

ENONDAS, S.A.

**Environmental Characterisation Study of the ENONDAS S.A.
Pilot Zone**

Executive Summary

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ATKINS

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the ENONDAS S.A. Pilot Zone**

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1. Introduction

This document is the **Executive Summary** of the Environmental Characterisation Study of the ENONDAS S.A. Pilot Zone, describing in a coherent and synthetic manner the essential issues covered in the Environmental Characterisation Report of the Portuguese Pilot Zone.

The Executive Summary is written in a language and format understandable to the generality of those potentially interested and is a document to be shared with the general public. For more detailed information, please refer to the complete Environmental Characterisation Report on the ENONDAS webpage www.oceanplug.pt.

The national Pilot Zone (PZ) was determined in Decree-Law no. 5/2008 of January 8th, with the objective of exploring, in territorial waters, the generation of electric energy from the power of sea waves, aiming, generally, at implementing offshore Renewable Energy, whose concession has been awarded to ENONDAS, S.A.

The Environmental Characterisation, compiling elements and information available at present time whilst also defining the scope and identifying additional work needed to be done, is intended to serve as a starting point for future environmental studies (EincA – Environmental Incidence Studies and/or EIA – Environmental Impact Assessments) required for projects that may be set up in the PZ.

In terms of methodology, the Environmental Characterisation Study was carried out according to the following stages:

- Stage 0 – Definition of the study area;
- Stage 1 – Organisation and collection of information
- Stage 2 – Environmental Characterisation;
- Stage 3 – Creation of the final report

The Environmental Characterisation Study is based on documental research, reference to aerial photography, cartography, legislation, and other elements available, complemented with field surveys to confirm the results of the documental research and close any existing gaps. Particularly, in the case of some descriptors, specific field surveys were carried out, aimed at characterising the situation occurring during the period when the study was made.

The study was carried out by a multidisciplinary team coordinated by **Atkins Portugal**, and took place between February and September 2014, covering the entire study area determined for the project.

Table 1.1 – Technical Team in charge of the Environmental Characterisation Report of the Pilot Zone

PROJECT RESPONSIBILITY	NAME	BACKGROUND
PROJECT COORDINATION	Cristina Reis	Environmental Engineer
ABIOTIC SYSTEM		
Climate	Raquel Lopes	Environmental Engineer
Water resources	Cristina Reis Cláudia Oliveira	Environmental Engineer Environmental Engineer
Hydrodynamics and sedimentology	Ana Sousa	Civil Engineer
Acoustic environment	Cristiano Soares	Systems and Computation Engineer

PROJECT RESPONSIBILITY	NAME	BACKGROUND
BIOTIC SYSTEM		
Aquatic flora	Helena Coelho	Biologist
Benthic ecosystems	Sérgio Leandro	Biologist
Fish	Nuno Vasco Rodrigues	Biologist
Marine ecology	Sandra Rodrigues Paulo Maranhão	Biologist Biologist
Marine mammals	Inês Figueiredo	Biologist
Flying vertebrates	Ross McGregor	Ecologist, Doctorate in Zoology
	Ana Teresa Marques	Biologist
SOCIO-ECONOMIC SYSTEM		
Landscape	Cláudia Sequeira	Landscape Architect
	Maria Lopes	Landscape Architect
Territorial and maritime spatial planning	Marlene Francisco	Geography and Regional Planning
	Ana Roxo	Architect
Waste	Raquel Lopes	Environmental Engineer
Population and economic activities	Marlene Francisco	Geography and Regional Planning
Archaeological Heritage	Jorge Freire	History, master in Archaeology
	Alexandre Canha	Archaeologist
GIS and Cartography		
GIS and Cartography	Hugo Faria	Drafter

2. Study Area

The national Pilot Zone (PZ) was defined in Decree-Law no. 5/2008 of January 8th, to explore, in territorial waters, the generation of electric energy from the power of sea waves, aiming, generally, at implementing offshore Renewable Energy.

The PZ consists of the maritime space in waters under national jurisdiction over 30 m deep (offshore), and occupies an area of 320 km², located 5-8 km off the coast of the municipalities of Marinha Grande and Leiria. The area is under maritime jurisdiction of two harbourmaster's offices from the North Maritime Department (Capitania da Figueira da Foz), and the Centre Maritime Department (Capitania da Nazaré), responsible for the preservation of the marine environment and shipping safety.

The Image below demonstrates the administrative framework and the PZ delimitation, as well as the channels for the electric cables, which will enable the connection of the PZ to the mainland (each around 500 m wide).

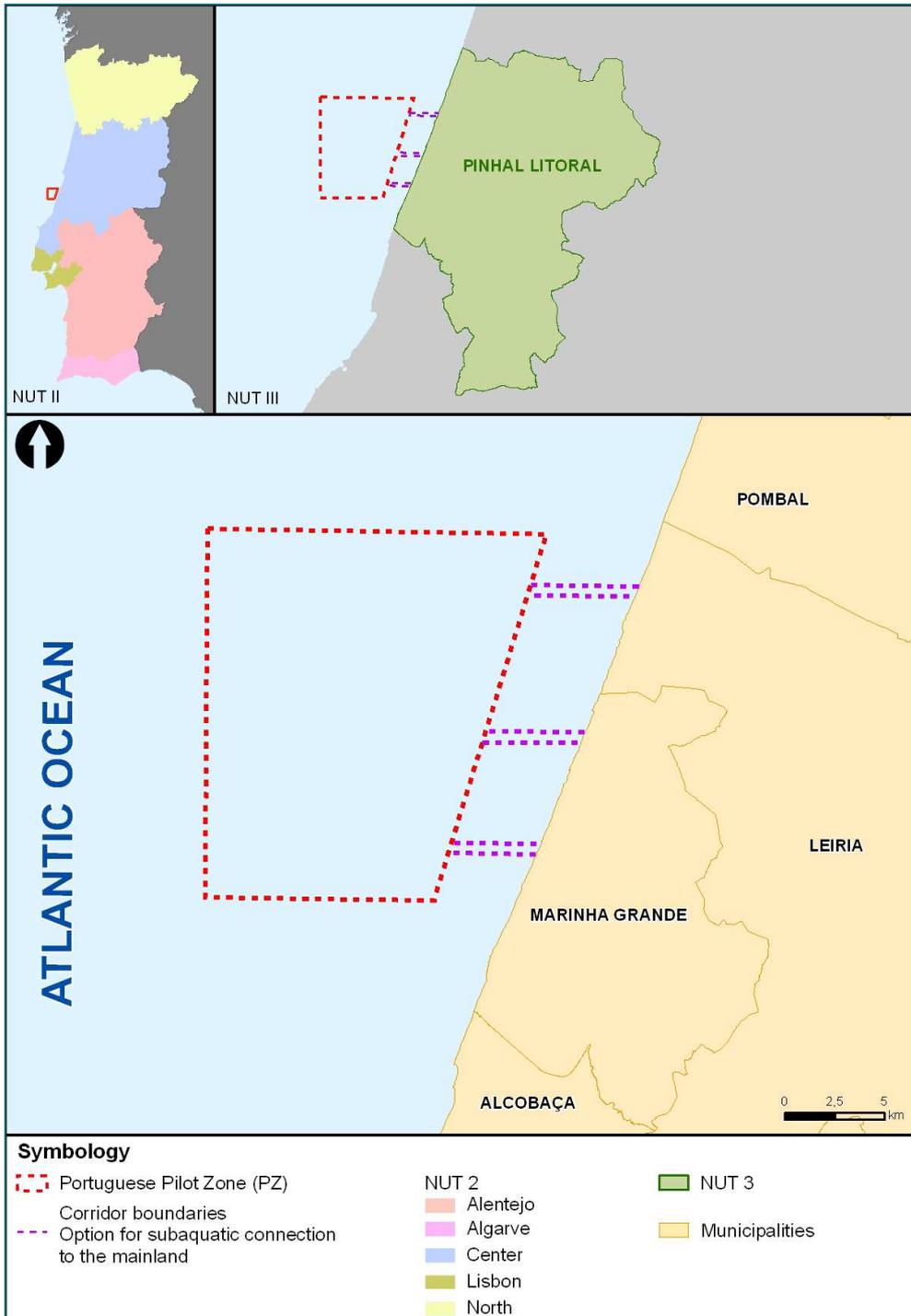


Image 2.1 – Administrative Framework. Delimitation of the Pilot Zone and the corridors connecting to the mainland

The PZ is located above the continental shelf, corresponding to a zone intensively exploited by the fishing sector. The continental shelf along the area is narrow, and has a discontinuity, forming the *Nazaré Canyon*, an underwater valley over 2000 m deep. This occurrence imposes a strong oceanic influence characterized by a heavy swell, predominantly from the Northwest (NO, 71.3%) and West (18%) (Costa *et al.* 2011). During Summer time, the area is characterized also by the occurrence of deep water resurgences of high intensity.

The marine environment has very peculiar physical characteristics, which support rich animal and plant communities, with the relevant occurrence of high biologic values regarding birds. However, the PZ is not covered by any area of the National System of Classified Areas (SNAC)¹, which incorporates protected areas, Natura 2000 sites, and remaining classified areas under international commitments undertaken by the Portuguese State.

