CASE STUDY 3J – CORNOUAILLES, FR (Brittany)

Case Study Area: Cornouailles, Brittany, France

Main geomorphological types: Soft cliffs, dunes, sandy beaches and saltmarsh.

Main Coastal Change Processes: Coastal erosion, dunes instability, beach change.

Primary resources used: Art and archaeology.

Summary: The study area comprises extensive sandy beaches and dunes which are subject to erosion and instability. Numerous megalithic monuments, located along the tidal belt, provide evidence of sea level rise while artistic depictions have enabled us to see the rate and scale of coastal erosion over the last few decades.

Recommendations: Coastal managers should use these resources when predicting future rates of erosion, as they provide hundreds of years' worth of data to assist in the understanding of the rate of change. There is then an emergency in registering the natural and cultural heritage of all these threatened sites, as the physical protections could only slow the process but not really prevent the damage.

Coastal managers face an ongoing battle to moderate impacts from the sea in the face of a changing climate and pressures from human use of the coastal zone. The challenges that lie ahead are forecast to increase while resources are being forced to go further.

This case study report is part of the Arch-Manche project, which quantifies the value of under-used coastal indicators that can be applied as tools to inform long term patterns of coastal change. In addition, it provides instruments to communicate past change effectively, model areas under threat and interpret progressive coastal trends.

The Cornouailles area is one of four Brittany case study areas for the Arch-Manche project. This case study report introduces the study area and why it was chosen as part of the project. This report will mainly deal with the results of the art study, as no specific archaeological or palaeoenvironmental field work has been carried out during the project. However, as former field studies have provided data regarding coastal evolution in this area, the main results of such work will be mentioned. The analysis of these results and the potential for demonstrating the scale and rate of sea level change are then presented. Further details about the project methodology applied can be found in Section 2.

Within the Cornouailles area, the archaeological and palaeoenvironmental resource and the available art resource have been researched, scored and analysed. The extent of the detailed study areas are shown in Figure 3J1 below. The area considered for archaeology and palaeoenvironment has been selected to provide a representative range of types of evidence across a range of periods spanning from the Palaeolithic through to more modern coastal heritage. The art, photograph and map case study area encompasses a broader stretch of the coastline to reflect the various coastal morphologies and features which have been depicted over time.

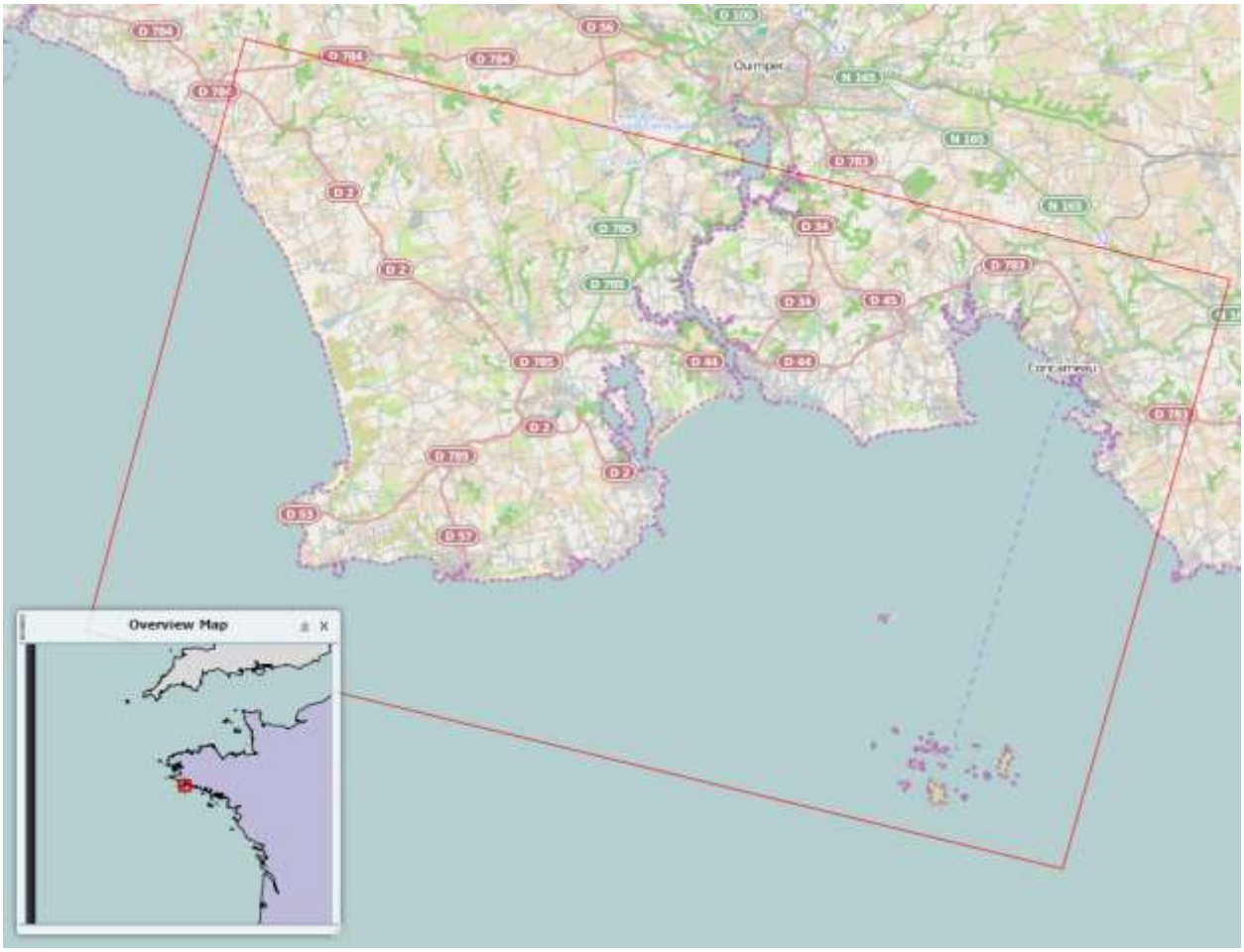

Figure 3J1. Map of the Cornouailles study area.

3J.1 Introduction to the Cornouailles study area

The Cornouilles case study area is located in south-west Brittany. It is bordered by the Atlantic Ocean to the west with the Audierne Bay and the Bay of Biscay to the south. Some islands are present, including the Glénan archipelago (about 22 islands and islets) and Moutons Island. It is part of the cultural area called "Pays Bigouden" which is an existing political and religious entity even today, where the economy and people's lives have a long association with the activities of the Sea. This economy evolved in the early 20th century, with the arrival of seaside tourism and in the years 1930-1950, especially in the Bay of Audierne with the birth of 'mass tourism'.

This region has interesting economic and historical assets, but also natural risks from coastal change. In recent centuries and decades the most usual response to protection of property and assets has been the construction of coastal sea walls and flood defences, especially in the exposed area of Penmarc'h and in the most settled and touristic towns (for example Bénodet, La Forêt Fouesnant and Lesconil. Coastal risk problems have often arisen because of a lack of co-ordination in the past between land use planning and development proposals.

3J.1.1 Geomorphology of the area

This section outlines the key geological and geomorphological features and processes within the study area. These factors have a significant impact on the on-going changes to the coastline

and associated sites, deposits and features preserved related to the archaeological and heritage resource, in addition to being depicted through a range of art sources.

Geological History

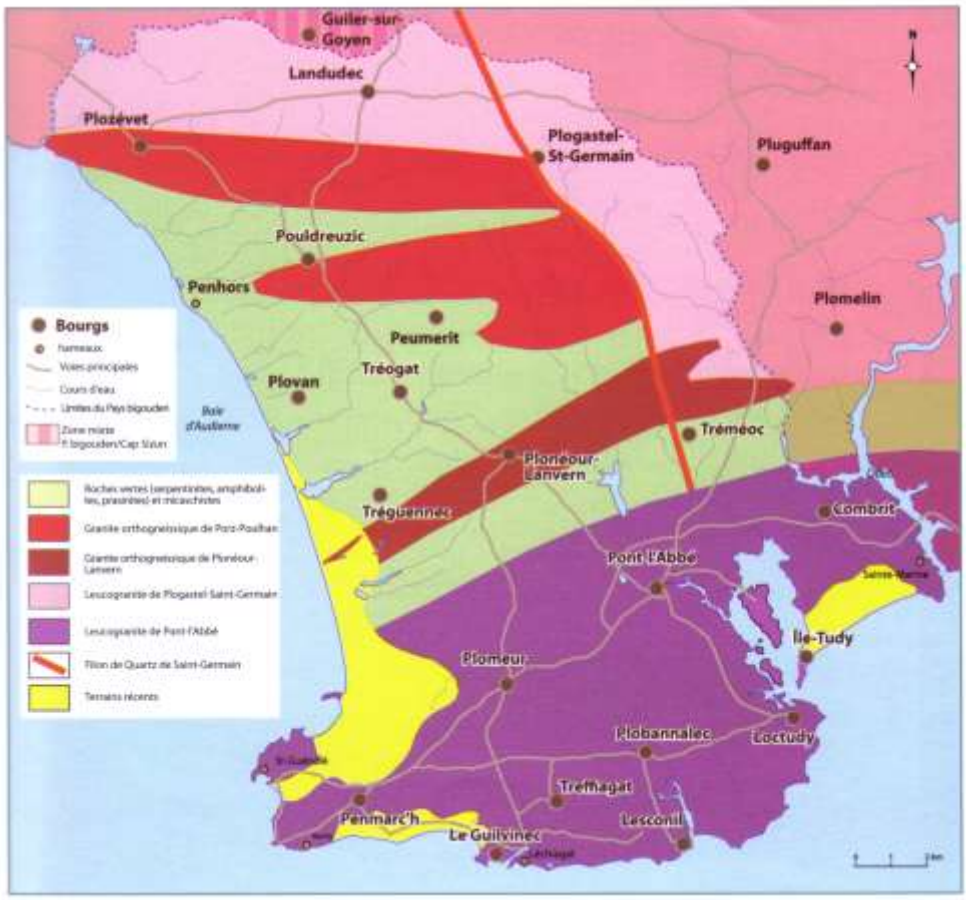

Figure 3J.2. Simplified map of the Cornouaillles geology (after Chauris 2011).

Geology (Figure 3J.2) can dictate the structures and landscapes on our shores. Geological formations have been subject to erosion over millennia which has created the landscapes that we currently have. Such erosion will vary according to the underlying geology and rock formations (e.g. chalk, granite). In this area, we are in a particularly flat landscape, especially in the west, with a few rocky points. Audierne Bay is a rather low side with a pebble bar (about 10 km long), and dunes and ponds (former tidal marsh cut from the sea) in the hinterland (Chauris, 2011).

In the northern part of the study area, the Pont Croix zone presents the following characteristic features (limited to the Pleistocene period, 1,8 Ma-0,01Ma) (Collective, 2002): there is a coastal formation of a pebble bar that blocks all the fresh water streams and causes the formation of tidal marshes in coastal rivers outlets. Locally, the bar has lost its effectiveness due to intensive exploitation and the balance of the coast is therefore often threatened (see below).

In the Concarneau area (Bechennec *et al.,* 1996) the coastal border of the continental shelf to the south of Brittany is characterized by the presence of several islands (Glénan archipelago

and Moutons island) and a shallow seafloor, which forms an offshore rocky ridge limiting the peri-coastal depression.
In the Pont l'Abbé zone, a detailed geological map doesn't yet exist but, as the areas mentioned above, the territory is mainly granitic, even if the islands geology is sometimes different (Jonin, 2010: 14-17).

Geomorphological Processes and Human Intervention
In this area, human intervention in sedimentary processes results in subsequent natural erosion further down the coast. In conjunction with this, swell on exposed shores, currents, vertical movements of sea level (caused for example by tidal cycles, storm surges and changes in barometric pressure) may cause extensive damage. Additionally, there are also continental processes that come into play: climate context (precipitation, wind, temperature, and humidity), infiltration and run-off, alternating freezing and thawing, chemical and biological processes (see Henaff *et al*., 2007).

Changes in this coastal region have been partly of anthropogenic origin for the last few centuries. In the absence of human occupation, this coastline has changed much more slowly (over the long term). Note that the various port facilities (e.g. dams and riprap) have caused a reduction in the rate of erosion on the nearby beaches.

