

The logo for ANCORIM (Atlantic Network for Coastal Risks Management) features the acronym 'ANCORIM' in a blue serif font. The letter 'O' is replaced by a blue globe showing the Atlantic Ocean region. Below the acronym, the full name 'ATLANTIC NETWORK FOR COASTAL RISKS MANAGEMENT' is written in a smaller, blue, sans-serif font.

ANCORIM
ATLANTIC NETWORK FOR COASTAL RISKS MANAGEMENT

Case study report

**Carried out in Esmoriz and Cortegaça
(Portugal)
by IHRH**

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CONTENTS

Part 1: Presentation of case study	p.3
Part 2: Characteristics and elements to be transferred to other European context	p.6
Part 3: Governance	p.9
Part 4: Executive summary	p.12



PART 1: PRESENTATION OF CASE STUDY

Location

The Esmoriz-Cortegaça case study is located on the continental Atlantic coast, in the northern region of Portugal. The coastal stretch under study is approximately 5 km long and is located about 30 km south of Porto and the Douro river estuary.

Problems and Needs

The coastal built-up waterfront of Esmoriz-Cortegaça is defended by four groynes and three longitudinal revetments (with a total length of approximately 2 km). The origin of coastal erosion problems along this stretch is related to the decreased volume of sediment transport by the littoral drift current, whose direction is predominantly from North to South. In the northern part of the built-up Esmoriz-Cortegaça waterfront, particularly in the coastal strip of Espinho, erosion began at least in the nineteenth century and led to the construction of the first coastal defence structures. Increasingly, these problems advanced toward the south, causing a profound change in the dynamics of connection between the Barrinha de Esmoriz / Paramos to the sea (located immediately north of the stretch under investigation) and led to the construction of structures on the beaches of Esmoriz and Cortegaça.

In some areas of this coastal stretch, erosion has reached the point where it may advance inland, approaching the first row of houses separated from the sea only by the coastal defence structures. Moreover, there are a number of buildings in a forward position, forming a sort of artificial line relative to the current alignment of the shoreline, which are secured by longitudinal revetments. This is an extreme situation in terms of coastal defences, and it is highly vulnerable, with certain areas exposed to high risk. Flooding situations occur with some frequency, most recently in February 2011. Immediately to the south of the urban waterfront, there is an extensive forest area subject to gradual erosion, which has resulted in the toppling of several hundred pine trees.

Implementation of the Esmoriz-Cortegaça Case Study

The Esmoriz-Cortegaça Case Study was conducted under the scope of the Ancorim project; it aims to evaluate alternatives for development planning and coastal defence, particularly the removal of populations, to minimize erosion problems in the maritime boundaries of the two settlements, Esmoriz and Cortegaça, and, based on scenarios of climatic and physiographic change, to present different options for development planning.

Its implementation involves the following phases: geography and historical framework of defence interventions; possible scenarios for the evolution of coastal physiography on the built-up waterfront of Esmoriz-Cortegaça; possible alternatives to consider for its defence, also looking at scenarios for action at the level of land planning; and identification and discussion of potential positive and negative impacts that can be associated with these alternatives. Finally, a methodology is proposed to address this issue.





Due to its geographical location, south of a major coastal city (Espinho) where the effects of extremely strong erosion have been manifesting for several decades (more than ten), which led to the loss of land to the sea (e.g., between 1885 and 1910, the shoreline in Espinho retreated about 225 m - at the impressive rate of 9 m/year) and have motivated the construction of the first coastal defence structures (built in 1909, destroyed in 1911) and by the weakening of alluvial sources (changes in river basins, reservoirs and dams, extraction of sand from the Douro River, and dredging in navigation channels), coupled with high urban pressure, the Esmoriz-Cortegaça built-up waterfront faces a critical risk of coastal erosion and episodes of flooding.

The construction of the first coastal defence structures occurred in the 1970s, with the construction of the North Cortegaça groyne in 1972 (reserviced in 1982) and two longitudinal revetments in Esmoriz in 1977 (serviced in 1985) and 1978. Since then, more than three groynes have been built, the North and South Esmoriz groynes in 1987 and the South Cortegaça groyne in 1989 and two longitudinal revetments in Cortegaça, built in 1990.