For the purpose of the PZ framework, and to collect information regarding descriptors on land territorial incidence, a study area was determined, which encompasses the PZ and the surrounding terrestrial zone, up to a distance of 100 m from the high-water line. The representation of this area is shown in the Image below.

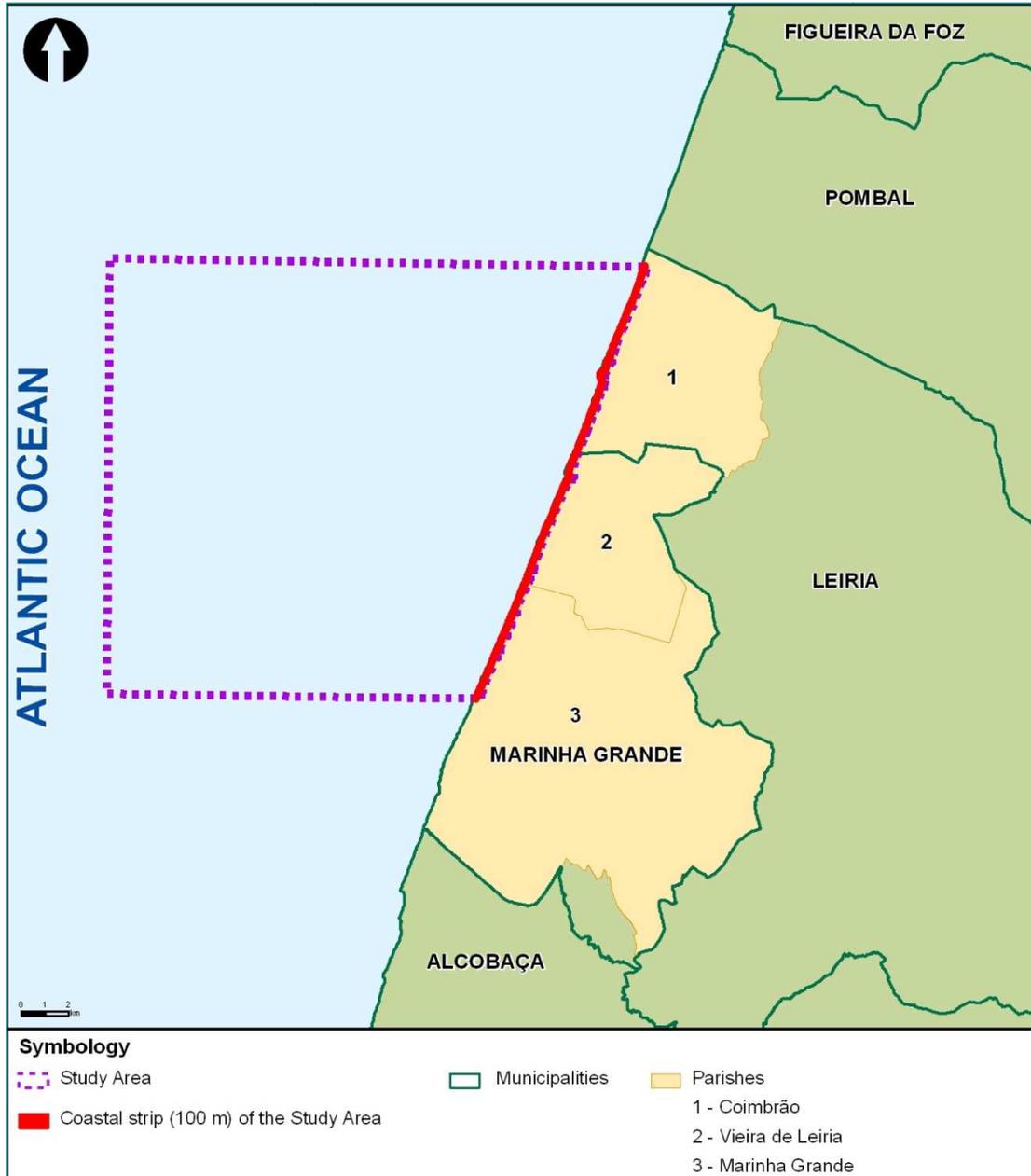


Image 2.2 – Delimitation of the study area

¹ Decree-Law no. 142/2008, 24 July

3. Legislative Context

The National Strategy for the Seas, created by Resolution of the Council of Ministers no. 163/2006², December 12th, established a set of actions and steps, namely concerning the investment in renewable energies.

In 2008 the legal framework for the use of the resources of the Public Maritime Domain was established, including the use of territorial waters for the production of electric energy from renewable energy of oceanic source or location within the **Pilot Zone (PZ)**, as well as the management regime, access, and performance of said activity (Decree-Law no. 5/2008³, of January 8th). The PZ is the maritime space defined under national sovereignty or jurisdiction in waters over 30 m deep (offshore), within which the promotion of the production of electric energy based on the power of sea waves is intended, as well as carrying out other activities, in accordance with Decree-Law no. 5/2008⁴, of January 8th.

For this purpose, the **concession** for the exploitation of the PZ was awarded, which includes the permission to use the corridor for the implementation of connection infrastructures to the public power supply, and to use the water resources from the public water domain under a concession scheme, as identified in attachment I to Decree-Law no. 5/2008, of January 8th, as well as to monitor third party use of the water resources needed for the generation of electric energy from wave power. The bases for this concession were approved by Decree-Law no. 238/2008⁵, with the Portuguese State awarding ENONDAS (a company created by REN — Redes Energéticas Nacionais, SGPS, S. A.), an initial period of 45 years for the production of renewable energy of oceanic source or location, within a PZ.

With the approval of the National Energy Strategy (ENE2020) by Resolution of the Council of Ministers no. 29/2010⁶, in 2010, the need arises to reduce the country's external energy dependency, in view of a gradual national independence regarding fossil fuels and the reduction of energy imports through energy generated from indigenous sources. To this end, Portugal set the target of reducing imports of fossil fuels by EUR 2 billion by 2020.

Thus, the government predicted the stimulation of an industrial cluster linked to sea activities, enabling a PZ for the installation of devices in a pre-commercial phase, contributing to the development of the use of renewable energies, whose source or location is the ocean, and whose potential is estimated at 5 GW of power. The PZ shall have infrastructures that allow the installation of up to 250 MW.

2010 saw also the approval of the concession contract for exploitation, as a public service, of the PZ identified in Decree -Law no. 5/2008, of January 8th, and the private use of public water resources, including the use of territorial waters. (Resolution of the Council of Ministers no. 49/2010⁷, of July 1st).

In turn, the Plano de Ordenamento do Espaço Marítimo (POEM), 2011, intends, after the identification of spatial classes, to provide guidelines and standards for the management of maritime space and to achieve the following vision: *"A Maritime Space, which differentiates the national identity, sustainable, orderly and safe, supporting socio-economic activities and potentiating resources, based on knowledge, innovation, and geographical specificity". Thus, the POEM presents the purpose of " affirming the economic, environmental and social importance of the Sea, based on the promotion of the knowledge of natural resources and existing and potential activities, as well as on the integrated planning and adaptive management of the uses that develop in the maritime space in close coordination with the coastal zone management, with*

² Published in the Official Journal (Diário da República) no. 237, 1st series, of 12 December 2006

³ Published in the Official Journal (Diário da República) no. 5, 1st series, of 8 January 2008

⁴ Published in the Official Journal (Diário da República) no. 5, 1st series, of 8 January 2008

⁵ Published in the Official Journal (Diário da República) no. 241, 1st series, of 15 December 2008

⁶ Published in the Official Journal (Diário da República) no. 73, 1st series, of 15 April 2010

⁷ Published in the Official Journal (Diário da República) no. 126, 1st series, of 1 July 2010

*international, EU and national standards and other instruments of sectoral planning and territory management, involving different actors and agents*⁸.

Considering the types of projects to be implemented in the PZ, the creation of "pilot zones" intended for installing offshore units of renewable energy production in real size for tests in actual operating conditions stands out as a strategic bet of POEM⁹. In this context, its Action Program¹⁰ identifies as a structural measure the identification and delimitation of the areas of greatest potential for installation of offshore platforms for the production of marine energy (wind and waves) and setting procedures for their licensing and exploitation, including the preparation of procedures for granting these sites, identifying connection points to the public power supply.

In turn, the National Ocean Strategy 2013 - 2020 (ENM), adopted in 2014 by Resolution of the Council of Ministers no. 12/2014¹¹, is based on four strategic pillars: the reference territory, the size, the geography, the national identity, and it has the following vision: "*The Portugal-Sea is a national goal whose potential will be fulfilled by the economic, social and environmental enhancement of the ocean and the coastal areas, for the benefit of all Portuguese*".

This vision is embodied in an action plan, the Portugal-Sea Plan (PSP), which, in the Strategic Areas of Development of Non Living Resources, particularly in the Programmatic Area of Energy Resources that cover projects planned in the PZ, presents the goal of achieving the **research and evaluation of the combined potential of marine energy resources**, ensuring good environmental practices and social benefits of its future exploitation.

Also within the legal framework an exhaustive collection was made, as well as the corresponding summary, of all the general and specific legislation applied to the project, the site under consideration, and to the descriptors under evaluation.