We must not forget the important climatic events such as storms or tidal waves, which can alter the coastline temporarily or in the longer term. More than 40% of the observed erosion is caused by storms and marine activities (shore with the waves, flooding low-lying areas, etc (Henaff *et al*., 2007). This change in the coastline may cause subsequent changes to existing human activities (e.g. fishing, sailing) and therefore also to any associated infrastructure.

This risk is particularly acute in low-lying areas such as the Glénan archipelago (Figure 3J.3). There, archaeological and paleoenvironmental studies have shown relatively rapid evolution, in fact, one can imagine that there are 5000-6000 years of landscape change within a single large island the size of that of the Groix Island (Morbihan). Due to the rise in sea level, the lowest areas were flooded and the islands are separated. It is also estimated that, over the past 2500 years, the islands have lost around half of their extent (Daire & Hamon, 2013) (Figure 3J.3). Erosion is exacerbated by humans, with the amenities of rivers, aggregate extraction in river beds and sea drainage of coastal marshes, planting work impeding natural sediment transit; implantation of structure beachfront, followed by the establishment of building defense against sea erosion often accelerates erosion. The extraction of sand near sedimentary shores helps to further accentuate this erosion.

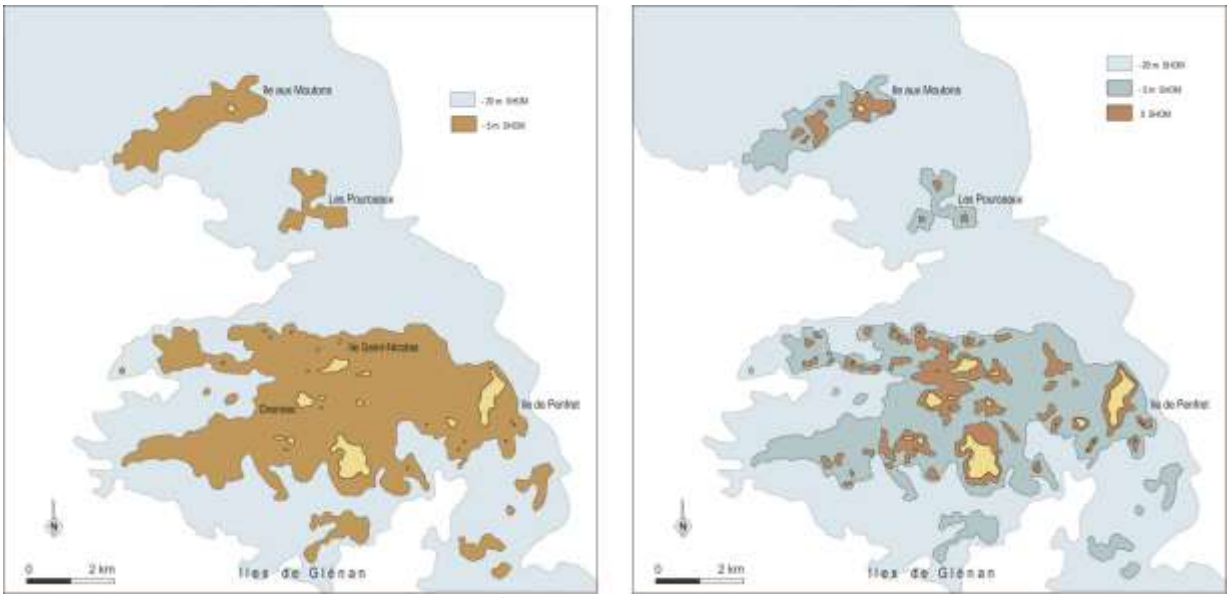

Figure 3J.3. Glenan archipelago (Finistère): hypothesis for the landscape evolution with the situation during early Neolithic period (left) and Iron Age (right) (doc. Daire & Quesnel, after Daire & Hamon, 2013).

3J.1.2 Archaeological, Palaeoenvironmental and Coastal Heritage Resources Consulted for Project

The archaeological and palaeoenvironmental data has been obtained from the Atlas des Patrimoine (Culture Ministry), available online (http://atlas.patrimoines.culture.fr/atlas/trunk/), and from the databases of scientific research groups: AMARAI (Association Manche Atlantique pour la Recherche archéologique dans les Îles) association, CeRAA (Centre regional d'Archéologie d'Alet, Saint-Malo). Extensive documentation was also provided by the Archéosciences laboratory of the Rennes1 University, which is a component of the federative research group Unité Mixte de Recherche 6566 du CNRS- CReAAH (Centre de Recherche en Archéologie, Archéosciences, Histoire).

In this region, archaeological activity rests with several associations or institutions: the Archaeological Society of Finistère (created in 1846) which led to the discovery, excavation and study of several sites in the area (coastal or land); the Association Manche Atlantic Archaeological Research on the Islands (AMARAI, 1988), which addresses the archaeology of coastline and islands and initiates archaeological study and discovery. But the first detailed investigations are due to Finistérien Group Prehistoric Studies (PFEG) whose members were grouped around the Prehistoric Museum of St. Gwénolé Penmarc'h (López-Romero & Daire, 2013). These pioneers of scientific research have worked extensively in the region and left a legacy of many excavations and surveys (Bénard Le Pontois *et al*., 1919; Bénard Le Pontois, 1929), as well as some exceptional documentation, including photos preserved in the Archéosciences laboratory (University of Rennes 1), now curator for this documentary set (López-Romero & Daire 2013).

3J.1.3 Summary of the archaeology and history of the Cornouailles study area

As illustrated below, the area presents a very rich dataset concerning the archaeological and palaeoenvironmental record (Batt & Giot, 1980). However, the exploitation of the available data has not been systematic in this area, as there would be a huge amount of information to analyse. Accordingly, we have only exploited some sites within the case study area, which

appear to be the most informative regarding the issues of the project; that is to say dated monuments illustrating the coastal changes and related current management issues.

Many archaeological sites have been destroyed on the coast for various reasons including both natural (e.g. erosion, climatic events) or anthropogenic phenomena (recovery, ignorance, construction). This is especially the case during WWII, with the establishment of the Atlantic Wall. Many concrete structures were constructed along the coast which destroyed archaeological and historical remains. In other areas sea level rise and sedimentary transformation have also been responsible for the disappearance of numerous archaeological remains. This is the reason why ancient documentation often appears as the ultimate witness of the existence of some landscapes or sites. Archaeological sites are present in the Glénan archipelago and on Moutons island (megalithic monuments, Iron Age setllements, etc), some which are currently submerged, either partially or permanently (Bénard Le Pontois,1929; Daire, 2013) (Figure 3J.4).

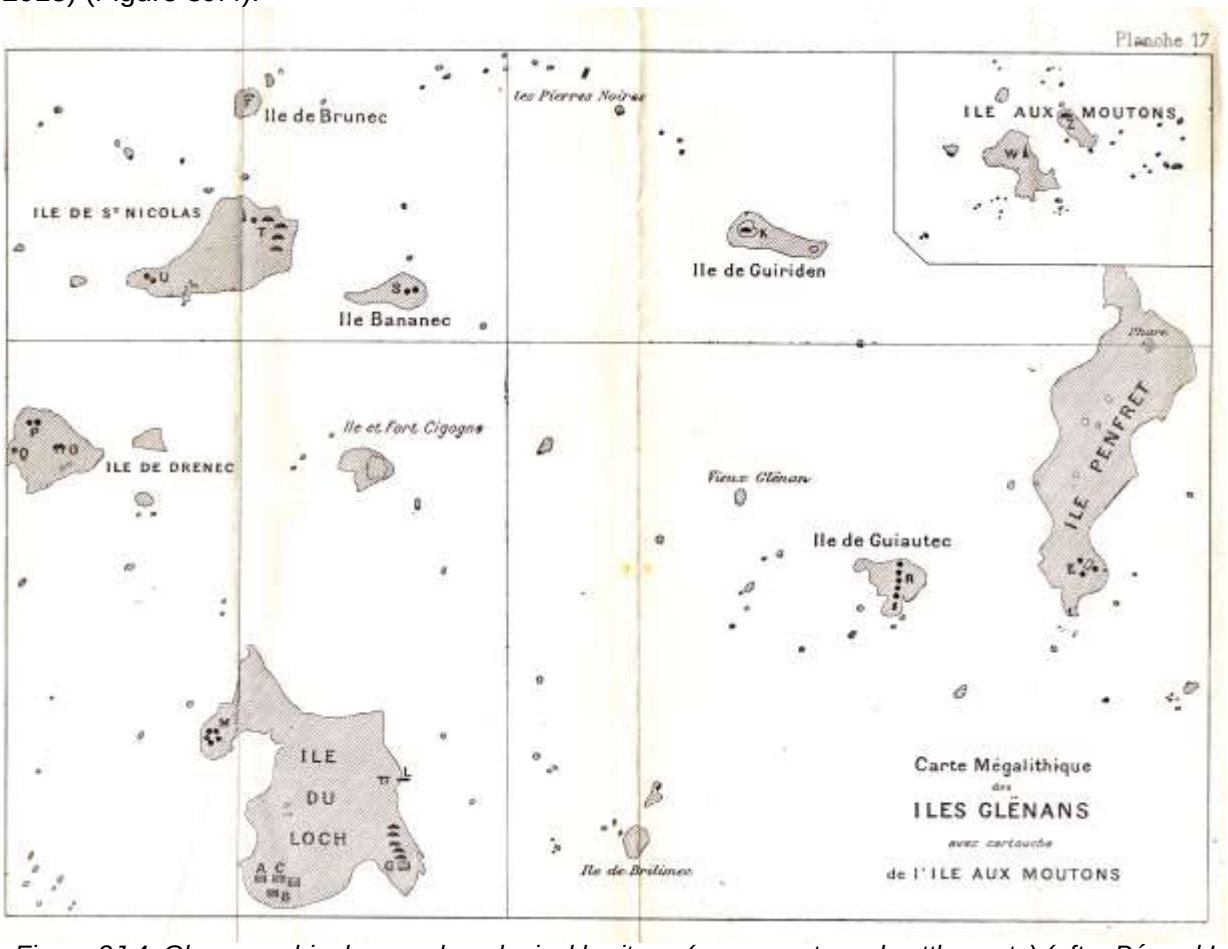

Figure 3J.4. Glenan archipelago archaeological heritage (monuments and settlements) (after Bénard Le Pontois 1929).

Early Prehistory (Palaeolithic and Mesolithic)

Several archaeological sites exist in the area dating back the Palaeolithic and Mesolithic periods. Most of them correspond with deposits located during surveys, not all of which have been subsequently excavated. Although located on the northern limit of the study area, we have to mention the major site of Menez Dregan, excavated in 1996 (Monnier *et al*., 1996). The prehistoric site of Menez Dregan is near the town of Plouhinec, Audierne and delivered remains

of the former Palaeolithic habitat dating from 350 to 500,000 years BP, some of which from the lowest levels are among the oldest known in the world.

The Pointe de la Torch (Beg an Dorchenn in Breton) is a natural peninsula barring the southeast end of Audierne Bay in the town of Plomeur. This headland is home to traces of a human presence in Mesolithic (shell midden) and Middle Neolithic (dolmen). The promontory was long frequented during the Mesolithic period, when the sea level was 10 meters lower than today. Such occupants left an important shell midden, which has almost disappeared due to erosion and excavations indicating a diet of oysters, clams, cockles, winkles, limpets, and also crabs, fish and scallops. Evidence for hunting wild boar and deer was also found, along with traces of hearths, tools and a habitation structure (Bénard Le Pontois *et al.,* 1919; Giot, 1947; Dupont 2003).