More recently, between 1995 and 2007, the Water Institute (INAG) performed a variety of emergency interventions and other interventions provided under the scope of the Ovar-Marinha Grande Coastal Zoning Management Plan, such as the reshaping the longitudinal revetments (1995); the implementation of the Esmoriz revetment on the Fishermen's Quarter waterfront, and a second landing in the revetment of Cortegaça on the Escolas front (1996); the maintenance and repair of the four groynes (1996-1998); the repair of Esmoriz revetment (west section), Cortegaça revetment (section south of Escolas) and the southern groyne of Cortegaça (October 1999 to August 2000) to repair the South groyne (rooting) and revetment immediately to the south, in Esmoriz and the Cortegaça revetment (section north of Escolas) between January and February 2001; maintenance of the north groyne of Esmoriz and reconstruction of the revetment at the Praia Velha in Cortegaça (Winter 2002/2003); and repair of leaks in the Esmoriz revetments (south of the south Groyne) and Cortegaça (south of the schools) in February and March 2007. Between November 2008 and 2009, the Water Institute sponsored the more recent rehabilitation intervention on the coastal defence works of Esmoriz and Cortegaça. This consisted of the rehabilitation of four groynes (North and South Esmoriz and and North and South Cortegaça) and the rehabilitation of the revetment between the north groyne of Esmoriz and the north groyne of Cortegaça (extension: 2000 m).

In parallel with coastal defence interventions and the progressive advance of the erosive phenomena from north to south, population settlements, initially fishery-related and in many cases seasonal, have grown in terms of the number of buildings and the spatial occupation of the territory.

Both conditions, intensification of the effects of erosion and urban expansion, have resulted in a critical condition confirmed for Esmoriz Cortegaça and identified and characterized in several studies and documents.

In general, these studies and papers share the view that the type of land use in Esmoriz-Cortegaça has a decisive influence on the hydrodynamics and hydromorphology of these coastal areas - in particular, by imposing restrictions on the natural dynamics of the shoreline and above all, by forcing it to be locked into a particular alignment through interventions in the form of coastal defences.





Over the last decade, due to the perception that these interventions have functional limitations and generate negative impacts, new approaches to solving the serious problems affecting this coastal stretch have received increasing attention, both from government agencies and from the scientific and technical community.

This case study of the Ancorim project will weigh scenarios for physiographic evolution based on questions such as: is new shoreline equilibrium possible? the increase or maintenance of the volume of sediment transported by longshore drift; the potential effect of climate change on the level of variation in paths of agitation; the persistence and frequency of storms, the general increase in average water levels, with subsequent deterioration of hydrodynamic action. The lack of updated topographic-hydrographic surveys (the current ones were obtained more than 30 years) is a severe limitation on the ability to make predictions for the evolution of the coastline under different scenarios.

These scenarios are the basis for further discussion on possible alternatives for coastal defence and on possible alternatives for spatial planning, which serve as reference for the elaboration of a methodological approach for resolving similar problems in fragile and/or at risk coastal areas inserted within highly energetic marine environments in terms of waves.

It is very difficult to assess the cost-benefits of various protection strategies: What are the evolution, trends and risks in the coast due to short-term (storms, tsunamis) and long-term actions? What is the “value” of the threatened land and property? How to quantify the value of scenic beauty, amenity or the value of coastal systems? What is the medium/long term effectiveness of any measure? What are the durability and the medium/long term stability of structural protection measures?

A methodology for a cost-benefits analysis has been proposed and a preliminary assessment has been concluded.

PART 2: CHARACTERISTICS AND ELEMENTS TO BE TRANSFERRED TO OTHER EUROPEAN CONTEXT

Part II presents a methodology based on the Esmoriz-Cortegaça Case Study, with a view to its possible transfer to other similar fragile and/or at-risk coastal areas; in particular, it suggests ways to identify key problems and define strategies, objectives and lines of action in accordance with the priorities previously identified based on existing problems.