⁸ Version of October 2011

⁹ Volume 5, Part 3 – Strategic Framework, Version of October 2011

¹⁰ Volume Synthesis – General Memory of the POEM proposal, Version of November 2012

¹¹ Published in the Official Journal (Diário da República) no. 30, 1st series, of 12 February 2014

4. Benchmark Characterisation

The PZ Environmental Characterisation is intended to be used as reference for any environmental studies, which will be carried out for each of the projects that may occur in the PZ.

The detail and the quality of the characterisation carried out should contribute to reduce the requirements of the characterisation to be developed by the promoters, allowing to speed up the project implementation process, which may be seen as a positive aspect for the installation in the PZ.

The aim is, thus, to carry out a characterisation of the descriptors seen as more relevant due to their guiding character and their specific relevance for the area under analysis, without claiming to answer all the legal requirements for the execution of the environmental studies required in subsequent phases and based on the projects to be implemented.

The descriptors characterized within the scope of this study are the following:

Table 4.1 - Environmental Descriptors selected for the Environmental Characterisation of the Portuguese Pilot Zone

System	Descriptor
Abiotic	Climate
	Water resources – Water Status and Environmental Status
	Hydrodynamics, sedimentology, geology, seismicity, and neotectonics
	Acoustic environment
Biotic	Aquatic flora
	Benthic ecosystems
	Ichthiofauna
	Sea turtles
	Marine mammals
	Flying vertebrates
Socioeconomic	Landscape
	Territorial and maritime spatial planning
	Waste
	Population and economic activities
	Archaeological heritage

4.1. Abiotic System

4.1.1. Climate

The climate characterisation was carried out by means of existing studies and bibliography, namely the data from the climate normals of S. Pedro de Moel and Marinha Grande weather stations, which are considered to be the most representative of the area under study, and the climate data from the directional wave buoy provided by ENONDAS.

Within the framework of the climate characterisation carried out, regarding **extreme events** it is worth mentioning the number of frost days (29,9 days at the Marinha Grande station) and the number of thunder days (11.8 days at Marinha Grande and 10.5 days at S. Pedro de Moel). The remaining meteors are not noteworthy due to a very low frequency of occurrence.

The occurrence of **fog** in the area under study represents a very low percentage: an average of 52.3 e 27.5 fog days occur per year at Marinha and S. Pedro de Moel stations, respectively, the higher values occurring during the Summer (8.1 days in August in Marinha Grande, and 6.3 days in September in S. Pedro de Moel) and the lower values in Winter (2.0 days in November in Marinha Grande, and 0.7 days in November in S. Pedro de Moel).

From the analysis of the **cloudiness** records, we can see that the minimum values (clear skies) occur in July and August, and the maximum number of overcast days occurred in January (16.7 days in Marinha Grande and 16.1 days in S. Pedro de Moel). Inversely, at the Marinha Grande weather station the data shows an annual **insolation** value of 2437.2 hours, corresponding to 54%, in which the maximum number of sunshine hours occurs in the months of July and August, and the minimum number in January and December.

The data analysis of the **air temperature** allows to establish that the study area is located in a region with a **Temperate Climate** ($20\text{ °C} < t < \geq 10\text{ °C}$), with an average annual temperature of 15.1 °C , and a **Temperate** ($20\text{ °C} < t < \geq 10\text{ °C}$) and **Cold Climate** ($10\text{ °C} < a < \geq 0\text{ °C}$), regarding the annual temperature range, with variations of 10.2 °C in Marinha Grande, and 7.4 °C and 7.6 °C in S. Pedro de Moel.

Regarding **wind regimes**, in terms of average annual values, the most frequent are North winds in both seasons (23.7% and 22.7% of all occurrences in Marinha Grande and S. Pedro de Moel, respectively), along Northwest winds in Marinha Grande (21.3% of all occurrences). It is also noted that North winds have the highest speeds (ca 14.2 km/h in Marinha Grande, and 13.3 km/h in S. Pedro de Moel), whereas the periods of calm (winds under 1 km/h) have an average value of 22.7% in Marinha Grande, and 6.8% in S. Pedro de Moel.

On the other hand, we can see that the data regarding the wind regime registered at the directional wave buoy lead to the conclusion that, in terms of average values, the South winds are the most frequent, and the average gust speed is 28.5 km/h , the highest average values occurring in the months of February and May 2012, at around 33.6 km/h .

Finally, the **precipitation** data analysis shows that the average annual precipitation varies between 909.4 mm at Marinha Grande station, and 710.2 mm (in 1964/1980) and 651.9 mm (in 1971/2000) at S. Pedro de Moel station, and the months with the highest rainfall are the Winter months, July and August being the driest months.

4.1.2. Water Resources

The characterisation of the water resources benchmark consisted in the characterisation of the ecological status of the coastal water bodies and of the environmental status of the marine environment.

In the first case, **ecological status of the coastal water bodies**, according to the analyzed data of the River Basin Management Plans, the coastal water body associated with river Lis presents a final classification of Good Ecological Status, whereas for the coastal water body associated with the West streams, the study area where the PZ is located, the ecological status is indeterminate.

Regarding the **environmental status of the marine environment**, considering the descriptors in the Marine Strategy Framework Directive¹², it can be concluded that, in general, the study area obtained the classification of Good Environmental Status Achieved.

¹² DQEM – Decree-Law no. 108/2010, of 13 October

4.1.3. Hydrodynamics, sedimentology, geology, seismicity, and neotectonics

In terms of methodology, the characterisation of the present descriptors was produced exclusively on a basis of desk work, referring to the “Geophysical Characterisation of the Pilot Zone Study” carried out by the Hydrographic Institute (Instituto Hidrográfico).

In the **hydrodynamics** characterisation, the following phenomena are covered: tidal regime, sea disturbance, currents and swell.

The **tidal regime** was determined for the Figueira da Foz “Cais dos Serviços” station and compared to the tidal level of the Nazaré and Peniche stations revealing that the levels are identical in all stations. Figueira da Foz station presented the highest astronomical tide calculated value of 3.98 m, and the lowest astronomical tide calculated value of 0.07 m. Regarding tidal range (the difference between the value of the highest astronomical tide, and the value of the lowest astronomical tide), it has been found that Nazaré station presents values slightly higher (3.95 m) than those of Figueira da Foz station (3.91 m). Peniche station is the one with the smaller tidal range (3.68 m). Regarding the value of the water maximum height, it was observed at Figueira da Foz “Cais dos Serviços” station at 4.40 m (recorded on 1st March 2010). The minimum value of the water height was 0.18 m, also at Figueira da Foz “Cais dos Serviços” station, on 25th September 1984.

In what concerns **current** characterisation, the collected data refer to the period of time between January and March 2012 and a depth varying between 10 m and 50 m, and it shows that the current magnitude is relatively even along the different depths under analysis (10 m, 20 m, 30 m, and 40 m). According to observation during around 96% of the month of January, the marine current was flowing southward, and this situation continued during the month of February. During the month of March slight changes were observed in the wind patterns, i.e., there was a slight reduction in the wind speed, and the wind direction, unlike what had happened in the previous months, was not constant. The changes in the wind conditions led to a reduction of the marine currents strength, with no prevailing direction.

The study area characterisation in terms of **sea disturbance** was carried out based on data collected by the directional wave buoy for the “Geophysical Characterisation of the Pilot Zone Study”, and the same parameters were analysed as mentioned in the global characterisation (significant height (hm0), mean direction during peak period (Thtp), mean period (Tm02), and peak period (Tp)).

Thus, regarding the **significant height** the most frequent values, both during winter months and Summer months, fall under the 1 and 2 m class, around 39% and 67%, respectively. During the Winter months the 2-3 m and 3-4 m classes represent around 31% and 13%, respectively. Regarding heights over 7 m only one occurrence was recorded in December 2011. Regarding the Summer months, the second most significant class represent heights between 2-3 (approximately 16%) and the values over 5 m represent only 0.19%.

Regarding the **average period**, the most frequent values in the Winter months fall between 7 and 8 s (representing 24%), followed by the period between 8 and 9 s (approximately 23%), and the values under 1 s represent around 4%. In the Summer months, the most frequent values fall between 5-6 s, approximately 36%, followed by values between 6 and 7 s (around 33%). The values under 1 s represent 1%.

As to the **peak period**, around 19% of the Winter months' values fall between 12-13 s, followed by values between 11 and 12 s (around 16%). In the Summer months the most frequent values represent 8-9 s, around 21%, and the values of 9-10 s approximately 20%.

Regarding the **peak mean direction** associated with the peak period, we can see that both during the Winter and the Summer months the prevailing direction is Northwest, approximately 91% and 92%, respectively, followed by the North sector with values around 4% during the Winter months, and 6% during the Summer months.

The **swell** characterisation was carried out by referring to the same source of information, and covering the following parameters: wave height, wave direction, peak period, and energy period.

Thus, for the time frame between 1995 and 2010, the swell during the Winter months and transition periods presented high sea disturbance conditions, the monthly average wave height values being higher than 2 m, and the monthly average peak period being approximately 12 seconds.

According to the results obtained, the most frequent wave direction was Northwest (around 89%), generated by the low pressure systems to the East. Only 6% of the waves come from the West direction. Nevertheless, during the Winter months a rotation of the wave peak to the West-Northwest quadrant can be observed. It is, indeed, during the Winter period that the wave direction varies the most.