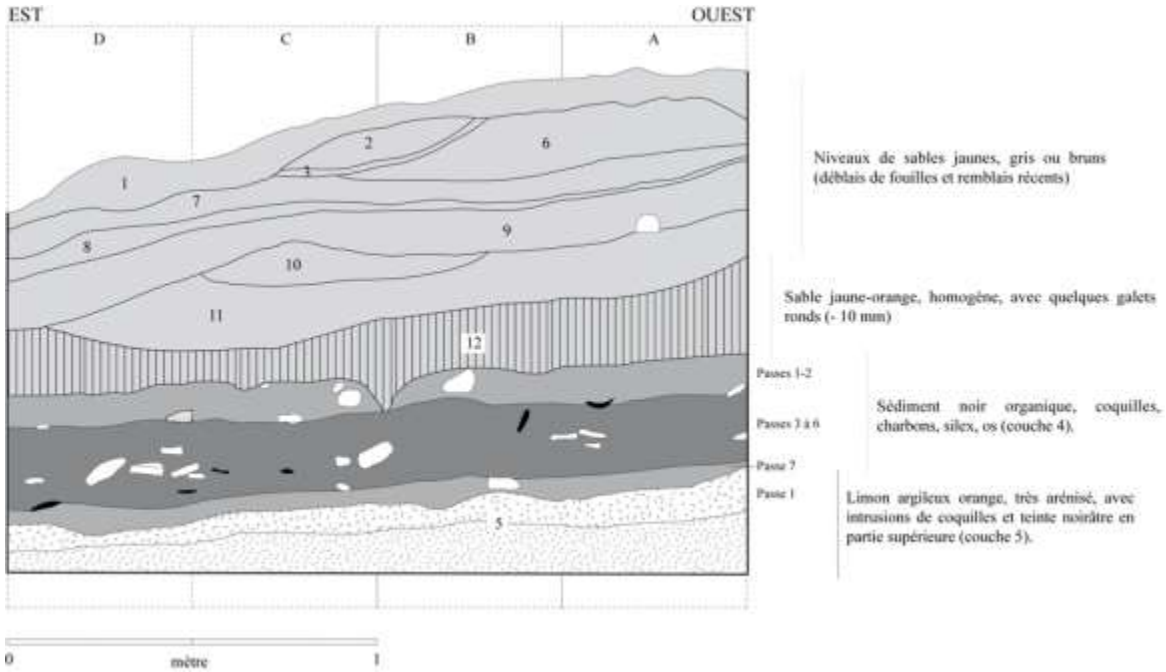

Figure 3J.5. Beg-an-Dorchenn (Pointe de la Torche), Penmar'ch, stratigraphy coupe du sondage 2001 (relevé et DAO : G. Marchand) (after Dupont 2003)

Later Prehistory (Neolithic, Bronze Age and Iron Age)

The Neolithic is a very well-illustrated in the archaeological record of the case study area, especially through the megalithic phenomenon. In addition, this area contains a lot of archaeological remains that provide evidence of coastal changes and sea level rise. Examples of such impact includes standing stones located in the tidal area, or a Bronze and Iron Age necropolis covered by thick sandy dunes.

Among all these records, some remarkable sites, illustrating coastal changes, must be mentioned:

- On the Pointe de la Torch (Beg an Dorchenn in Breton) promontory, a mound was built on top of a granite promontory during the middle Neolithic. There remains a short corridor dolmen and two side compartments, where human bones were found, dating from about 4,300 BC. Later still, the corridor lies on the slope of the promontory, "a sort of passage grave corridor" where later Iron Age materials were located (Figure 3J.5 & 3J.6). During World War II, German bunkers were built on the site, damaging the dolmen (Bénard Le Pontois *et al.*, 1919; Giot, 1947; Dupont, 2003).

- The Neolithic standing stone of Lehan (Tréffiagat) is nowadays partly submerged in a swamp, behind a sandy dune.
- The Neolithic standing stone of Penglaouic, at the limit of Loctudy and Pont-l'Abbé towns, is submerged at high tide in a side swamp of the Pont-l'Abbé river.
- The Neolithic dolmen of the Ezer beach in Loctudy (Figure 3J.7)was discovered in the 1950s after a retreat of the sandy bar due to a storm (Giot & Morzadec, 1992: 57). It seems that this dolmen has been destroyed some years later, when channelling works were carried out in order to dry the marsh behind the coastal bar (Giot & Morzadec, 1992: 59).

Numerous cists stones were discovered on several sites located on beaches, which are dated back to the Bronze Age or the early Iron Age, for example in Mousterlin bay (Fouesnant) or the Glénan archipelago (Figure 3J.8). The iron Age continues to be well represented in this area, through the hundreds of granite stelae (corresponding to burials or cemeteries markers) (in Saint-Jean-Trolimon, Kerviltré (at least 5), Combrit, Savenic near la Clarté, Tréogat, Tréguennec, Plomeur, Penmarc'h, Treffiagat, Plobannalec, Loctudy, Pont-l'Abbé, Fouesnant, La Forêt-Fouesnant and Concarneau). In Penmarc'h, during construction of the St-Gwénolé port, a coin from Agrigente (400 BC) has been found. A burial was located 600-800m west to Rosmeur, and contained charcoal, pottery sherds and a sword (Galliou, 2010: 273). In Treffiagat, on the Kervarch and on the Letty sites, and in Loctudy and in the La Forêt-Fouesnant bay, remains of settlements were associated with salt production workshops dating from the late Iron Age (Galliou, 2010: 438-439, 252 & 202).

Figure 3J.6. Mésolithic site and Neolithic passage grave of Pointe de la Torche/Beg and Dorchen (Finistère) (by P.R. Giot, C. 1950 © Labo Archéosciences UMR 6566 CReAAH).

Figure 3J.7. Neolithic standing stone lying in the tidal area in the Loctudy port (Finistère) (A. Devoir, c.1920) © Labo Archéosciences UMR 6566 CReAAH).

Figure 3J.8. Stone cists burial (late Bronze Age or early Iron Age), Loc'h island, Glénan archipelago (by C.T. Le roux, 1970) © Labo Archéosciences UMR 6566 CReAAH).

Roman Period

In contrast to earlier periods, Roman *villae* and remains are not numerous in the study area. We can mention the ancient road that goes along the Audierne bay in Plomeur and in various other points of the Cornouailles and some ceramics (Galliou 2010: 292). Remains of Roman buldings

are scarcely mentioned, except in the Kerity port, where Roman tiles and bricks were discovered, as well as in the eastern part of the village where a Roman villa was discovered in the tidal area, although regularly covered by the sea. (Galliou 2010 : 273)

Medieval Period (AD500 – 1485)

The early medieval period is characterised by the appearance of many granite chapels (Chauris 2011). However, records from the later Medieval period are marked by only one major find: the Saint-Saturnin cemetery (or Saint-Urnel, Plomeur), dated back to AD 600 and located under a dune. The site was first excavated in 1920 and 1924 (Figure 3J.9) (Bénard, 1929), then again by P.R. Giot from 1946 to 1950, and from 1973-1975. Although first identified as an Iron Age cemetery, the new excavations allowed radiocarbon dating to be conducted (Giot & Monnier, 1977) which identifed the medieval burials (inhumations), with lower levels dating back to the Iron Age.

Some building at the coast are now right on the seafront, as with the 15th century chapel of Notre-Dame-la-Joie Penmarch (Figure 3J.10). This has been subjected to various storms that have led to the development of a dam, without which it would probably have been destroyed (the dam has already been destroyed due to storms). This is an example of the difficulty of coastal buildings and ensuing developments. In Concarneau, the first coastal defence rampart was built in 1373, followed by numerous modifications until the end of the 15th century, and later on with Vauban defence plan.

Figure 3J.9. The medieval cemetery in the dunes of Saint-Urnel (Plomeur) under excavations in the 1920s' by the Groupe finistérien d'Etudes Préhsitoriques (© Labo Archéosciences UMR 6566 CReAAH).

Figure 3J.10. The medieval chapel Notre-Dame-de-la-Joie (Kerity, Penmarc'h), ancient postcard from Villard c. 1900 (private collection).

Post-Medieval Period (AD1485 – 1901)

In the relatively flat Audierne bay, there is little human settlement and the major anthropogenic changes are relatively recent (20th century) and include features such as quarries. In contrast, the south of Cornouailles is more conducive to human settlements, with ports, a fortified town, facilities protection (e.g. seawall, jetty, etc).

The Audierne Bay is less altered through human action than the south of Cornouailles, because it is particularly inhospitable for ships. However, there is the presence of small fishing ports (landing ports, harbours for sheltering ships, etc) that leave a lesser mark in the landscape. In the south, there are more port facilities, some dedicated to fishing while others are marinas. Changes in ports are associated with changes in fisheries and vessels with an increasing tonnage (such as deep-sea fishing) or the development of tourism.

Prior to the 18th century, activity on the foreshore was restricted to a subsistence economy. The Industrial Revolution of the 19th century led to considerable changes to fisheries, shellfish and trade. At the end of the 19th century, the coastline became a privileged space for urban settlement, industrial and seaside tourism. The latter was witnessed through a new found fashion for sea-bathing combined with the democratization of railways and thalassotherapy. As a result of this the coastal areas are now experiencing an economic and ecological demographic pressure.

There are several types of traditional exploitation of the coast:
Seaweed gathering, originally harvested on foot or dredged at sea, is an ancient tradition throughout the 'bigoudène' coast (Figure 3J.11). Seaweed, itself very abundant, was used as fertilizer in the fields and dried fuel for the winter. But, in the second half of the 19th century and

the first half of the 20th century it developed a soda industry. The coastal population, especially women and children gathered seaweed to be piled, before burning, in rectangular pits (4-5m long and 40cm wide). Kilns were then used to obtain soda bread which was subsequently treated in plants located in the Penmarc'h soda factory (in Saint-Gwénolé, Saint Pierre and Kérity) and Larvor and Loctudy to obtain iodine and other chemicals.

Figure 3J.11. Les ramasseurs de varech by Howard Russell Butler, 1886 (Smithsonian Institution). Seaweeds gatherers in the area of Concarneau.

The sardine fishery appears to have started during the 17th century, prior to which hake and herring were fished. Sardines themselves appearing on the coast from the 16th century as a result of the warming temperature following the 'Little Ice Age'. Initially, sardines were dried in the same manner as used for the herring catch, but this changed and the technique of the sardine press was developed.

The rocks of the coastline have also been worked by human forces, the traces of which are still visible. The extraction of stone could be made as ripper, career (for Public Works), or simply recovery rock to make stone, rubble or metalling. These stones are used for local construction (house, harbor, church/chapel, cross, roads, plinths, etc.) or for export to other regions. These quarries are often sporadic in their distribution and made visible by many small excavations, sometimes revisited and then discontinued (Chauris, 2011: 49-51).

At the foreshore of Mousterlin (Fouesnant), a "barricade" and concreting has been put in place by the owners of the holiday homes to preserve the coastline in its existing location. This point was originally a low rocky plateau which was divided into two spits whose wings barred the lagoons. Some modern ideas allow for a 'freezing' of the coast in its present state, but it is sometimes completely changed visually and in its very structure. Such changes, as described for Mousterlin, to allow the nature of the coastline to be 'frozen' lead to subsequently to sedimentary changes (Guilcher, 1990: 36).

Another example is the coastal construction on Île Tudy, formerly accessible through a connection to the mainland at low tide via a *tombolo*, at the tip of Combrit. During high tides or storms, such *tombolo* could have large gaps thus isolating the island. A dam was then built in 1852 to remedy this isolation. Currently, only the pond at Kermor remains witness to such marine incursions (located behind the dam) (Chauris, 2011: 124-131).

From the mid-19th century, we can see the emergence of tourism in France, including Brittany (Clairay & Vincent, 2008: 202-204). This seaside and health tourism is initially seen in specific sites for the aristocracy, evolving over time to encompass all layers of society with the introduction of paid holidays in 1936. Such tourism brought with it various facilities such as pathways for walks, houses along the coastline and the various institutions and establishments related to enjoying the beach. Some cities without an existing port created structures for the tourist boom in the form of piers for walking along. Those who already had small ports inshore, sometimes faced trouble in adapting to the changing face of sailing, notably the increase in vessel size and as a result develop marinas to meet the tourist demand (Clairay & Vincent 2008: 226). This tourism is important in south Cornouailles, largely encouraged by the arrival of the railways and these shores will undergo various alterations, largely favoured by the absence of a law preventing the long construction and on the coast.

Finally, there has also been tourism development to the Glénan islands since 1880, although the islands are not really affected by the majority of construction. The archipelago has long been left to the fishermen (of fish, shellfish and crustaceans), as well as the seaweed farmers who are few in number (less than 200). They suffered little compared to the other islands of Brittany, although we can see a very important development on the Cigogne island.

Modern

Fishing, mainly for sardines, was a very successful activity, especially during the second half of the 19th century (Figure 3J.12). But, from 1902 a crisis affected all fishing ports of the south coast of Brittany, and particularly those of Bigouden. In the 1920s, this resulted in a significant exodus, with many people moving to urban areas for economic reasons. These are mainly concentrated on the coasts, which in turn brings greater urbanization and exploitation of coastal and maritime resource (INSEE).