- Formularization of the Problems.
- Characterization and Diagnosis (geography, geology, natural forcing actions, coastal environments, past and present coastal dynamics, economic activities, heritage, vulnerabilities, history of defence interventions, risk analysis, SWOT analysis, management and institutional framework).
- Discussion and Public participation.
- Formulation of key questions and answers.
- Possible scenarios for physiographic evolution and alternatives for coastal defence and spatial zoning of the territory.
- Discussion and Public participation.
- Analysis Cost – Benefit.
- Proposals (objectives, strategies, management plan, lines of action, projects).
- Final Discussion and Public participation.
- Implementation and Evaluation.

Both the scenarios and the alternatives are formulated through reference to a set of key questions and answers.

The following questions are examples in discussing possible scenarios for the topic “future changes in physiography”:

- Will the "coastline" reached a new equilibrium and will future problems be mitigated?
- What is the actual sediment budget? What is the trend for the sediment budget evolution?
- Will climate change translate into changes in agitation paths, the persistence and frequency of storms, a general increase in average water levels, aggravating hydrodynamic actions?
- Is it possible to make predictions for the evolution of the coastline under different scenarios, without having up-to-date topographic/hydrographic surveys (the current ones were obtained more than 30 years ago)?

The following questions are some examples in discussing “coastal planning” topic:

- Should built-up waterfronts and the coastline keep the current configuration ("hold the line")?
- Will the built-up waterfronts be removed in a planned manner?
- Will there be expansion of the built-up area?
- Will the built-up waterfronts have a buffer zone to demolish and renaturalize?
- What is the timeframe for possible relocation interventions (5, 10, 20, ... years)?

Finally, on the topic "possible coastal defence alternatives", the following questions are considered as examples:

- It is possible to reconstruct dunes on the built-up waterfronts?
- Is artificial sand nourishment feasible?
- Should existing defences be removed? Or just the groynes? Or only the longitudinal revetments? When? Who takes responsibility?
- Are there applicable "soft" defence solutions (artificial seaweed, geosynthetics, lowering of groundwater beach levels by pumping, ...)?
- Should existing defences be rehabilitated and maintained?
- Should the groynes be added to? Should the groynes have curved configurations?
- Should the solution of detached breakwaters be adopted?
- Should defence interventions be mixed?

After discussing each of the key questions and the overall discussion on each main topic (physiography, land zoning and coastal defence alternatives) and between topics, it is possible to present proposals and to define the fundamental lines of action and suggests means for deciding on and implementing these actions, seeking to mitigate the problems.

A Methodology used for the Analysis of Cost-Benefit of the various protection strategies or alternatives considers:

- Several Scenarios of planned retreat and coastal protection alternatives.
- Short term, medium and long term Time Scale.
- A 1-10 scale of impacts on the Evaluated Factors.
- Social, economic and environmental Dimensions and Dimensions weight.
- Evaluation factors for the Social Dimension: affected population perception, population perception, safety of people, safety of property, juridical and negotiation process, local community change, local fisherman community change, change on tourism activities, change on surf and other water activities, opportunities for territorial qualification...
- Evaluation factors for the Economic Dimension: maintenance of existing coastal protections, new coastal protections, coastal structures demolition, reallocation of population, tourism revenue, local fishing activities, taxes revenue....

- Evaluation factors for the Environmental Dimension: change to landscape, coastal dynamics, ecosystems, impacts during construction and demolition,...
- Weight of each factor inside each Dimension Group: multidisciplinary and independent expert panel proposals after discussion.
- Simulations of Scenario Impact on the Evaluation Factors: total weighted value considering {Scenario} x {Time Scale} x {Dimension / factor / weight}.
- Best Scenario.
- Uncertainties.
- Critical evaluation of methodology and results.