It should be noted that the PZ is subject to the occurrence of storms, which can originate waves higher than 5 m, and peaks with periods over 12 seconds, namely during the winter months, and the transition months. The months of May and June represent typical swell situations during the Summer months, with a monthly average wave height under 2 meters, and monthly average peak periods under 10 seconds.

During the Summer months the wave significant height ranged from 1.38 m (in July) to 2.07 m (in April) being generally under the annual average (2.04 m). As regards the Winter months, the monthly average is always higher than the annual average, ranging from 2.19 m in the month of October to 2.87 m in the month of January. It should be noted that the months of October and April represent the transition months of the Winter and Summer conditions, thus explaining the atypical values recorded when compared to the annual average.

Regarding the peak period during the Summer months, the values range from 8.43 s (July) to 10.69 s (April), whereas during the Winter months the values range from 12.20 s (January) to 10.92 s (October).

Regarding the energy period, as with the situations previously seen in the Summer months, the values are lower, ranging from 6.71 s (July) to 8.87 s (April), whereas in the Winter months the values range from 9.23 s (October) to 10.28 s (January), always above the annual average value. It should be noted that the highest values of the energy period represent an increase in wave height.

In the morphology characterisation the subaquatic morphology of the Pilot Zone and the corridors connecting to the mainland were analysed, and the characterisation of the coastal morphology of the beaches adjacent to the connection corridors (Pedras Negras beach, Vieira beach, and Pedrogão beach) were carried out.

The **subaquatic morphology** of the Pilot Zone is characterized between the bathymetric 30 m and 110 m, because it is a relatively flat area, with mild slopes, interrupted only where the abrupt transition occurs between different sedimentary deposits. Nevertheless, in the Northeast area an outcrop of chalk formations exists that can vary between 8 and 10 m (maximum 16 m) in height. This outcrop is quite extensive, and not totally covered by recent sediments. We can also see the occurrence of other rocky outcrops, located in the south area of the PZ, 45 m deep, and another one, around 6 m high, located on the south limit of the PZ, 65 m deep.

Regarding the morphology of the area of the three corridors for the connection cables (North, central, and South) the surveys carried out show that there are morphologic differences, namely the presence, in the South corridor, of a 5 m high and 400 m wide elevation.

As previously mentioned, the characterisation of the **coastal morphology** was carried out for the three beaches adjacent to the corridors for the electric cables, namely: Pedras Negras beach (South corridor), Vieira beach (central corridor), and Pedrogão beach (North corridor).

Pedras Negras beach is located in Marinha Grande Municipality, and is the beach adjacent to the southern corridor. According to the "Biophysical Characterisation of the Pilot Zone Study", the beach was divided into 4 profiles, which were analysed in the surveys carried out in June 2011, September 2011, December 2011, and March 2012.

The sediment accumulation values occur mainly in the central area of the beach, whereas the erosion situations occur at both ends of the beach, mainly between the South limit of the upper zone of the beach and the dune, and in the North limit, along the transverse profile of the beach.

Between the months of June and September 2011 the main variations on the beach resulted in the deposition of sediments, representing a volume of around 60.000 m³, i.e. with a positive balance of approximately 54.000 m³, and between the months of December 2011 and March 2012 the beach lost around 19.000 m³ of sediments, but it received approximately 38.000 m³ of sediments, resulting also in a

positive balance of around 19.000 m³. Thus, the balance of sediments throughout the analysis period suggests a growth of the beach area of around 49.000 m³, whereas the loss of sediments was around half that value, which results in a positive balance of approximately 22.000 m³.

Vieira beach is located in Marinha Grande Municipality, and is the beach adjacent to the central corridor. In the “Geophysical Characterisation of the Pilot Zone Study”, the beach was divided into 5 profiles, and the survey periods were the same as those of the previous beach.

During the months of June and September the balance of the sediment volume on the beach was negative (-5.774 m³), with a sediment increase of around 19.000 m³, and a loss of around 25.000 m³. During the months of September and December 2011 the beach erosion trend continued, with a negative balance of around -27.000 m³. During the period between the months of December 2011 and March 2012, however, a significant increase was recorded in the volume of sediments deposited on the beach (around 48.000 m³) and a loss of around 3.000 m³, resulting in a positive balance.

Pedrogão beach is located in Marinha Grande Municipality, and is the beach adjacent to the northern corridor. In the “Geophysical Characterisation of the Pilot Zone Study”, the beach was divided into 7 profiles, and the survey periods were the same as those of the previous beaches.

Between July and September 2011 Pedrogão beach saw an increase in the volume of sediments of around 32.000 m³, whereas the loss of sediments was approximately 9.000 m³, resulting in a positive balance of around 23.000 m³. From September to December 2011, the beach continued to grow, around 12.000 m³ of sediment accumulation, with a sediment erosion volume of around 8000 m³. During the following period the positive balance of sediments switched to a global negative balance (-2.000 m³) with the loss of a sediment volume of around 11.000 m³ and a sediment accumulation of approximately 8.000 m³. Thus, globally between June 2011 and March 2012 Pedrogão beach saw a positive balance of around 24.000 m³, with sediment accumulation values of approximately 30,000 m³ and erosion values of approximately 6.000 m³.

Overall, from the **sedimentology** characterisation four types of deposits can be identified in the Pilot Zone: sandy shoreline deposits (quite movable and subject to wave action); gravelly sands and gravels, formed in different sedimentary cycles, when the mean sea level was lower than it is today, sands and clayey sands, both formed by a mixture of ancient and modern particles. The sedimentary analysis was carried out taking into account the sediment texture, the mineral fraction, and the presence of calcium carbonate.

The sediments in the PZ present a texture corresponding to sediments formed essentially by sand, the deposits near the East and West limits containing over 50% of sand particles.

Analyzing the distribution of the average size of the sediments' grains it can be identified the presence of two areas in the central zone, corresponding to fine shingle deposits from the central platform, with predominance of coarse sand (diameter between -1 and 0) and fine gravel (diameter between -2 and -1). These deposits are delimited by a fine layer of sand (East-West limit).

On the other hand, the mineral fraction in the sandy sediments of the PZ is characterized by the presence of the following key minerals: calcite (20.9 %), mica / illite (15.9 %), zirconium (13.6 %), feldspar (13.6 %), plagioclase (12.8 %), and quartz (11.3%). In smaller quantity, the following minerals were identified: chlorite (3.4%), kaolin (3.3%), anhydrite (1.8%), siderite (1.3%), pyrite (1.3%), amphiboles, aragonite, ilmenite, and Mg-calcite.

Regarding the presence of calcium carbonate, the values identified in the samples collected in the PZ range from 1.67% to 49.98%. The highest values were found in the Northwest end along the rocky outcrops, coinciding with the highest values of calcite and silty clay. Regarding the value of the total organic carbon detected in the surface samples it was found that it is below the quantification limit (0.4%).

The characterisation of the **sediments of the beaches** adjacent to the corridors shows that, overall in the Pedras Negras beach the majority of the sediments represent medium sands, and in the scattering zone, particularly during the months of June and March, an important increase was noted in the percentage of coarse sand. Regarding Vieira beach most of the collected sediments represent coarse sands to medium sands, moderately graduate and with varying asymmetry. Finally, in Pedrogão beach the majority of the collected segments represent coarse and medium sands, and we can see that the “high beach” zone

(bottom of the dunes) shows some seasonal and longshore drift variability, whereas the “low beach” zone showed strong variability.

The characterisation of **sediment transport processes** in the tree corridors connecting the PZ to the mainland takes the characteristics of the marine currents and the waterborne particles into account.

The average between the highest, and lowest water level values recorded was 2,33 m in the southern corridor, 2,19 m in the central corridor, and 1,42 m in the northern corridor. However, the records of the marine currents show a significant asymmetry between South and North. The currents from the North are longer, and with higher speeds than the currents from the South.

During the Summer period the waterborne particle concentrations are, in general, reduced in the southern corridor, with an average concentration of 80 ml/l (88 cm above the bottom), and 150 mg/l (48 cm above the bottom). In the central corridor the waterborne particle concentrations are two orders of magnitude higher than the concentrations recorded in the southern and northern corridors, which are similar. During the Winter period, the waterborne particle concentrations recorded are, generally lower, particularly in the central corridor.

Regarding the characterisation of the **sediment quality**, we can see that the pH values found in the PZ do not show a very significant variation (between 8.09 and 9.08), the greatest contribution coming from the interstitial water in the sediments; the percentage of organic matter found in the sediments reveals some variability along the PZ, the maximum value being 5.5%, the minimum <0.8%, and the medium value 2.3%. The lowest values were found closer to the shore; the value of nutrients found in the sediments is rather heterogeneous, the nitrate and ammonium values being rather low, while the phosphorous values are slightly higher; regarding contamination with heavy metals (As, Hg, Cr, Pb e Zn) the data in the PZ allows us to classify them as “Class 1: Clean dragged material”, except for the heavy metal – Arsenic, whose concentration found in some of the sediments leads to a classification as “Class 3: Slightly contaminated dragged material”.