Figure 3J.12. The sardines preserve factory Cassegrain at Saint-Guénolé-Penmarc'h in 1920 (source http://www.archinoe.net/cg85/visu_affiche.php?PHPSID=ea422277651823bb63b7b0b3b8da7343&param=visu&page=1)

The majority of sites from the 20th Century comprise WWI and WWII defence systems, most famously the Atlantic Wall built by the Germans in the 1940s. This included the blockhouse built at Saint -Jean- Trolimon in 1942, which is now on the foreshore at Tronoën due to the changed coastline. In the Bay of Audierne Penhors (Poudreuzic) a pebble bar of marine origin is located on the coast as far as Tronoën. This has a length of 12 km, a width of 100m, a height of 5m and has promoted the formation of tidal marshes for about 600,000 years. Stones from the bar were originally used in small quantities for traditional architectures. During WWII, the bar was exploited extensively by the Germans and an estimated one million tons of pebbles was collected in three years. Removal of pebbles continued to a lesser extent after the war and resulted in the disappearance of a large part of the coastal strip in conjunction with a rapid shoreline retreat of about 2m per annum, exacerbated by wind and wave action (Chauris, 2011: 151). The bar is no longer a natural barrier for the adjacent inland areas and quite violent storms can dramatically alter the shoreline (e.g. by 20 to 25m in late 1989/early 1990), leading to the implementation of beach replenishment schemes.

The building of the Atlantic Wall and post-war construction has also influenced the dune system in the same area (e.g. Saint-Jean-Trolimon), having been largely gutted by a large cavity just behind the shoreline. These formerly consisted of sand dunes that were still being deposited in the 17th/18th century but which have retreated as a result of construction work and related attack by the sea. Some of the WWII construction also provides an illustrative example of the coastal retreat in the Audierne bay (Figure 3J.13).

Figure 3J.13. La Torche Plomeur, WWII blockhouse in the beach, Finistère (doc. M. Monros).

3J.1.4 Art History of the Area

This section presents the background to artistic representations within the area including key artistic schools and individuals, allowing a broader consideration of individual artworks within the study area. The Cornouailles area itself is the privileged through the attraction of Brittany to painters and the area seems to have grouped and amplified the Breton pictorial phenomenon (Collective 1993). The coastal region of Southern Finistère (Pays Bigouden) has been quite often depicted by painters, a major source of inspiration for artists from all over the world and where the Pont-Aven School of painters was created in the nineteenth century. The art study area itself extends for a distance of 50 km as the crow flies, from Concarneau in the south to Audierne in the northwest. This distance is much greater (c. 150km) when directly following coastline and including the islands and estuaries.

3J.1.5 Art Resource Consulted for the Project

The main resources used for the paintings of the area are located in a variety of places; several local museums own paintings representing this study area, as well regional ones (Musée des Beaux arts de Brest, Musée départemental Breton de Quimper, Musée Bigouden in Pont L'Abbé) and galleries located in Paris or other towns.

Additionally, some illustrated books provided a wealth of paintings and watercolour drawings (Delouche 2003). The main source used here is the remarkable collective work published in 1993 "*La route des peintres en Cornouailles, 1850-1950*", which includes a general overview of the schools of painting and artists who worked in Cornouailles (Collective 1993) (Figure 3J.14).

One very important resource was the Joconde online database. The Culture ministry database "Joconde" is the gateway of museum and public gallery collections in France. The catalogue contains nearly 500,000 records of objects of any kind (archaeology, fine arts, ethnology, history, science and technology) enhanced by thematic journeys, zooms and virtual exhibitions. Joconde is the result of an ongoing partnership between the office of the digital broadcasting service collections of museums in France and the participating museums.

For this area, art approach drew upon existing academic work (Masters) led in the Rennes2 University by E. Motte (Motte 2013). The theme of the dissertation was: "*Representation and Evolution of the Shoreline: What can regional paintings teach us about the Breton coastal environment*?". In order to establish the art resource available for this study, it was necessary to review the topographical paintings, drawings and prints held by the principal national, region and local collections covering the case study area.

In addition, some pioneers of early photographic techniques represented numerous parts of this area; especially due to the development of tourism and the creation of some seaside resorts. Photographic postcards related to such activity produced many visual records of coastal touristic areas. For the photos, the main documentary sources were firstly the collection of old photographs from the collection of the former Laboratory of Anthropology of the University of Rennes1 (López-Romero and Daire, 2013) and, on the other hand, vintage postcards, many of which are available online.

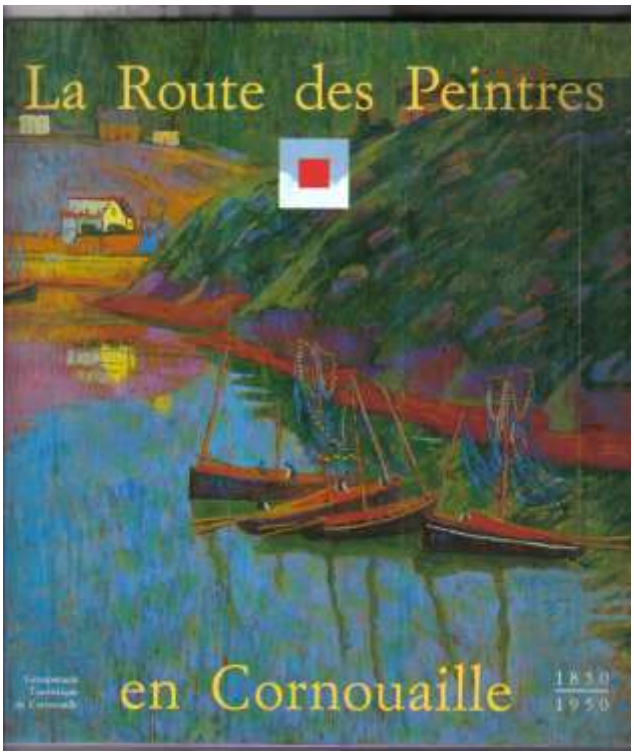

Figure 3J.14. Cover of the collective book "La route des peintres en Cornouailles, 1850-1950" (Collective, 1993)

3J.2. Current environmental impacts/threats and coastal management approach

This section considers the current environmental impacts and threats along the coastline and reviews the current coastal management issues and approaches.

3J.2.1 Review of key contributors to coastal change

Contributors to coastal change are common in various parts of Brittany and we will not revisit the elements presented in the previous sections related to the case study areas in Brittany, such as natural erosion, human activities, etc. But, some key factors are noted here, as specific to local contributions to coastal change:

- Exploitation of the pebble bar in the Bay of Audierne has caused a shoreline retreat that has been very notable since WWII. This is also the case with intensive farming of sand dunes located further inland.
- The intensification of coastal urbanization has increased (economic attractiveness) tourist pressure (mass tourism) resulting in coastal adaptation (see especially the southern part of the area, around the Odet estuary).
- Many activities (aquaculture, seaweed exploitation, biochemistry) require infrastructure and special operations, increasing the pressure on coastal zones.
- Significant weather events (storms, tides, waves, etc.) can cause temporary or permanent coastal retreat.
- Exploitation of aggregates can change the seabed.

All these processes and pressures lead to a change of the coastline (geomorphology) and natural habitats of wild fauna and flora.

3J.2.2 Summary of current coastal management approach

Coastal risk management is a responsibility of coastal local authorities in partnership with local associations for coastal defence. Through the shoreline management planning process the requirement for upgrading of coastal defences can be identified and a number of major projects have been undertaken along the Audierne bay, and more generally the Cornouailles coastal area. Such work has included the building of dykes in the southern area and dunes protection, in Audierne bay and Glénan archipelago. Coastal risk management falls within the overall framework of integrated coastal zone management, which has been actively developed along the study area coastline.

Figure 3J.15. Map showing the distribution of all the protection measures in the study area. (source Inventaire National du Patrimoine Naturel : http://inpn.mnhn.fr/carto/metropole/).

Many parts of the coast are protected by various organizations, which limits human impact on some areas (Figure 3J.15).

- As part of the Natura 2000 network (European Union, ratified by France in 1996, the Ministry of Ecology, National Inventory Mapping Natural Heritage), several sector within Cornouailles are protected: Glénan archipelago, Audierne Bay, Mousterlin marshes; Pont l'Abbé and Odet rivers, Penmarc'h rocky coast.
- The Conservatoire du Littoral owns a lot of lands in Cornouailles for example: some islands in the Glénan archipelago (Figure 3J.16).
- The National Nature Reserve of Saint-Nicolas Glénan was created in 1974 to protect one very rare endemic plant, the *Narcissus Glénans* (Natural Reserves France, Mapping the National Inventory of Natural Heritage).
- There are currently some biotope protection orders (applied in France since 1976, Ministry of Ecology, National Inventory Mapping Natural Heritage, the Environment Code) to the Moutons island (next to the Glénan archipelago) and Penmarc'h area, that allow "*preservation of habitats or other natural formations necessary for survival (breeding,*

feeding, resting and survival) of protected species on the list referred to in Article R 411-1 of the Environmental Code. Environment protection against activities that may affect their biological balance ".

- The Important Areas for the Conservation of Birds (European Union since 1979) The IBA which is a census of the most favourable areas for the conservation of wild birds; some of them concern the coast and islands in the Cornouailles area.
- The Conseil Général du Finistère has bought some areas in order to protect them and manage any natural heritage facing human pressure.

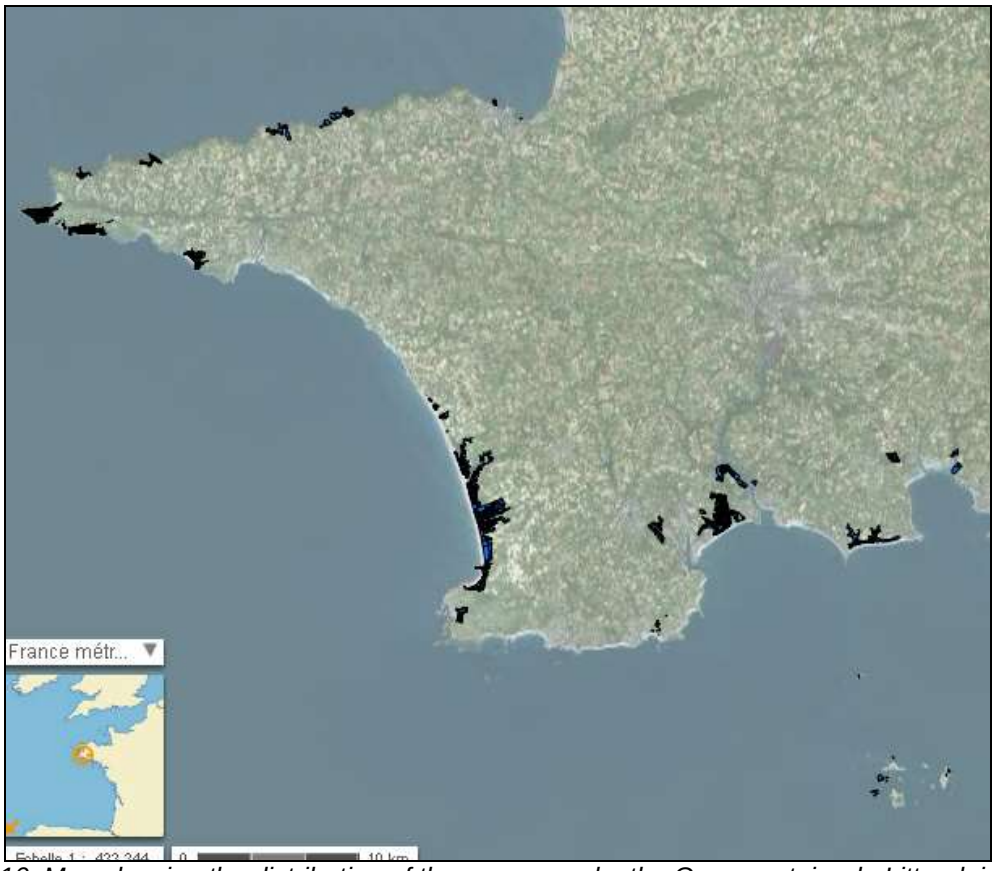

Figure 3J.16. Map showing the distribution of the areas own by the Conservatoire du Littoral in the study area. (source Géoportail).

3J.3 Ranking Artistic Depictions

The ranking systems developed for artworks, historic photographs, maps and sea charts were applied to each of the selected depictions, the results are described in more detail below.