PART 3: GOVERNANCE

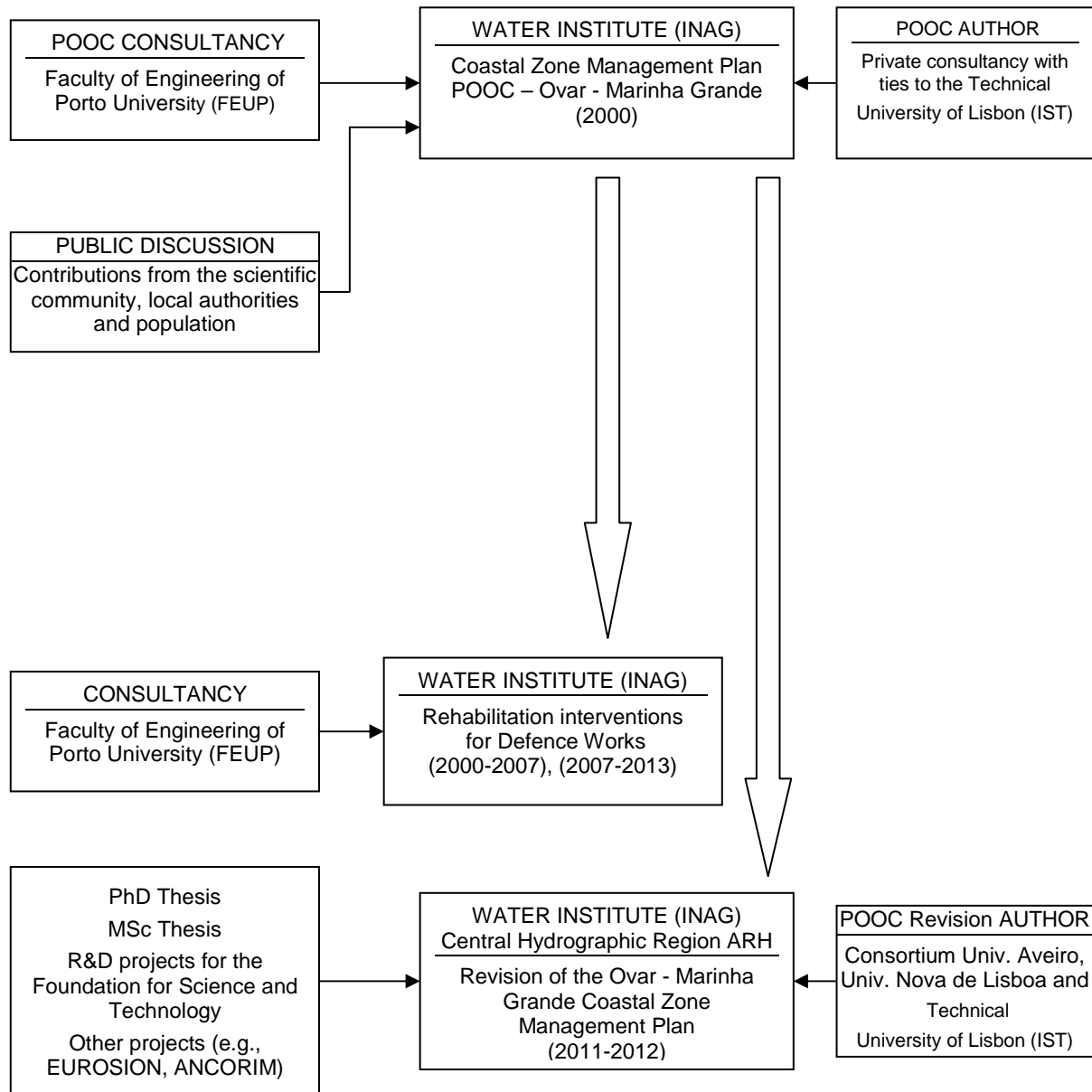
The Water Institute (INAG) of the Ministry of Environment is the National Authority that governs the management of water and coastal areas in Portugal. The ARH Centre has expertise on the coastal zone within the Central Region. The Municipal Board of Ovar manages the territory in terms of use and occupancy on a local scale. The Portuguese Navy has oversight functions on flat water and in the Maritime Public Domain (to 50 m). Other agencies also have jurisdiction (Central Region Coordination Commission, the National Forestry Authority).

Part III of the case study describes the relationships between decision-makers and scientists, specifically in relation to the area under investigation.

These relationships are schematically shown in the following flowchart, which outlines how the relationships between decision-makers and scientists are manifested in the study under investigation. Out of all these, emphasize should be made on the importance that teams and consultants from the scientific community and the private sector have had in defining planning instruments for the shoreline, and for reviewing these interventions and proposals for coastal defence interventions.