The **geologic** characterisation of the study area (aquatic and terrestrial zone) highlights the fact that the coastal zone in question is formed by a succession of wide and extensive beaches, limited by 5 km wide dunes from the Holocene Epoch. These deposits are superposed on ancient formations, such as detritic rocks from the Pliocene, sands and clays from the Miocene, detritic layers from the Eocene-Oligocene, and carbonates from the Cretaceous and the Jurassic.

According to a tectonostratigraphic diagram of mainland Portugal (adapted from the Portugal Geological map, scale 1:1 000 000, 2010) the study area is located in the Mezo-Cenozoic Basin, and is part of the groups Lusitania Basin (interior basin), and Peniche Basin (external basins).

We can also see that the area above water presents formations from the Cenozoic, Quaternary, Holocene from the Mezo-Cenozoic Basin, represented by sands, gravel beds, silts, and clays, whereas the formations in the area under water range from Cenozoic to Mesozoic formations, represented by sands and limestones, along with clays, silts, dolomites, sandstones, and argillites, among others.

Regarding potential existing geologic resources, according to the information received from the Directorate-General of Geology and Energy, the PZ is entirely located in a potential area of sand and gravel extraction.

Regarding **neotectonic seismicity**, according to the Chart of Historic Seismic Intensity recorded in mainland Portugal, modified Mercalli scale (applicable only to the Earth’s surface), the study area in the terrestrial zone is located in an area with a seismic intensity rate VIII, whereas according to the Maximum Seismic Intensity Chart the area in question falls in a zone of seismic intensity rate VII (very strong).

On the other hand, according to the **Regulation of Safety and Actions for Buildings and Bridges Structures**, which quantifies the actions of earthquakes in Portugal, the study area in the terrestrial zone is located within the earthquake zone B, which is the second with highest seismicity in mainland Portugal.

In terms of neotectonics, the Pilot Zone is located on the Eurasian plate, to the north of the Azores-Gibraltar fault, and is crossed by a probable active fault with an unknown type of movement.

4.1.4. Acoustic Environment

The characterisation of the underwater noise of the study area was carried out based on a field data survey, through the implementation of a monitoring campaign in May 2014, and reference information research. The campaign took place over 2 days, and consisted of obtaining environmental noise recordings at the 4 vertices and in a position at the centre of the study area. During each of the days observations were carried out of the underwater noise at one of the 5 positions planned.

The characterisation strategy implemented in this campaign consisted of a reference measurement, which is why the current sources of noise are mainly natural (e.g. wind, swell, etc.) and arising from the presence of fishing vessels operating in the area that can be included in the so called ambient noise or background noise, considered a low frequency continuous noise. For that reason, the analysis favoured a statistical analysis based on averages and percentiles, in order to obtain exceedance thresholds for representative observation intervals.

From the observations obtained, and the corresponding analysis, the following conclusions can be drawn:

- The degree of sound contamination of the area comprising the pilot zone depends on the sampling site;
- The sampling sites to the South present higher levels of anthropogenic noise than the sites to the North. This situation arises from the local vessel traffic, and is directly related to the access to the Port of Nazaré;
- The central sampling site revealed the influence of the maritime traffic on the assessment of the sound levels obtained;
- At the sites to the North it is not clear that the maritime traffic has influenced the assessment of the sound levels obtained;
- It was found that at the sampling places to the South the variation between the two days was significant, as a result of the maritime traffic variability at the time.

4.2. Biotic System

4.2.1. Aquatic Flora

The characterisation of the aquatic flora in the PZ was carried out based on reference to databases, studies, experts, and entities. This descriptor was analysed in the light of 3 sub-themes: habitats, phytoplankton, and other flora.

In the study area and immediate surroundings the potential presence of **8 Habitats** was identified, as determined in Decree-Law no. 140/99 of April 24th, amended by Decree-Law no. 49/2005 of February 24th, and by Decree-Law no. 156-A/2013 of November 8th. The habitats listed are relatively common in the country, with the occurrence of some whose presence in the study area and direct coastal surroundings is unlikely or restricted to the final course of river Liz. The habitats identified are the following: Habitat 1110 – Sandbanks which are slightly covered by sea water all the time; Habitat 1170 – Reefs; Habitat 1210 – Annual vegetation of drift lines; Habitat 1310 – Salicornia and other annuals colonizing mud and sand; Habitat 1330 – Atlantic salt meadows (*Glaucopuccinellietalia maritima*); Habitat 1420 – Mediterranean and thermo-Atlantic halophilous scrubs (*Sacocornetea fruticosi*); Habitat 1430 – Halo-nitrophilous scrubs (*Pegano-Salsoletea*); and Habitat 8330 – Submerged or partially submerged sea caves.

With regard to **phytoplankton**, this includes pelagic marine ecosystems, which are open systems, characterized by the existence of reduced barriers to movement and wherein the biological processes generally occur at scales which can reach thousands of kilometres.

The ecology and particularly the planktonic structure of the study area is significantly poorly known, but given the continuity of pelagic systems (open ocean waters above the benthic environment of the bottom of the

sea) it is considered that the planktonic processes, as far as the PZ is concerned, can't be separated from those occurring in broader areas of the Portuguese continental shelf.

From the studies consulted it was possible to determine that the phytoplankton community is composed mainly of diatomaceae (around 92%), often associated with the resurgence process, and forming small chains of small and medium size. A characterisation was also carried out of the phytoplanktonic biomass distribution patterns (chlorophyll *a*), which are generally associated with the stratification conditions of the water column, nutrients availability, and intensity or persistence of coastal upwelling, a gradual biomass increase occurring from late Winter up to the maximum peak recorded over the Spring period.

Regarding other **aquatic flora**, the presence of macro-algae should be noted, particularly associated with the coastal area. Studies of this aspect regarding the study area or direct coastal surroundings are scarce or nonexistent, however several sampling actions have been carried out in northern Portugal, and at Berlengas Natural Reserve, located south of the project area. By consulting experts and professional literature, it was possible to inventory 86 macroalgae species for the study area and its surroundings.

4.2.2. Benthic Ecosystems

The characterisation of the benthic ecosystem in the study area involved the identification of the benthic community potentially present in the PZ, particularly in terms of its structure and composition, as well as the definition of a reference mapping of the habitats. The characterisation was carried out based on bibliography consultation and information research in the study area and its surroundings.

The benthic environment of the study area is mostly made up of moving sediment, with some rocky outcrops which represent a small fraction of the substrate in the area. Based on the assessment carried out within the scope of the implementation of the Marine Strategy Framework Directive (MSFD) in Portugal, it was considered that in the vast northwest coast of the continent subdivision in which the study area is located, two types of benthic habitats may occur:

- sedimentary coastal benthic (0 – 50 m);
- sedimentary continental shelf benthic (50 e 150 m).

The European Environment Agency (EEA) in collaboration with experts from various European institutions has developed a hierarchical classification system of habitat / biotope consisting of 5 levels (UNIS / European Nature Information System), and 4 habitats were mapped in the study area based on this system, namely habitats A5.25 - Circalittoral fine sand, A5.27 – Deep circalittoral sand, A5.44 - Circalittoral mixed sediments, A5.45 – Deep mixed sediments.

With regard to the structure and composition of the benthic community, given the nearly total lack of data for the study area, it was only possible to present a set of species, which make up the potential benthic community of the existing moving sediment. Of these, it was observed that polychaeta are the group with the greatest diversity, followed by molluscs and crustaceans. However, the lack of robust data on density and biomass of the species prevents a more detailed analysis of the community structure. In the list presented, it was only possible to confirm nine species, which result from a one-off sampling and have very low abundances. Considering the existing rocky outcrop in the study area, it was also possible to provide a list of macrobenthic fauna species, which may occur on that substrate. This characterisation was based on literature on the characterisation of adjacent areas.

4.2.3. Fish

The characterisation of the fish species in the PZ area encompassed the ecological and biological characterisation of the potentially present and migratory species in the PZ, particularly in terms of the characterisation of the species present and the identification of species under protection status in the area and its surroundings, as well as the identification of the corresponding fisheries relevance, although it hasn't been possible to accurately determine whether the catch / species landed in fish auctions adjacent to the study area (Nazaré and Figueira da Foz) were caught in the study area.

In addition to the reference to databases and entities, contacts were established with fishermen, vessel owners, and facilitators of fish auctions in Nazaré and Figueira da Foz, as well as Vieira de Leiria beach and its market in April 2014 with a view to identifying the species and their potential origin. Based on the information gathered, a list of the species identified by these partners was created, and the conclusion was reached that these form the basis of the existing fish community in the study area.

The most numerous family in terms of species includes commercially relevant fish such as the white seabream, the porgy, and the gilt-head bream, among others. In association with this group, regarding conservation it is relevant to note the presence of the grouper, classified as "Endangered" by the International Union for Conservation of Nature and Natural Resources Red List (IUCN Red List), as well as some tuna species.

With regards to sharks specified reference information was consulted, highlighting the possible presence of three species in the study area, namely the blue shark, considered Near Threatened by the IUCN Red List, the shortfin mako, and the carcharhinus, both classified with the Vulnerable status. The literature review and consultations resulted in no specific records of this group for the area.