3J.3.1 Art Ranking

The research undertaken selected seven exhibiting artists, among a large panel of artists having represented various landscapes of the area. The development of the ranking system has been described above. By entering the data on artwork type, medium, subject matter, time period and other parameters the database was then able to calculate the ranking scores for seven works of art from the case study site (Table 3J.1 and Figure 3J.17). Within the highest ranking artworks, in this area, artists tended to draw a precise depiction not only of the landscapes but also of the people and activities of the fields and the seashore. Among these artists, some of them illustrate coastal management and changes during the last decades:

- Gaston de Latenay (1859-1943) provided a representation of the Concarneau old harbour that has been deeply transformed during modern times.
- Lucien Simon (1861-1945) painted the chapel Notre-Dame de la Joie à Penmarc'h, which was located along the seaside; recently, a dike has been built in order to protect this area and prevent it from flooding.

A more detailed explanation of each site and the interpretation of the individual artworks is provided below.

ID No	Location	Artist	Date	Score type	Score style	Score enviro	Total Score
96	Chapelle de la Joie à Penmarc'h	Lucien Simon	1913	Oil	Topographical	Detailed view	66
121	Port de Concarneau	Gaston de Latenay	1859-1880	Fine pencil	Picturesque	General view	51
122	Arrivée du Pardon à Fouesnant	Théophile Louis Deyrolle	1881	Oil	Topographical	General view	44
264	Penmarch-Kerity	Charles-François Daubigny	1871	Oil	Picturesque	General view	40
265	Kerity Penmarch	Charle-François Daubigny	1867	Oil	Picturesque	General View	33
266	Chapelle Notre-Dame-de-la-Joie	Karl Daubigney	1846-1886	Oil	Picturesque	Detailed	48
267	Les Vanneuses	Karl Daubigney	1868	Oil	Genre subjects	Detailed	44

Table 3J1. Top art ranking results in the Cornouailles study area.

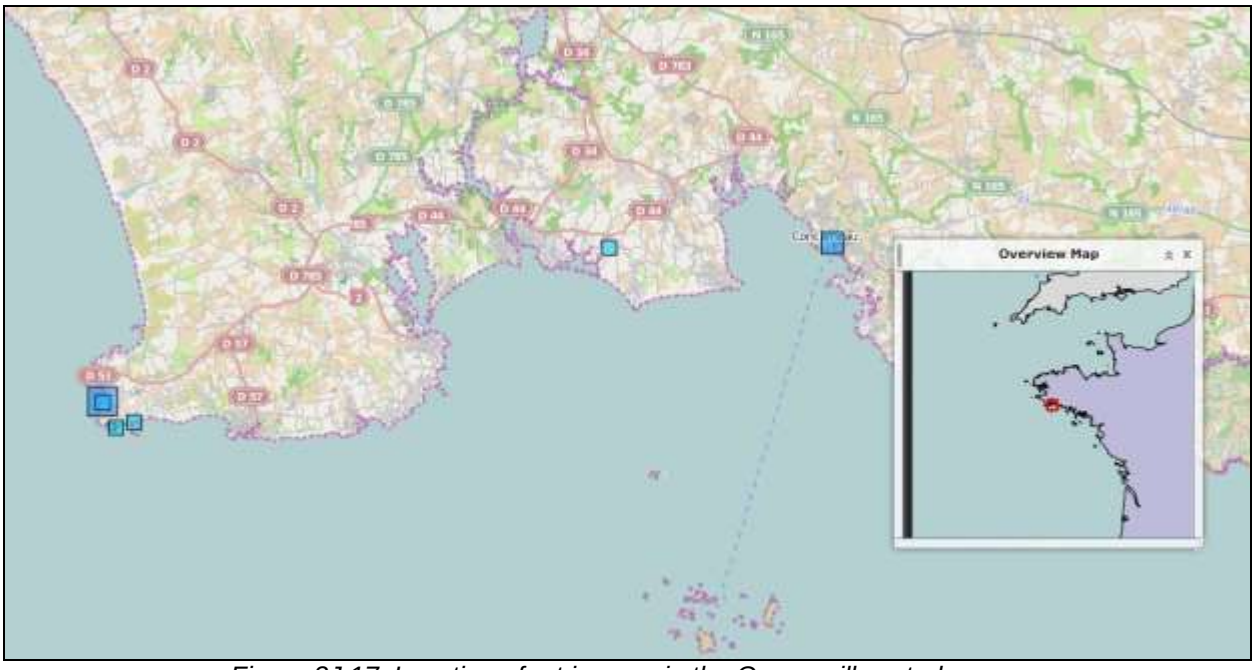

Figure 3J.17. Location of art images in the Cornouailles study area.

3J.3.2 Historic Photograph Ranking

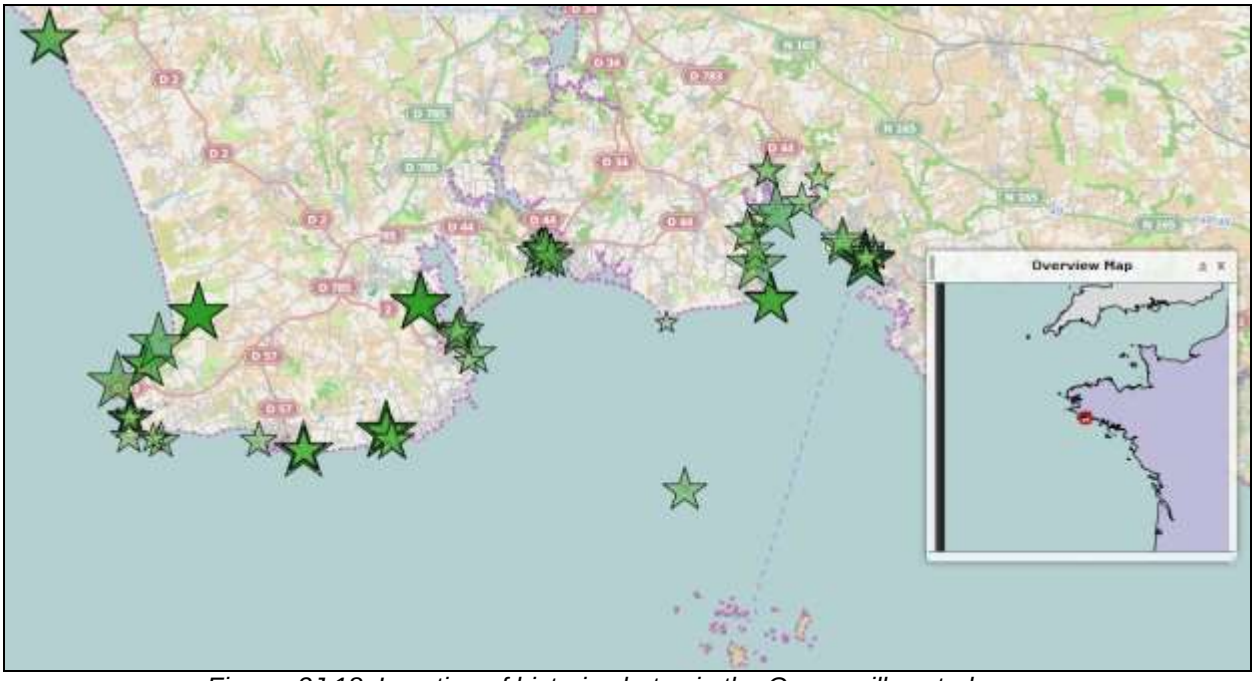

Figure 3J.18. Location of historic photos in the Cornouailles study area

A total of 113 historic photos (Figure 3J.18) were assessed as part of the project, images were primarily chosen from locations along the coastline where historic paintings and archaeological sites were also known. The photographs were collected and then scored using the methodology outlined in the general section above. Hundreds of historic images exist for this stretch of coastline, it should be noted that this study is not intended to be exhaustive, it simply aims to highlight the potential for historic photos to provide information on coastal change. A brief search of resources available online was carried out, although further research online, in museums and galleries, as well as private collections has the potential to provide many more.

The Table 3J.2. below outlines the results of the ranking, note that photographs were scored as either a heritage view or a non-heritage view, see section above for details.

Img_uid	Title	Year	Score Heritage View	Score Non Heritage View	Physical Image State	Total Score
285	Menhir de Men Rouz (Plobannalec-Lesconil)	1900-1930	High		Good	100
293	Menhir de Men Rouz (Plobannalec-Lesconil)	2011	High		Good	100
354	Menhir de Lehan (Tréffiagat)	1922	High		Good	77
372	Menhir de Penglaouic (Pont-L'Abbé / Loctudy)	1922	High		Good	100
394	Nécropole de Saint-Saturnin (Plomeur)	1920-1924	High		Good	100
404	La plage de Conte (Plozévet)	1900-1925	High		Good	100
427	Ville Close (Concarneau)	1900-1930	Medium		Good	100
938	Pointe de la Torche (Plomeur)	1900-1908		High	Good	100
939	Notre Dame la Joie (Penmarch)	1900-1925	Medium		Good	55

942	Le sémaphore (Penmarch)	1896	Medium		Fair	66
962	Le Cap Coz (Fouesnant)	1900-1925		Medium	Good	100
972	Entrée de la Ville Close (Concarneau)	1900-1925	High		Good	100
989	La Roche Percée (Fouesnant)	1900-1925		High	Good	100
1189	Kerity Miln	1920	High		Good	55

Table 3J.2. Top photo ranking results in the Cornouailles study area.

The majority of photos assessed were of heritage views, containing features which can be identified today, the oldest photo assessed was taken in the late 19th century.

For the ranking table (Table 3J.2), we have selected high scoring photos (c. 100), generally of good quality and showing coastal changes, as compared with today's situation. For this area, 112 photos were available. Not a lot of sites were pictured by the protographers, but generally several photo exist for a given site, showing different views and angles. In such cases, the most representative photo has been selected.

A majority of these photos date from the first quarter of the 20th century, the most ancient dating from 1896. As this area was (and still is) very touristic, a lot of porstcards illustrate the land and the seascape. But, some areas were not pictured by photographers, for example the Glénan archipelago and this prevents us from comparison and evolution analysis in such areas. On the contrary, some areas encountered an early attractiveness and the iconic documentation gives an opportunity to study the landscape evolution: Concarneau fortified city, Bénodet (a seaside resort), Fouesnant, Cap Coz rocks, etc.

Scholars from Finistère provided us pictures highlighting the evolution of the coastline, through monuments: the Neolithic menhir of Lehan-Treffiagat is currently located in a swamp behind a dune coast; the Neolithic menhir of Penglaouic-Pont l'Abbé is regularly submerged at high tide; the Neolithic menhir Men Ruz (Plobannalec-Lesconil) which is submerged at high tide and now integrated into the port; the medieval necropolis of Saint-Saturnin Plomeur was buried under the dunes. Although not all of the photos have a precise geographic locations due to lack of visual clues, including; difficulty when the resumption of excavations by Giot (see above), to find the exact location.

We can follow a part of the evolution of the Notre-Dame-la-Joie Penmarch via photos and postcards. The first postcards, dated to the 1st quarter of the 20th century and we are presented with a beachfront chapel, with a little dam built made of rock and piled-up soil. One century later, we see a concrete dam, protruding from the ground.

3J.3.3 Maps/Charts Ranking

Several historical maps exist of the coastline, with some going back over 300 years (Figure 3J.19 and Table 3J.3). Eleven maps were assessed as part of the project using the methodology outlined in Section 2. It should be noted that this study is not intended to be exhaustive, it simply aims to highlight the potential for historic maps and charts to provide information on coastal change. A brief search of resources available online was carried out, although further research online, in museums, libraries and galleries, as well as private collections has the potential to provide many more. This could also be combined with the study of historic maps and charts where searches were carried out, for example in the Glénan archipelago.

Although the focus of this project was on the Cornouailles area, the majority of maps consulted depicted the whole of the southern Finistère department. These maps were only used in an illustrative purpose in this section. The majority of cards that we have at our disposal date from the 18th century, on which defensive points along the coast are highlighted (e.g. Concarneau). We could state the difficulty of properly representing the Glénan archipelago, because it has many rocks and islets. This problem is still present today, as the SHOM (Hydrographic and Oceanographic Service of the Navy) is struggling to establish an accurate map (including the number of islands) of the archipelago.