The Ovar-Marinha Grande Coastal Zone Management Plan (POOC, for its initials in Portuguese), the main planning tool for the coastal zone (published 20 October 2000) was prepared by a private consulting firm in connection with the Technical University of Lisbon, Instituto Superior Técnico. A team from the University of Aveiro formed part of a consortium with the New University of Lisbon and the Instituto Superior Técnico, put together to review and update the Ovar-Marinha Grande Coastal Zone Management plan (POOC) (Order No. 22400 / 2009).

The Department of Engineering of the University of Porto has advised the Water Institute (INAG) and more recently the Administration of the Central Hydrographic Region (ARH-Central); these agencies are responsible for management of the coastal zone in question at the national and regional levels, for all stages of decision-making, and specifically for the preparation of the Ovar-Marinha Grande Coastal Zone Management Plan (POOC) and the plan for coastal defence interventions.



Finally, it should be noted that several master's and doctoral theses, as well as Research & Development projects funded by national (e.g., the Foundation for Science and Technology) and international (e.g. EUROSION, ANCORIM) organizations reflect the seriousness of erosion problems on the built-up ocean waterfronts in Esmoriz and Cortegaça.

It is expected a short term change in the Portuguese institutional framework related with coastal zone management.



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PART 4: EXECUTIVE SUMMARY

The Esmoriz - Cortegaça case study is located on the continental Atlantic coast, in the northern region of Portugal. The coastal stretch under study is approximately 5 km long and is located about 30 km south of Porto and the Douro river estuary.

The construction of the first coastal defence structures in the area under investigation occurred in the 1970s, with the construction of the North Cortegaça groyne in 1972 (serviced in 1982) and two longitudinal revetments in Esmoriz in 1977 (serviced in 1985) and 1978. Since then, more than three groynes have been built, the North and South Esmoriz groynes in 1987 and the South Cortegaça groyne in 1989 and two longitudinal revetments in Cortegaça, built in 1990. Between 1995 and 2007, the Water Institute (INAG) performed several emergency interventions and other interventions provided for under the Ovar-Marinha Grande Coastal Zone Management Plan. More recently, between 2008 and November 2009, the Water Institute has promoted a more rehabilitative intervention for the coastal defence works in Esmoriz and Cortegaça, which consisted in the rehabilitation of four groynes (North and South of Esmoriz and North and South of Cortegaça) and rehabilitation of the revetment between the northern Esmoriz groyne and the northern Cortegaça groyne (extension: 2000 m).

In parallel with the operations of coastal defence and the progressive advance of the erosive phenomena from north to south, population settlements, initially fishery-related and in many cases seasonal, have grown in terms of the number of buildings and the spatial occupation of the territory.

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In general, these studies and papers share the view that the type of land use in Esmoriz-Cortegaça has a decisive influence on the hydrodynamics and hydromorphology of these coastal areas - in particular, by imposing restrictions on the natural dynamics of the shoreline and above all, by forcing it to be locked into a particular alignment through interventions in the form of coastal defences.

Over the last decade, due to the perception that these interventions have functional limitations and generate negative impacts, new approaches to solving the serious problems affecting this coastal stretch have received increasing attention, both from government agencies and from the scientific and technical community. A contribution has also been made to this end due to the importance that the teams and consultants from the scientific community and the private sector have had in defining planning instruments for the shoreline, and for reviewing these interventions and proposals for coastal defence interventions.

This case study of the Ancorim project will weigh scenarios for physiographic evolution based on questions such as: is a new shoreline equilibrium possible? the increase or maintenance of the volume of sediment transported by longshore drift; the potential effect of climate change on the level of variation in paths of agitation; the persistence and frequency





of storms, the general increase in average water levels, with subsequent deterioration of hydrodynamic action. The lack of updated topographic-hydrographic surveys (the current ones were obtained more than 30 years) is a severe limitation on the ability to make predictions for the evolution of the coastline under different scenarios.

These scenarios are the basis for further discussion on possible alternatives for coastal defence and on possible alternatives for spatial planning, which serve as reference for the elaboration of a methodological approach for resolving similar problems in fragile and/or at risk coastal areas inserted within marine environments in terms of very energetic waves.