The sardine, the sarda, the mackerel, and the horse mackerel are also part of the community identified. These are the most important species caught using the encircling method or *Xávega*, the main gear used by the fleet of small vessels operating in areas adjacent to the PZ. In addition, it is also worth mentioning the existence of the conger eel, and some batoidea species, as these are also part of the fishery resources landed (in large quantities) in the ports adjacent to the area under study.



Image 4.1 – Photography of fish caught in the coastal area adjacent to the study area using the circling method, and sold at the market in Vieira de Leiria beach (April 2014).

4.2.4. Sea turtles

The characterisation of the PZ in terms of use by marine reptiles took into account the identification of the species most likely to occur in the area, and the possibility that these species may be affected in the PZ. For this group, it was observed that there is still a great lack of information on the occurrence and use of the marine area by this type of organisms, both for lack of targeted studies and for lack of availability of the existing information from ongoing projects.

The community of marine reptiles occurring in mainland Portugal, and specifically in the study area and surroundings, is considered to occur occasionally since there are no records of any species breeding in Portugal and they are only occasionally found in our waters, which reveals that they won't be using the area

permanently. According to the literature review of the possible distribution of the 7 species of marine reptiles in the world, only five have possible occurrence in the study area since one of them comes from the region of Australia (Australian Turtle or Flatback Sea Turtle) and another has the Cape Verde islands as its most northern Atlantic distribution limit (Olive Ridley Sea Turtle). Overall, the existing species in Portugal are rare in continental waters, although they can be regularly observed in the Algarve and often in Madeira and the Azores.

The Logger-head Sea Turtle is considered abundant in the islands, but in continental waters it is only considered to occur often as this is part of its development area for the pelagic juvenile phase. This species represents the only confirmation in the study area and its surroundings.

The Leatherback Sea Turtle is also one of the species most frequently found in the waters of mainland Portugal, compared with the other species of extremely rare occurrence. Studies indicate that in Portugal this species appears to use the more offshore zone without approaching the shore, unlike the Logger-head Sea Turtle.

The Kemp's Ridley Sea Turtle is one of the rarest species in the world being, therefore, "Critically Endangered", and it is also one of the species that may occur in the study area. The use of the mainland Portugal marine zone by this species is considered accidental (carried by currents to European waters) by some authors. However, there is some controversy regarding the possibility of this area being part of its natural distribution, and it is possible that the low frequency of occurrence is influenced by the rarity of the species and the ease in being mistaken for the Logger-head Sea Turtle. Its frequency of occurrence in Portuguese waters in proportion to the Logger-head Sea Turtle is 1:100.

4.2.5. Marine Mammals

The characterisation of marine mammals aimed at identifying confirmed and potential species in the study area, spatial and temporal distribution of the species in vicinity of the PZ, and the presence of offspring/juveniles, among other factors.

The information collected did not confirm the presence of other species in addition to the common dolphin in the PZ, nor did it identify how the different species use the PZ or their distribution over time. Although there are elements that refer to their spatial distribution and preferred areas in the PZ surroundings, their movements are unknown both throughout the day and throughout the year for most species. It hasn't yet been possible to obtain information on feeding patterns and distribution of prey and predators for the species of marine mammals confirmed and of possible occurrence in the study area (see limiting factors).

The most common marine mammals in Portuguese continental waters belong to the cetaceans group, and are divided into two superfamilies: the odontocetes (toothed whales) and the mysticetes (baleen whales). There are records of the occurrence of at least 26 cetacean species belonging to seven different families. These records comprise direct observations at sea but most concern washed up animals (stranded on the coast).

Of the six species of cetaceans considered resident in the waters of mainland Portugal, and according to the available data regarding their distribution and preferred habitat, 4 are more likely to be present in the PZ: the bottlenose dolphin, the common dolphin, the La Plata dolphin, and the minke whale. As mentioned above, and according to the data available during the preparation of this study, the common dolphin is the only species confirmed in the study area. The La Plata dolphin, and the minke whale are categorized as threatened in the Red Book of Vertebrates of Portugal with the Vulnerable status. However, all cetaceans are protected by national and international legislation, and there are countless treaties and agreements involving these animals and / or their habitats.

Essentially from the analysis of wash ups (strandings on the coast) in mainland Portugal, two other species of cetaceans may be present in the study area: the pilot whale and the Risso's dolphin. Although it has an oceanic distribution, the pilot whale is a regular presence in the Portuguese continental waters, and recent observations indicate that it approaches the coast to areas with depths between 50 and 100 meters. The Risso's dolphin is distributed along the entire Portuguese Continental Shelf, and it can be seen in shallower

coastal areas. Recent observations of this species in the Peniche area include three sightings in the months of February and April.

Other marine mammals may accidentally occur in the Portuguese continental waters, and therefore be present in the study area, such as seals and sea lions. Five species of seals were recorded in mainland Portugal: the grey seal, the harbour seal, the ringed seal, the hooded seal, and the bearded seal.

There are no known migratory routes of marine mammals, which may coincide with the PZ area.

4.2.6. Flying vertebrates

The characterisation of the flying vertebrate community within the PZ covered two groups: marine birds, and bats.

Regarding the framework of the study area in terms of relevant areas for **seabirds** or areas of the National System of Classified Areas (SNAC = Sistema Nacional de Áreas Classificadas, the PZ only partially covers the Marine Important Bird Area (Important Bird Area – IBA) of Figueira da Foz (PTM01), as seen in Image 4.3. Important or classified terrestrial areas are not covered, the closest to the north and east being the Mondego Estuary IBA (PT039), about 23 km northeast, and the Site of Community Interest (SCI) Dunas de Mira, Gândara, and Gafanhas (PTCON0055), SCI Azabuxo / Leiria (PTCON0046), and SCI Serras d' Aire e Candeeiros (PTCON0015). Of these three only the first is located within the coastline, being therefore closer to the study area in terms of relevance and similarity of the species present. To the South/southwest of the PZ we find the set of classified areas of the highest relevance in terms of the marine community they harbour, comprising Peniche / Berlengas, namely Berlengas Natural Reserve, the SCI Peniche / Santa Cruz (PTCON0056) and Arquipélago da Berlenga (PTCON0006), the Special Protection Area (SPA) Berlengas Islands (PTZPE0009), the IBA Berlenga and Farilhões (PT014) and, finally, the marine IBA Berlengas (PTM02), which is an extension of the terrestrial IBA, and is located at a minimum distance of about 25 km from the PZ.

From the inventory prepared, 10 species were identified with a high conservation status, i.e., classified in mainland Portugal as "Vulnerable", "Endangered" or "Critically Endangered", according to the Red Book of Vertebrates of Portugal, which occur in different periods and abundance according to their adaptation to climate, ecology and global situation of each species. Most of the listed species occur in Portugal as migratory or wintering, nesting being very rare (in the surroundings of the study area only in Berlenga), and they are experts in capturing their prey mainly by diving, which may occur at different depths.

It is noted that many species of seabirds use national waters during migration and for longer periods, making it often possible to see in the area species such as the shearwater, the gadfly petrel, the tarrock, and the seagull, which may remain in our territory. These species were also the species with the highest number of recorded observations, and the ones for which it was possible to prepare maps of distribution within the PZ.

Among these, the gadfly petrel population is particularly important, and the species can be observed throughout the year and in significant numbers. However, it is most abundant during the winter months, or migratory passage to its nesting territories.

Regarding other seabirds (observed or potential), with the available data it is not possible to confirm in greater detail the usage patterns (temporal and spatial) within the PZ and associated corridors, the exception being the sanderling.

