danckerts II	<i>Nova et accurata tabula Hispaniae</i>	1687	Portugal National Library (cc-1214-a)	http://purl.pt/3711/3/
Père Placide Augustin & Charles Inselin	Le Portugal	1700	Portugal National Library (CC-1777-A)	http://purl.pt/3991/3/
Pedro Teixeira Albernaz	<i>Description del reyno de Portugal y de los reynos de Castilla</i>	1705-1716 Paris	Portugal National Library (cc-902-r)	http://purl.pt/16992
Johann Baptist Homann	<i>Regnum Portugalliae</i>	1736	Portugal National Library (CC-1383-a)	http://purl.pt/4078/3/

ANNEX 2



Fig. 6. 1570's Fernando Álvares Seco map of Portugal. Digital repository: <http://purl.pt/5901/3/>

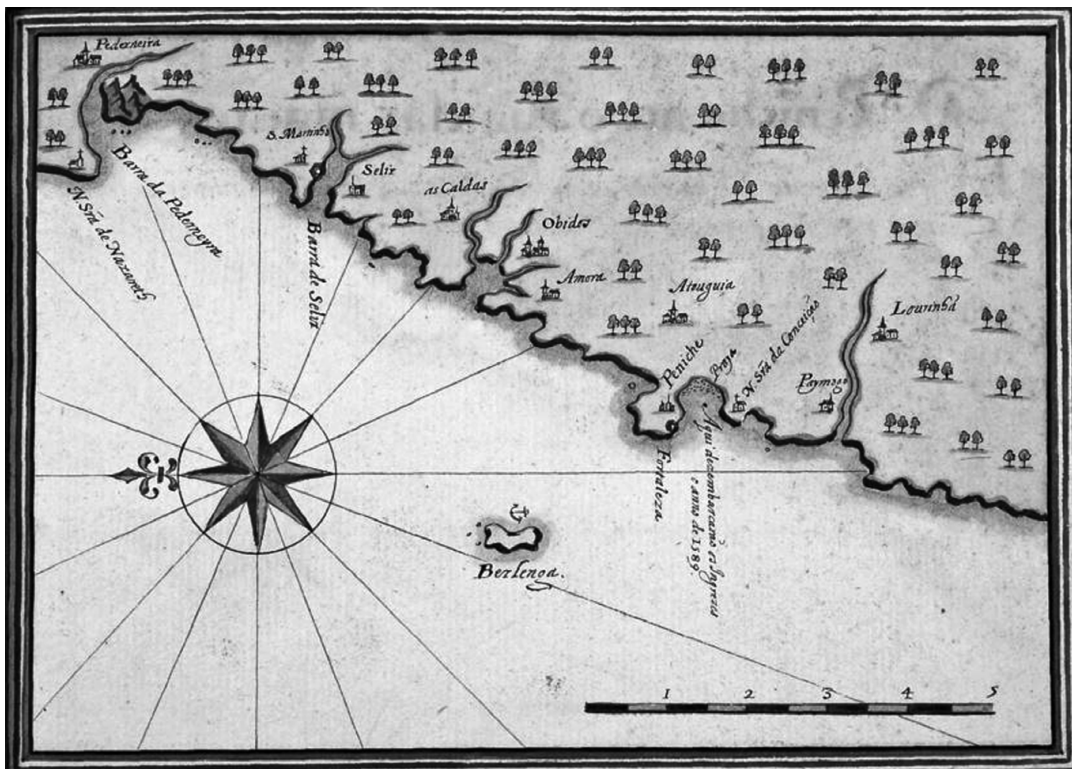


Fig. 7. 1648's João Albernaz Teixeira map, showing of a part of the West Portuguese coast

ANNEX 3



Fig. 8. Aerial photograph of current day Nazaré



Fig. 9. Aerial photographs of current day Peniche