Figure 3J.19. Location of the maps assessed along the Cornouailles coastline.

MAP_uid	Title	Year	Score Chronometric Accuracy	Score Topographic Accuracy	Score Detail in non-coastal area	Score Geometric Accuracy
114	Carte particulière et topographique des isles de Glenans levée en aoust 1748	1748	73.33	16.66	66.66	83.33
115	Iles de Glénan	1771	73.33	33.33	33.33	66.66
65	Port de Lesconil	1863	6.66	50	66.66	83.33
107	Plan de Concarneau	1764	73.33	33.33	100	100
109	Plan de Concarneau	17th	20	19.44	66.66	66.66
113	Plan de Concarneau	1693	73.33	27.77	66.66	66.66
108	Carte particulière de la coste du sud de Bretagne dans la partie de Concarneau, pour faire voir le gissement des isles de Glenans	Un-known	73.33	20.83	33.33	66.66
66	Ile du Loch	1878	6.66	16.66	100	50
104	Anse de Bénodet et Odet	1771	73.33	33.33	33.33	83.33
105	Coste de Bretagne depuis Plouan et roches de Pennemark jusqu'à la baye	1764	73.33	33.33	33.33	83.33

	de la Forest					
143	Extrait de la Carte des Ingénieiurs Géographes du Roy	18th	0	33.33	66.66	50

Table 3J.3. Top ranking maps within the Cornouailles study area.

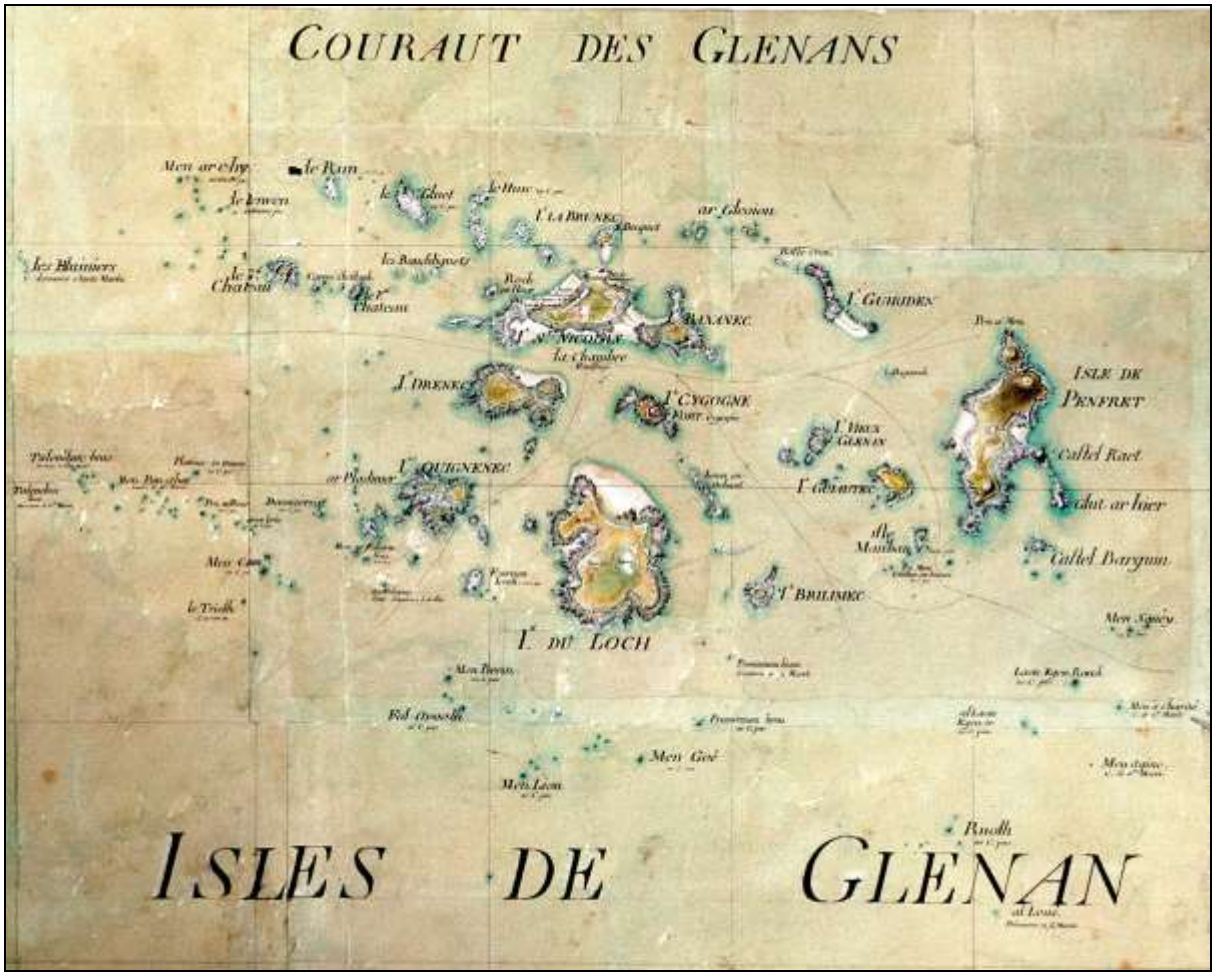

Figure 3J.20. Section of the 'Carte des ingénieurs Géographes du Roy' (18th century) featuring the Glénan archipelago (AMARAI archives).

Figure 3J.21. The Loc'h island, Glénan archipelago. (Left) Map 1878 (Archives départementales) (Right) Current aerial view (IGN Geoportail).

3J.4 Art and Field Research Studies

No dedicated archaeological and palaeoenvironmental fieldwork were carried out, within the framework of the Arch-Manche project, in the Cornouailles case study area, as the available documentation seemed to be numerous enough to develop some sites analysis. This section outlines the art research studies, demonstrating the relevance of research studies crossing pictures of different sorts (paintings, photos and maps). In addition to natural evolution, due to the touristic activity in this area, some parts of the coastline have been severely transformed during the last century. For example, in the Kerity-Penmarc'h area, as shown in the paintings of the great painters of the late 19th century and contemporary photographs, the coast, before the establishment of protection and constructions was really threatened by swell and storms.

3J.4.1 Key Research Questions

The research questions to be answered through the art representations, maps and photos concern:

- The visualization of coastal changes in selected area,
- The time scale and rhythms of the changes,
- The process and origins of the coastal transformation.

All these questions will contribute to a better understanding of the issues and help to propose solutions to the managers of the coastal areas.

3J.4.2 Approach to information gathering and fieldwork

Where it has been possible, fieldwork has been drawn (by E. Motte and M.Y. Daire) in order to assess the informative value of some paintings, maps and photos illustrating the coastal changes. Then, the following sites have been selected: the Kerity-Penmarc'h area (with several artworks and sites), the Loctudy village, and the Pont L'abbé river mouth.

3J.4.3. Art Field Data Gathering Results

J1. Kerity - Penmarc'h by Charles François Daubigny, 1871 (Figure 3J.22).

Location

The Kérity-Penmarc'h village is located in the Cornouaille area (Southern Finistère department), at the south western extremity of Brittany.

Why was the study site selected?

The site has been selected as it is one of the most exposed sites of the department; another point is that, as a touristic area, it has often been depicted by painters and photographers who left a great quantity of documentation nowadays available on various sources.

Geomorphologic setting

The geology of the area of Kerity-Penmarc'h is characterized by the presence of granite with very fine grains. On the whole area, the old Hercynian chain experienced a leveling phase which left two major sets of coasts: along the Bay of Audierne an impressive shingle bar that was intensively exploited for the construction of the Atlantic Wall during the WWII, and sandy dunes unfairly mined for construction.

Key coastal risk management issues for the frontage

These two formations, pebbles bar and dunes, are retreating under the onslaught of Atlantic swells, as evidenced by the position of German blockhouses which are now on the foreshore. However, human activities (quarries and construction) have also transformed the coastal landscape, until recently.

How the site can inform coastal risk management ?

The comparison between the Daubigny painting and present views (analysis carried out by E. Motte, 2013) shows that the shoreline has recently been protected by the construction of a dyke; some trees have been planted, probably in the aim of stabilizing the dunes. Nevertheless, some parts of the landscape have disappeared since the end of the 19th century, as well natural ones (rocks and dunes section) as private buildings.

Kerity-Penmarc’h village - Ranking score achieved: 40

Figure 3J.22. The Kerity village, by C.F. Daubigny (1871), analysis by E. motte (Motte, 2013).

J2. Kerity - Penmarc'h by Charles François Daubigny, 1867 (Figure 3J.23)

Location
Same as above.

Why was the study site selected?
Same as above.

Geomorphological setting
Same as above.

Key coastal risk management issues for the frontage
Same as above.

How the site can inform coastal risk management ?
Same as above.

Kerity-Penmarc'h village - Ranking score achieved: 33

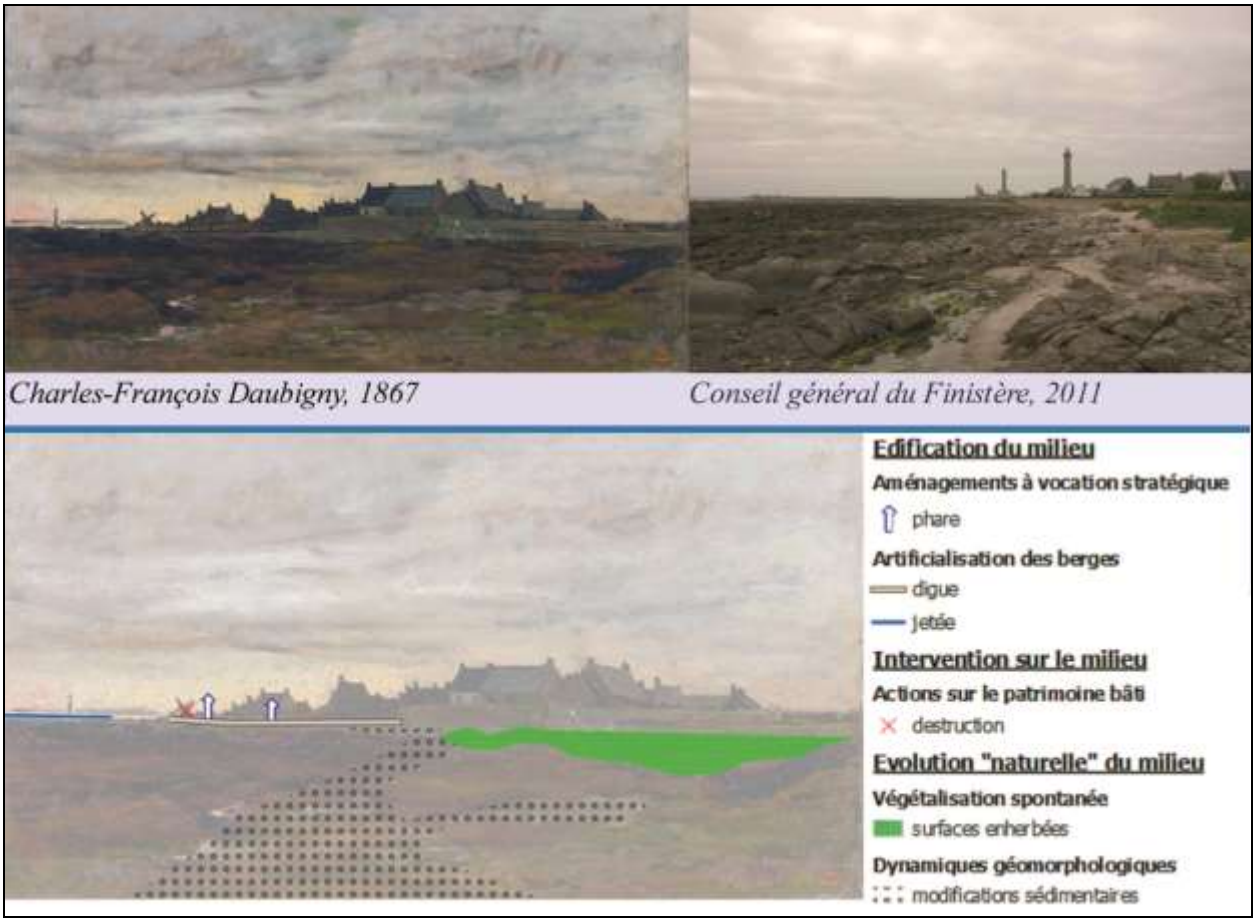

Figure 3J.23. Kerity - Penmarc'h by Charles François Daubigny, 1867, analysis by E. Motte (after Motte, 2013).