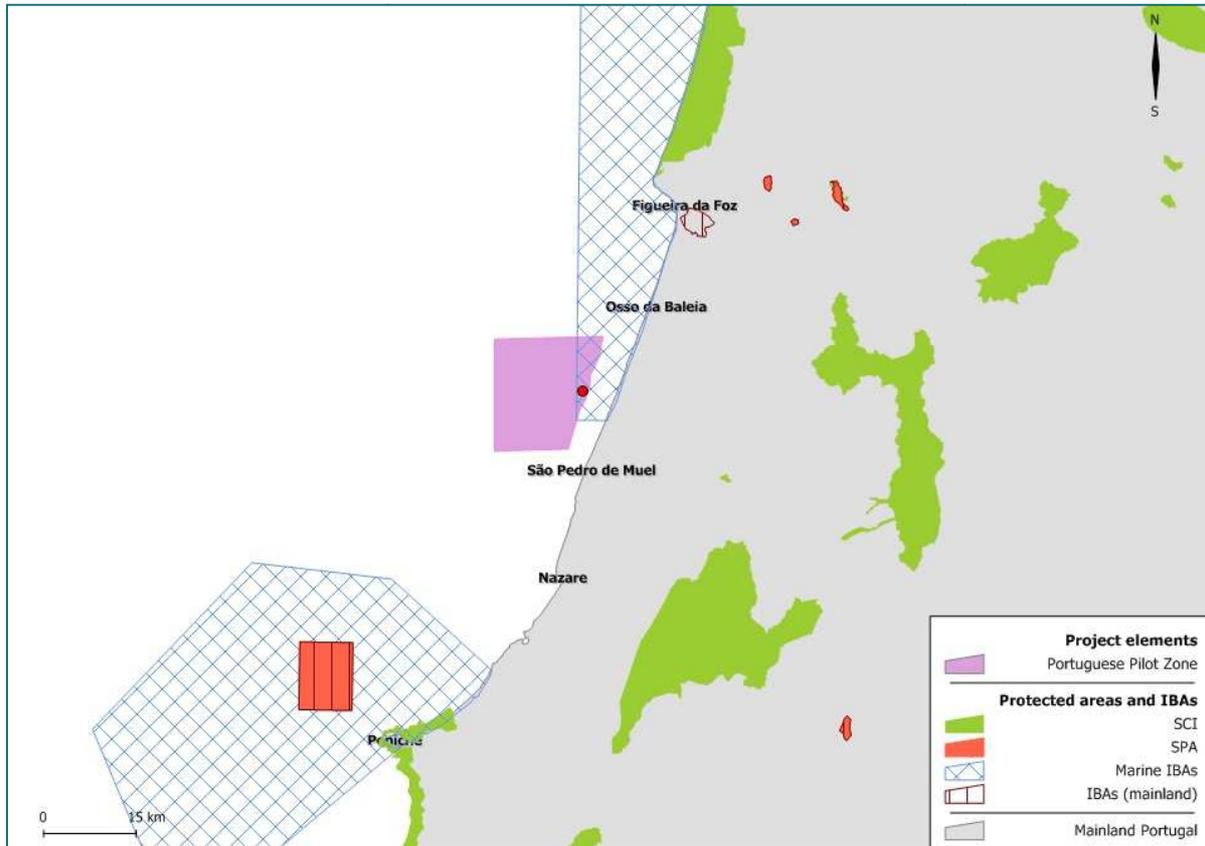


Image 4.2 – Framework of the study area for relevant areas (coastal, at sea or ashore) in terms of the diversity they harbour: Areas of the National System of Classified Areas (SNAC)- SCI and SPA; Important Bird Areas - terrestrial IBAs and marine IBAs.

According to the analysis carried out for the species recorded, those that could potentially be more sensitive were identified, taking into account the susceptibility to potential impacts associated with the types of projects / prototypes to implement in the PZ,.

As regards the seabird species in the PZ, considered to be the most sensitive were all the species with a high conservation status in Portugal ("Vulnerable", "Endangered" or "Critically Endangered"), as well as species that have behavioural characteristics (eg. feeding strategies) and/or abundance in the study area that can lead to significant impacts on their populations and have the potential to cause damage to the infrastructures. This selection resulted in the listing of 10 species considered the most relevant to the study, namely, the guillemot, the great black-backed gull, the shearwater, the little tern, the gadfly petrel, the tern, the lesser black-backed gull, the yellow-legged gull, the European shag, the common scoter, and the band-rumped storm petrel.

Currently there is not much knowledge about **bat** communities in offshore areas, particularly within the PZ, where no specific research has been carried out to date, at least none that has been published. Thus, the benchmark is strongly based on the existing bat community in the nearest coastal area to the study area and on the knowledge that has been obtained in northern Europe on bats in marine environments, particularly in Germany and the Scandinavian Peninsula, where offshore wind investment is already in place. Information was also gathered on migratory species, which may therefore tend to move through marine areas.

The Leiria National Forest is the nearest woodland to the PZ under study, and it is a forest set on a dune environment populated mainly with maritime pine. The literature research allowed the listing of 13 species / species groups of bats in this area, 5 of them classified with unfavourable statuses: the common bent-wing bat, the greater mouse-eared bat, and the *Myotis escalerai* classified as "Vulnerable", Bechstein's bat, classified as "Endangered", and the lesser mouse-eared bat, classified as "Critically Endangered".

It should be noted that of all these only the *Myotis escaleraei* has been confirmed, while the others belong to species groups and therefore their occurrence is possible. However, in the case of the greater mouse-eared bat and the lesser mouse-eared bat, although neither confirmed, they belong to a group comprised of only these two species, and it is certain that at least one of them will occur in the area.

In the vicinity of the pilot area there are six species, ranging between confirmed and possible, that show evidence of migration. The risk of collision with wind turbines onshore is documented in 3 species.

As regards the existence of shelters, the information collected has shown that no shelters are known in the immediate surroundings (10 km vicinity) of the PZ under study. The closest shelter of national importance known is about 45 km from the coastline.

4.3. Socioeconomic System

4.3.1. Landscape

The study area encompassing the mouth of the river Lis, presents a landscape dominated by marine presence and influence, which contributes to the frequent formation of morning mists, which, in turn, limit the visual connections between the coastline and the offshore sea. The landscape shows great homogeneity, also by virtue of the articulation between topography and climate. The terrain is essentially level, contrasting with the existing inland mountain formations (to the East), allowing for some different ambiances: *the interior of pine forests (diffused light, tranquillity and freshness, but also monotony, and reduced depth of views), the shoreline (relaxation, and open views, movement and light filtered only by atmospheric moisture (...)).*¹³

These physiographic and climatic characteristics stress the restrictions on the use of the land, the formation of dunes occurring from extensive sandy areas at low altitude, which gradually evolve into extensive pine forests (Leiria pine forest). The narrow coastal strip is sparsely populated, despite the demand during the summer.

In the area covered by the present study area, no areas whose relative altitude would allow for the visualization of vaster and more varied panoramas stand out, as the entire sea front is favoured by the absence of visual obstacles towards the vast oceanic water plane, while towards the interior the landscape is limited by the continued presence of the pine forest. The nearest scenic spot is Penedo da Saudade, on the cliffs of S. Pedro de Moel, 2892 m south of the study area and more than 4 km away from the PZ, therefore no visual connections are taken into account within the scope of the projects in question.

On a more local approach it is possible to identify eight landscape subunits for which a scenic characterisation was carried out - quality, absorption capacity, and visual sensitivity:

- Naturalized beach zone - narrow and rectilinear strips of beaches with generally medium to fine sands, and with no rock formations, under tidal influence, and whose coastal dynamics provides for the absence of any vegetation, the level and profile changing throughout the year, according to the seasonal trends of erosion and deposition of sand. In this subunit there is no support equipment to bathing activities, and there is very little human influence, despite its use mainly throughout the Summer.

This naturalization effect, associated with the presence of the sea, lead to its visual quality being high, but not very high, however, since there are no notable elements. In the absence of visual obstacles towards the "high seas", and considering only the effect of frequent mists and the waves themselves upon the visual acuity, it is considered that the visual absorption capacity is low. The presence of observers in this subunit varies greatly throughout the year, leading to visual sensitivity being consequently medium to high.

¹³ Study "Contributos para a Identificação e Caracterização da Paisagem em Portugal Continental" (Contributions for Landscape Identification and Characterisation in Mainland Portugal) (carried out by the University of Évora) – volume III, p. 151.

It is within this subunit that the corridors planned for the submerged connections of the PZ are intended for, each to its parish (Coimbrão to the North, Vieira de Leiria in the centre, and Marinha Grande to the South).

- Primary dune zone - can be clearly distinguished from the previous zone by the existence of natural slopes of greater or smaller height between the beach zone and the beginning of the dune surface, with the presence of vegetation, which becomes denser and more varied towards the interior, culminating in the more established areas of maritime pine (outside the boundary of the study area).

This subunit is embedded in a corridor between the mass of the ocean to the west and that of the dense pine forest to the east, which associated with the disorder of the trails that cross the dunes is a reason why it is considered that the quality is medium to high. Lying slightly higher than the neighbouring beach, one cannot say, however, that the visual depth and the panoramas obtained are very different as there are no visual obstacles towards the ocean, and so the visual absorption capacity is low. In this subunit the presence of observers varies seasonally, although these are people moving toward the beaches, not staying in the dune area, so the visual sensitivity is generally average.

- Pedrogão urban beach – corresponds to the stretch of beach confined by the village of Pedrogão. Resembling the narrow and rectilinear stretches of sandy beaches to the North and to the South, regarding both tidal influence, and the effects of coastal dynamics on its profile throughout the year, it is clearly distinct from the "Naturalized beach zone" subunit, due to the existence of support equipment, which ranges from various access walkways to bars and restaurants along the coastal road of the village of Pedrogão.

It is considered that the visual quality is average to high, given the poor maintenance of the equipment outside the bathing season and the accumulation of detritus in the southern zone. Also, in this case there are no visual obstacles towards the sea. Only the effect of the frequent mists and the waves themselves must be considered in terms of visual acuity, and so the visual absorption capacity is low. In this subunit the presence of observers is substantially greater, due to the vicinity of the residential area, as well as of services and support equipment, although it varies a lot throughout the year, leading to the visual sensitivity being high.

- Pedrogão village - the village and the beach of Pedrogão are the only beach resort in the municipality of Leiria, interrupting at specific points, and in a concentrate manner, the extensive area of pine forest and dunes. The village itself has no remarkable aspects, with a structure and organization just like other beach villages on the Portuguese coast, with buildings predominantly for seasonal use.

Given the lack of notable elements but, on the other hand, the presence of a scenic value, which is the sea, it is considered that the visual quality is average. With regard to absorption capacity, it should be noted that only the stretches along the perimeter of the village allow for direct visibility to the outside, and therefore effective sensitivity to any changes in the landscape, as the buildings themselves, are visual obstacles. Thus, it is considered that the visual absorption capacity is low to high and the visual sensitivity is low to high.