J3. Kerity - Penmarc'h miln, photo by Georges Chevalier, 1920 (Figure 3J.24).

Location
This mill is located in the Kérity-Penmarc'h village, in the Cornouaille area, at the south western extremity of Brittany.

Why was the study site selected?
The site has been selected as one old photo (early 20th century) was available in order to compare the coastal situation regarding the current one. This area has always been subject to important coastal changes through the centuries.

Geomorphological setting
The area corresponds to a flat coastal area.

Figure 3J.24. 'Kerity miln (Penmarc'h) (1) picture by Georges Chevalier, 26th of February 1920, (2) same area today (Source : panoramio.com) and (3) (© JLouis Guegaden, 2008 (source http://kbcpenmarch.franceserv.com/).

Key coastal risk management issues for the frontage
The key issue is to protect human installations and natural sites from erosion and sea submersion. The comparison between the ancient and recent photos also shows the evolution due to human pressure, as a modern road has replaced the sandy beach and landing port.

How the site can inform coastal risk management?
The small stone walls, visible on the photo n°1 (Figure 3J.24) reveals the poverty of local people as well as the low efficiency of such constructions which correspond to an attempt of protecting the land behind the shore.

Kerity-Penmarc'h miln - Ranking score achieved: 55

J4. Chapelle Notre-Dame-de-la-Joie by Charles François Daubigny or Karl Daubigny, late 19th century (Musée de Bretagne) (Figure 3J.25).

Location
Located between the port and the lighthouse of St-Gwénolé, the Kérity "Notre-Dame-de-la-Joie" chapel is one of the rare religious buildings settled along the immediate seashore, during the 15th century AD (Chauris, 2011).

Why was the study site selected?
The site has been selected as it is located next to the seashore and was subject to modifications illustrating risks and coastal management (see below).

Geomorphological setting
The geology of the area of Kerity-Penmarc'h is characterized by the presence of granite with very fine grains. On the whole area, the old Hercynian chain experienced a leveling phase which left two major sets of coasts: along the Bay of Audierne an impressive shingle bar that was intensively exploited for the construction of the Atlantic Wall during the WWII, and sandy dunes unfairly mined for construction.

Key coastal risk management issues for the frontage
The chapel was submerged by the sea in 1924. This monument is, for sailors and the local population, the symbol of the Virgin Mother protection facing every day life threats. A religious feast takes place there on the 15th of August (Chauris, 2011).

How the site can inform coastal risk management
As shown on the ancient post card and on the painting (n°1 & 3, Figure 3J.25), there was no physical protection until the 20th century, when a dike has been built all along the seashore. The dike is given to protect not only the chapel but all the buildings in the surrounding area from the submersion risk.

Chapelle Notre-Dame-de-la-Joie - Ranking score achieved: 48

Figure 3J.25. 'Chapel Notre-Dame-de-la-Joie , Kerity-Penmarc'h. (1) ancient post card (early 20th) century and (2 & 4) in 2012 (cl. M.Y. Daire), (3) painting by Karl Daubigney ? (Musée de Bretagne) (after Chauris 2011).

J5. Les vanneuses à Kérity by Karl Daubigny, 1868 (Musée des Beaux-Arts de Brest) (Figure 3J.26).

Location
The Kérity village stands along the immediate seashore, in the neighborhood of the Penmarc'h town.

Why was the study site selected?
The site has been selected as it is located next to the seashore and was subject to modifications illustrating risks and coastal management (see below).

Geomorphologic setting
The geology of the area of Kerity-Penmarc'h is characterized by the presence of granite with very fine grains. On the whole area, the old Hercynian chain experienced a leveling phase which left two major sets of coasts: along the Bay of Audierne an impressive shingle bar that was intensively exploited for the construction of the Atlantic Wall during the WWII, and sandy dunes unfairly mined for construction.

Key coastal risk management issues for the frontage
The painting insists on the vicinity of the seashore and the human installations and activities, such as seaweed collection and burning.

How the site can inform coastal risk management
As shown on the painting (Figure 3J.26), there was no physical protection until the 20th century, when a dike has been built all along the seashore.

Les vaneuse à Kérity - Ranking score achieved: 44

Figure 3J.26. Les vanneuses à Kérity by Karl Daubigny 1868 (Musée des beaux-arts de Brest, source: http://fr.wikipedia.org/wiki/Pays_Bigouden

J6. The Penglaouic prehistoric standing stone, Pont L'Abbé River (photo by A. Devoir) (Figure 3J.27).

Location
The standing stone is currently located in the mouth of the Pont L'Abbé River (Southern Finistère), in the tidal belt.

Why was the study site selected?
This monument/area was selected because it clearly illustrates the Holocene sea level rise. On the photo n°1 Figure 3J.27, the menhir appears partly submerged at high tide and the n°2 shows the marks of the repeated submersion of the standing stone.

Geomorphological setting
The geomophological setting is the mouth of the Pont L'Abbé River, which is a kind of ria under the influence of the maritime tides.

Key coastal risk management issues

The menhir appears here as an archaeological evidence of the sea level rise and coastal change in this area, as we can state that since it was erected, the shore has been the subject of a an important retreat. Currently, we can observe an increase of the sediment deposit in the river mouth, which progressively hides the base of the standing stone.

How can the sites inform coastal risk management?

The mudflats of the Pont l'Abbé River, that are part of the public maritime domain and straddle the communes of Pont l'Abbé and Loctudy, consisting of mudflats and marshes are an ZNIEFF (Zone naturelle d'intérêt écologique, faunistique et floristique) (Natural Area of ecological interest, flora and fauna) of 208 ha. hunting and wildlife reserve, especially a wintering area for many species of birds.

The Penglaouic standing stone: 100

Figure 3J.27. The Penglaouic standing stone, Pont L'Abbé river mouth (Finistère) (1) photo by A. Devoir (c. 1910), (2) by P.R. Giot (c. 1960), (3) after Taylor & Nodier ((© Labo Archéosciences UMR 6566 CReAAH).

3J.5 Analysis

The Cornouaille area study has combined the use of archaeological and palaeoenvironmental data, paintings, historic photographs, maps and charts in order to demonstrate how these tools can be used to improve our understanding of coastal change in the long and short term. The archaeology and palaeoenvironmental data provides evidence of coastal changes mainly at the pluri-millennial scale, i.e. the scale of the Holocene period, as the Palaelolithic sites are scarcely represented in this area, except by the exceptional cave site of Menez Dregan. The medium and short scale changes are especially evidenced, in this zone, by painters and photographers. Some documents constitute an illustrative witness of a former state of the coasts.

3J.5.1 Archaeology and Heritage Features

As described in section above, the archaeological assessment focussed on the vulnerability of soft rocks, coasts and dunes of the Cornouailles area. Submerged deposits have been registered in the area, such as peat layers, sometimes showing some ancient traces of ploughing that could be dated back to the metal ages (Giot *et al*., 1982).

Although much work has been carried out on reconstructing the coastline from the medieval period, further work is required to understand the rate and scale of coastal change from the Palaeolithic. To this end, in the northern part of the study area, the Menez Dregan grotto, which was excavated in 1996, provides new data on one of the most ancient occupation of Western France (Monnier *et al*., 1991); if the site is nowadays located at the foot of a cliff exposed to marine waves, its human prehistoric occupation corresponds to a continental one, on the border of a large plain favourable to the observation and hunting of big mammals.

It is also interesting to note that a number of the archaeological sites which have significant potential for holding data to inform on coastal change are themselves likely to be lost through continuing erosion of the coast, especially the tidal megalithic monuments and the archaeological sites located behind the sandy dunes levels. A good illustration is provided by the small stone cists burials generally discovered on the beaches of southern Finistère after the winter storms. The constant erosion of these sites (see the ALeRT project assessment) highlights the need to gather data from those high and medium scored sites to capitalise on this information before it is lost.

Concerning more precisely the palaeoenvironmental approach, we can mention the discovery of ancient forests in the bay of Concarneau (Delanoë & Pinot, 1977). During pre flandrian regression, rivers were running across Concarneau Bay towards the south-east. Holocene transgression came through the main valley into the pre-littoral depression, where it built pro-estuarine accumulations at several levels, in front of the river mouths, and coastal spits, namely 47m, 37m and 27m below similar forms seen today. The relations between these forms and the alluvial terraces make it possible to find some correlations between the climatic characteristics of the streams and the major sea-level stands. When the sea level was about 37 m below the present one, alluvial sheets of coarse materials have been deposited in wide divagating valleys. In a later stage, when it reached 23m below the present level, rivers have cut narrow valleys into these coarse deposits. The coring studies gave also data concerning the coastal evolution during the Holocène. Some of these forests of the Concarneau bay regularly re-appear after winter storms and are subject to new studies and analyses (by V. Bernard, UMR 6566 CReAAH, and E. Werthe, Phd in progress). The oak trees of the Sables Blancs beach have been dated back to the Néolithic period (- 5000 BP) (Figure 3J.28).

Figure 3J.28. The Neolithic tidal forest (oak trees) of the Concarneau beach, as it could be recently seen (19/02/2014). Source: http://www.letelegramme.fr/img/diaporamas/CONCARNEAULAFORETFOS-20140219/PHO05.jpg

3J.5.2 Artistic Depictions

Following the research and location of a large number of artistic images of the study area coastline it was possible to rank their relative importance in terms of their value in informing on long-term coastal change. The art case study area was extensive in the Kerity Penmarc'h area, as many painters represented the coastal activities and sites in this area.

Concerning the regional artistic depiction, the story of this area is dominated by the painting school names "Ecole de Pont Aven". Lower Brittany had indeed become a trendy area, the "Bretonneries" selling well at the Salon of French artists, the area became a favorite destination for painters. Attracted by a rural civilization still intact, the small town of Pont-Aven and the surrounding countryside were a source of inspiration. From the summer of 1866, a dozen artists, most of them being American or English are present at Pont-Aven. In 1880, a second wave of artists frequented Pont-Aven, which became the "new Barbizon", there are forty artists, English or American landscape painters, and painters from northern Europe such as Denmark (Collectif, 2003). As they often painted the coastal areas, it has been possible to compare these detailed views with the current ones, in order to assess local coastal change. In addition, several historic photographs and maps were also assessed, which provided helpful information, especially regarding the coastal and tidal megalithic monuments providing well dated benchmarks for the coastal evolution.

3J.5.3 Combined Resources

As demonstrated above, several megalithic monuments of the case study area illustrate the coastal changes and the sea level rise. The following image (Figure 3J.29) shows another standing stone, located in the port of Lesconil. This site is very interesting as it shows a combination of natural evolution of the site and human transformation.

As for the Pengalouic menhir (see above), the early 20th century photos (n°1 & 2 Figure 3J.29) show a standing stone (dating back to Neolithic or Bronze Age) located in the small port of Lesconil (southern Finistère). The standing stone was, in that time, regularly submerged while high tide. We have recently tried to re-examine this monument and it appeared very difficult to find it back, as the Lesconil port was severely transformed during the second half of the 20th century (Figure 3J.30).