- Pedrogão rocky area - this subunit forms the southern boundary of the previous subunit "urban beach", forming a clearly delimited zone of rocky outcrops.

Given the fact that it is in itself a brief prominent element in the continuous sandy area, it is considered that its scenic value is medium to high. The characteristics of this outcrop, however, do not allow the formation of visual obstacles to the sea and, although the rock does not encourage the beachgoers to stay, it is a magnet for anglers and divers, and it is considered to have a low visual absorption capacity, and a high visual sensitivity.

- Surrounding the mouth of the river Lis - this subunit is part of the municipality of Marinha Grande (parish of Vieira de Leiria), being the articulation area between the central portion of the subunit "Naturalized beach zone" and the beach of Vieira (following subunit). The mouth of the river Lis is

considered to have gradually shifted its course from an area closer to the Pedrogão beach to the current location, being now channelled by side piers.

Despite the presence of the sea water and river water planes, the artificial character of its margins makes for an average visual quality. However, the dune zone arranged with walkways and a restaurant is considered to be high quality. The visual absorption capacity is identically low for both landscape typologies, due to the absence of visual obstacles. On the other hand, it is considered that the visual sensitivity is average in the zone closest to the river and high in the dunar zone for being a magnet for observers.

- Vieira urban beach – corresponds to the stretch of beach limited by the village of Vieira. Resembling the narrow and rectilinear stretches of sandy beaches to the North and to the South, regarding both tidal influence, and the effects of coastal dynamics on its profile throughout the year, it is distinct from the first subunit, due to the existence of support equipment, with walkways, bars, and restaurants along the coastal road of the village of Vieira.

It is considered that the visual quality is high, and also in this case there are no visual obstacles towards the sea, and only the effect of the frequent mists and the waves themselves must be considered in terms of visual acuity, and so the visual absorption capacity is low. In this subunit the presence of observers is similar to that of the “Pedrogão urban beach” subunit, due to the vicinity of the residential area, as well as of services and support equipment, although it varies a lot throughout the year, leading to the visual sensitivity being high.

- Vieira Beach Village – the village and the beach of Vieira, similarly to Pedrogão, interrupts at specific points, and in a concentrate manner, the extensive area of pine forest and dunes. Such as in Pedrogão, the village has no remarkable aspects, despite its structure and organization having a more cared for aspect outside the bathing season, when compared to the village of Pedrogão.

In this case, the more picturesque aspect of the built-up area, and the continued presence of the sea lead to the consideration that the visual quality is high. Regarding the absorption capacity, given the terrain unevenness of the village in some places, even beyond the village perimeter, it is possible to have direct visibility to the outside, and thus effective sensitivity to changes that may occur in the landscape. Thus, it is considered that the visual absorption capacity is low to average and the visual sensitivity is average to high.

4.3.2. Territorial and maritime spatial planning

The characterisation of the study area in terms of territorial and maritime spatial planning encompasses the identification of all the territorial management instruments and plans with influence in the study area, and the surrounding terrestrial area, namely in what concerns local, regional or national scope projects, and also plans, which may in any way affect or be affected by projects planned for the Pilot Zone. In this analysis several documents were considered, of which the following instruments are noteworthy:

<ul style="list-style-type: none"> • Maritime space 	Maritime Spatial Plan (Plano de Ordenamento do Espaço Marítimo - POEM) Portuguese <i>Strategy for Integrated Coastal Zone Management (PS-ICZM)</i> National Strategy for the Seas 2013 – 2020 (ENM) Action Plan for the Protection and Enhancement of the Coastline 2012 – 2015 (PAPVL)
<ul style="list-style-type: none"> • Terrestrial Space 	Spatial Planning Plan for the Coastline Ovar-Marinha Grande (POOC Ovar-Marinha Grande) River Basin Management Plan of rivers Vouga, Mondego, and Lis, and the streams of the West region (PGRH4) Territorial Spatial Planning for the Centre (PROT - Centro) Leiria Municipal Master Plan (PDM) Marinha Grande Municipal Master Plan (PDM)

From the analysis of the above mentioned documents, the identification of the strategic options, goals, guidelines, and regulations in terms of activities, uses, and functions applicable to the study area was carried out.

4.3.3. Population and economic activities

In the characterisation of this descriptor the following dimensions of analysis were considered: Populations' dynamics; Populating the territory, and Housing and economic Dynamics, the latter encompassing the components inherent to the local economic dynamics (fishing activity and transportation of goods, existing navigation corridors, and recreational, sporting, and ludic activities).

The basic information was based mainly on the official statistics from the National Statistics Institute (INE), ensuring the analysis, when appropriate, on the three geographic scales: the regional level (consisting of NUTS II – Centre and NUTS III – Coastline Pine Forest¹⁴), the municipality level (consisting of the municipalities of Leiria and Marinha Grande), and the local level (parishes, and census places¹⁵ within the study area).

In terms of **population dynamics** there has been a population growth over the past three decades in the two municipalities under study, and only the population residing in the parish of Coimbrão (Leiria municipality) suffered a decrease. The analysis of the age structure of the residing population reveals that the dominant age group consists of the active population class - aged 20 to 64 – representing around 60% of the population in the study area.

In the study area there are two urban conglomerates with population concentration, namely the conglomerate (Praia de) Pedrogão, belonging to the Leiria municipality, and the conglomerate (Praia de) Vieira de Leiria, belonging to the Marinha Grande municipality. Between 2001 and 2011 there was an increase in population density in both municipalities, with a similar behaviour in the Marinha Grande parish. In both conglomerates there are multi-family residential buildings (corresponding to several housing units), but also single-family and two-family residential buildings (corresponding to one or two housing units), the non residential usage representing a part of the buildings of very low significance.

The statistical data also shows that in the Coimbrão parish (Leiria municipality) the proportion of seasonal use housing is quite high (71%), followed by the Vieira de Leiria parish (Marinha Grande municipality) where 27% of the housing is a second residence or for seasonal use. It is also in these parishes that we can find the conglomerates (Praia de) Pedrogão and (Praia de) Vieira de Leiria, in which the seasonal occupation of the housing units can be perceived through the countless plates advertising room and holiday flats rental.

Regarding **economic activities**, the field scouting carried out concluded that in the study area the following activities occur: catering (cafés, restaurants, seafood restaurants, grillrooms, bars, and beach bars), housing (hotels and similar), wholesale and retail trade, administrative activities, and support services.

We can also see that specifically in the locations of the study area there is a predominance of the population working in the tertiary sector, followed by the secondary sector, and lastly the primary sector, and we can say that fishing has an important local relevance, visible not only in the number of fishermen, but also in the equipment, and support buildings, such as the fish auction centre, and fishing related warehouses. Along fishing, and considering only the field work carried out, there are also several recreational, sports, and ludic activities in the study area:

Regarding the movement of goods, this only happens at the Port of Figueira da Foz, there being no navigation corridors near the coast and the study area. The movements of the fishing vessels are determined by the fishermen themselves, there being also no corridors actually established for the activity.

Finally, in terms of the economic dynamics, we analysed the labour market behaviour, regarding the activity and unemployment. The activity rate, in 2011, was 50% in the municipality of Leiria, and 47.6% in the

¹⁴ Nomenclature of Territorial Statistical Units (NUTS)

¹⁵ A census place is any "population cluster with ten or more housing units intended as homes, and with a specific designation, irrespective of belonging to one or more parishes" (<http://smi.ine.pt/Conceito/Detalhes/2990>).

municipality of Marinha Grande, the parish of Marinha Grande being the one with the highest number, 48.6%, followed by the parish of Vieira de Leiria with 42.7%, and the parish of Coimbrão with 44.2%. This means that less than half the total population contributes actively for the local economy and wealth creation. Regarding the unemployment rate, in 2011, the municipality of Marinha Grande presented a rate of 11%, whereas the municipality of Leiria has a slightly lower rate (9%). The parishes of the study area present similar values to those of the municipality they are part of, although the parishes of Coimbrão and Vieira de Leiria have higher values than those of their municipalities, namely 9.7% and 11.3%, respectively.

4.3.4. Archaeological Heritage

In order to carry out this characterisation a methodology was followed based on the analysis of the quantitative data collected from different reference sources, both for the land and for the marine environment.

The PZ is located in an area of human occupation during prehistoric times, with a probable concentration of activities (food collection, tool creation, and temporary housing) in the northern area. The marine activities, which have since then been carried out, lead to the recording of 56 occurrences of heritage relevance, which, due to their chronologic nature, have a high heritage and scientific value or are associated with events of international relevance. The lack of their exact location leads to the creation of three zones of archaeological potential within the PZ: the first in the northern area, in front of Pedrogão, whose archaeological potential is extreme; the second in front of river Lis, with a high potential, and, finally, a third zone of low archaeological potential, where some shipwrecks are known to have occurred.

5. Conclusion

On the whole, it is considered that the Environmental Characterisation Study of the Pilot Zone achieved the proposed goals, and it was possible to establish a baseline scenario suitable to surveying the abiotic, biotic, and socioeconomic characteristics of the PZ, allowing also the definition of recommendations for the subsequent development stages of environmental studies by the promoters of offshore renewable energy projects.

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