Figure 3J.29. Combined document used for the analysis of the coastal change in the Lesconil port (Finistère, Cornouaille). (1) View of the standing stone, early 20th century (© Labo Archéosciences UMR 6566 CReAAH).(2) Location on the Etat major map (19th century),

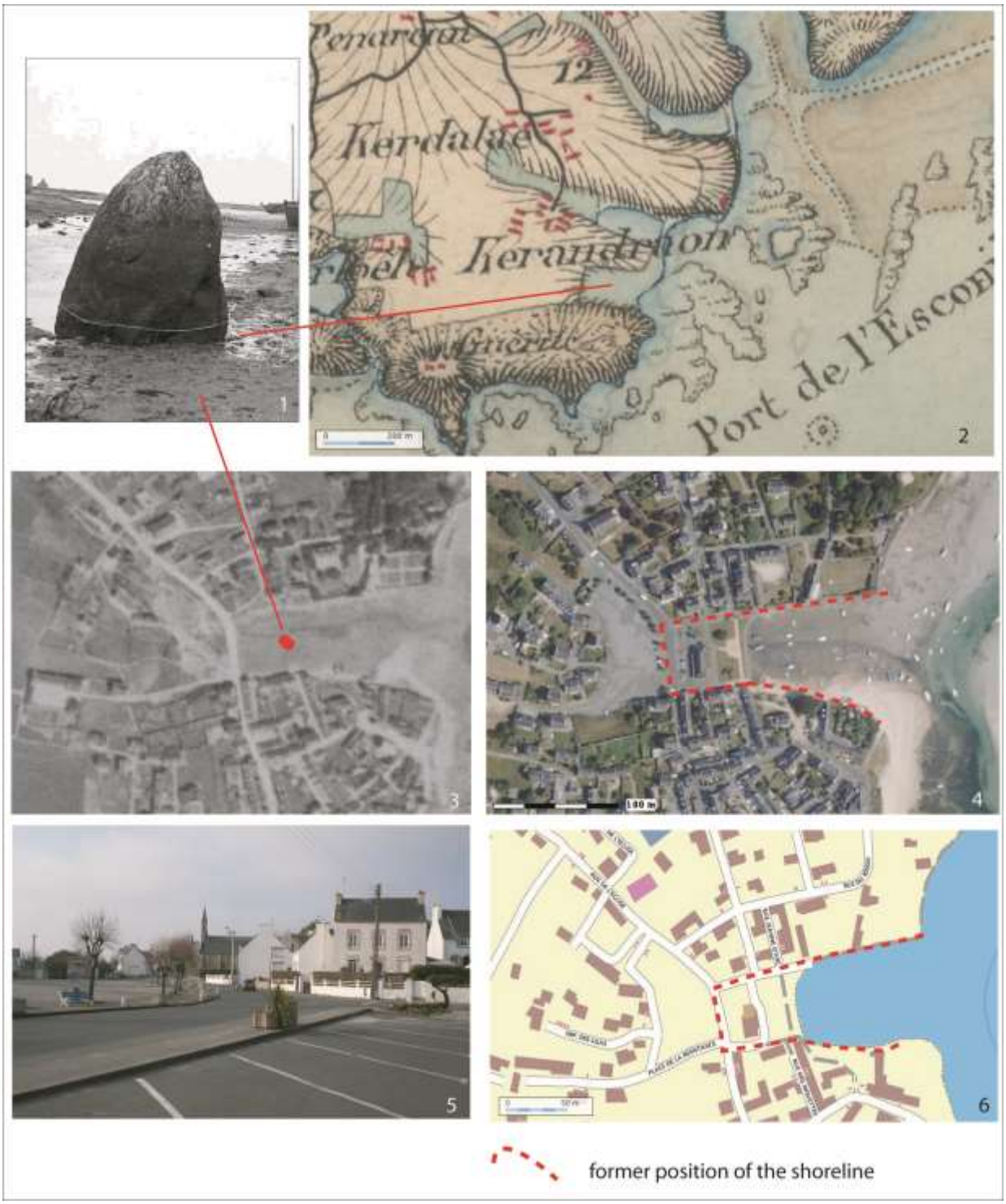

Figure 3J.30. Combined document used for the analysis of the coastal change in the Lesconil port (Finistère, Cornouaille). (1) View of the standing stone, early 20th century (© Labo Archéosciences UMR 6566 CReAAH).(2) Location on the Etat major map (19th century), (3) IGN aerial view 1952, (4) IGN aerial view 2006, (5) Current view of the filled in area (cl. by M.Y. Daire), (6) IGN map 2006.

The study of aerial photos of various periods (since 1952 to 2006) (n°2 & 3, Figure 3J.30) indicate that land has been reclaimed in the area where the menhir was standing, in order to build a car park and a new post-office (n°4 & 5, Figure 3J.30). The menhir was then included in the new wall surrounding the port, and is currently only partly visible in the construction (n°3 & 4, Figure 3J.30). The small river which was ending in the bay and port has been either covered or canalised in a drain.

Combining the documentation on the Lesconil monument allows us to retrace the ancient and more recent evolution of the shore line at a local scale, but gives also a good indication of the consequences of the coastal management by authorities. This is a good illustration of submersion risk in link with the submersion by the sea as well as the human pressure on settled coastal areas.

Figure 3J.31. Combined document used for the analysis of the coastal change in the Lesconil port (Finistère, Cornouaille). (1) IGN aerial view 1952, (2) IGN aerial view 2006, (5) Current view of the filled in area (cl. by M.Y. Daire), (6) IGN map 2006.

3J.6. Conclusions and Recommendations

In the Cornouailles case study area, the vulnerability of the soft coasts has been assessed through several examples, demonstrating how fast changes can occur, especially during winter storms. This phenomenon combines with the long term erosive process. Nowadays, due to the sea level rise, some low areas (such as the Islands of Sein and Glénan archipelago) are really threatened with inundation.

The Sein island has an area of only 0.5 km² and is low-lying, its average height being only 1.5 meters. It was several times almost overwhelmed by storms with those of 1830, 1868 and 1897

being marked by their extraordinary power; old people remember ancient generations who went to take refuge on rooftops to avoid being swept away. In the bay of Audierne, the sandy dunes are subject of special attention from coastal managers, one part of them being protected and belonging to the Conservatoire du Littoral. These dunes are, in essence, mobile and extremely fragile coastal changing formations, threatened both by climate events faced by the human action (Guilcher & Hallegouët, 1991).

There is then an emergency in registering the natural and cultural heritage of all these threatened sites, as the physical protections could only slow the process but not really prevent the damage. Concerning the protection of natural sites, the prefectural authority fixed measures relating to the conservation of a particular biological environment necessary for feeding, breeding or resting some endangered species. These orders can protect dunes, marshes, coastal heath land. Such protection is a little bit extended and exploited by human space. The problem is that they are limited in time.

This report is a section of the Technical Report for the Archaeology, Art and Coastal Heritage – tools to support coastal management and climate change planning across the Channel Regional Sea (Arch-Manche) Project. To cite this report please use the following:

Martin, C Daire, MY Olmos, P & López-Romero, E. 2014 Case Study 3J – Cornouailles, France. In Satchell, J & Tidbury, L (eds) *Arch-Manche Technical Report*.

For further information on the project and to access the full Technical Report please go to www.archmanche.hwtma.org.uk/downloads

The project has been part funded by the European Regional Development Fund through the Interreg IVA 2 Seas Programme. This report reflects the authors' views. The INTERREG IVA 2-Seas Programme Authorities are not liable for any use that may be made of the information contained therein.

3J.7 Case Study References

Batt M., Giot P.-R., 1980. Quelques observations d'archéologie du paysage en Finistère, *Bulletin de la Société Archéologique du Finistère*, t. CVIII,: 17-25.

Bechennec, F., Guennoc, P., Guerrot, C., Lebret, P., Thieblemont, D., avec la coll. de Carn, A., Delanoë, Y., Giot, P.R., Hallegouët, B., Le Meur, S., Monnier, J.L, Morzadec, H. 1996. *Notice explicative, carte géologique France (1/50 000), feuille Concarneau (382)*. Orléans, BRGM, 129p.

Bénard Le Pontois C., Favret P.M., Boisselier G. 1919. *Importance archéologique de la presqu'île de la Torche, Penmarc'h, Finistère*, Quimper, Jaouen, 1919.

Bénard Le Pontois Ch., 1929. *Le Finistère préhistorique*. Publications de l'Institut International d'Anthropologie, n° 3. Librairie E. Noury, Paris.

Chauris, L. 2011. *Pays Bigouden : des pierres et des hommes. Impacts du sous-sol dans le bâti d'un territoire cornouaillais*. Ed. Skol Vreizh, Morlaix, 160p.

Clairay, P. et Vincent, J. 2008. Le développement balnéaire breton : une histoire originale. *In Annales de Bretagne et des Pays de l'Ouest*, 115-4: 201-233.

Collective 1993. *La route des peintres en Cornouailles*, 1850-1950. Groupement touristique de Cornouailles publisher, 130 p.

Collectif 2002. *Notice explicative, car géologique France (1/50 000), feuille Pont-Croix (345)*. Orléans, BRGM, 49 p.

Daire M.Y., Hamon G. (eds), 2013. *L'Île aux Moutons (Fouesnant, Finistère), Un établissement gaulois dans son contexte atlantique. Etude pluridisciplinaire*. Les Dossiers du Ce.R.A.A., supplément n°AJ, 234 p.

Delanoë Y., Pinot J. P., 1977. Littoraux et vallées holocènes submergés en Baie de Concarneau (Bretagne méridionale). In Bulletin de l'Association française pour l'étude du quaternaire - Volume 14 - Numéro 3 - 1977. pp. 27-38. doi : 10.3406/quate.1977.1309 http://www.persee.fr/web/revues/home/prescript/article/quate_0004-5500_1977_num_14_3_1309

Dupont C., 2003. Les coquillages alimentaires des dépôts et amas coquilliers du Mésolithique récent/final de la façade atlantique de la France », *Préhistoires Méditerranéennes*, 12 | 2003: 221-238.

Galliou P. 2010. *Carte archéologique de la Gaule. Le Finistère*. Ed. Académie des Inscriptions et Belles Lettres, Ministère de l'Education Nationale, Ministère de la Recherche, Ministère de la Culture et de la Communication, Maison des Sciences et des Hommes, Paris, 495p.

Giot P.R. 1947. Le tumulus mégalithique de Beg-an-Dorchenn en Plomeur (Finistère), *Gallia*, 5: 167-170.

Giot P.-R., Batt M., Morzadec M.-T., 1982. *Archéologie du paysage agraire armoricain,* éd. Travaux du Laboratoire d'Anthropologie de l'Université de Rennes 1, Rennes, 76 p.

Giot, P.-R. & Monnier, J.-L. 1977. Le cimetière des anciens Bretons de Saint-Urnel ou Saint-Saturnin en Plomeur (Finistère). *Gallia*, 35-1: 141-171.

Giot, P.-R. et Morzadec, H. 1992. Des dolmens à couloir au péril des mers actuelles», *Revue Archéologique de l'Ouest* 9: 57-66.

Giot P.-R., Briard J., Pape L., 1995. *Protohistoire de la Bretagne,* Ouest France éd., Rennes, 423 p.

Giot P.R., Monnier J.L., L'Helgouac'h 1998. *Préhistoire de la Bretagne*, Ouest France éd., Rennes, 452 p.

Guilcher, A. 1990. Sur le recul actuel des rivages meubles de la Bretagne de l'Ouest. *In Revue Archéologique de l'Ouest. La Bretagne et l'Europe Préhistoriques, mémoire en hommage à Pierre-Roland Giot*, sup. 2: 31-36.
Henaff, A., Michard, B., Le Visage C. 2007. Erosion côtière : c'est la nature qui commande. http://www.bretagne-environnement.org/Mer-littoral/Les-menaces/L-erosion-cotiere/Erosion-cotiere-c-est-la-nature-qui-commande.

Guilcher A., Hallégouët B., 1991. Coastal dunes in Brittany and their management. *Journal of Coastal Research,* vol. 7, n° 2, p. 517-533.

Hénaff A., Bodéré J.-C., Lageat Y., 2002. Érosion côtière et vulnérabilité du trait de côte en Bretagne, rapport annuel, année 1, *Rapport PRIRE*, LETG-Géolittomer-Brest, 29 p.

Jonin, M. 2010. *Géotourisme en Finistère, petit guide géologique pour tous*. Biotope, Mèze – Muséum National d'Histoire Naturelle, Paris (col. Géotourisme), 96 p.

López-Romero E., Daire M.Y., 2013. The ICARE project: an insight into the formation and consolidation of archaeology in western France (ca. 1850-1990). *Bulletin of the History of Archaeology* 23(1):3, 1-11. DOI: http://dx.doi.org/10.5334/bha.2313

Monnier, J.-L., Hallégouët, B., Hinguant, S., Van Vliet-Lanoe, B., Falguères, Ch., Laurent, M., Bahain, J.-J., Marguerie, D., Mercier, N., Geigl, E. et Molines, N. 1996. Menez Dregan (Plouhinec, Finistère) et le Paléolithique inférieur à l'ouest de la France, in: *Actes du XIIIe Congrès UISPP*, Facchini, F., Palma di Cesnola, A., Piperno, M. et Peretto, C., (Éds.), Forlì, ABACO éd., vol. 2 - Lower and Middle Palaeolithic: 99-108.

Motte, E. 2013. *Représentations et évolutions du littoral en Bretagne*. Mémoire de Master 2 soutenu à l'Université Rennes 2, département de Géographie, 23p.