

Coastal Protection Measures

Spanish scale





Co-Evolve4BG

Analysis of Threats and Enabling Factors for Sustainable Tourism at Pilot Scale

Coastal protection measures Spanish scale

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OVERVIEW

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REVIEW

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Abstract

This deliverable will provide an analysis of coastal protection plans at the Mediterranean Spanish-scale. First, it will create an overview of the coastal protection measures in the Mediterranean Sea level. Then, it will provide an analysis of the commonly adopted approaches for monitoring and modeling of coastal areas. Later on, it will tackle the strength and weakness of coastal planning management in relation with defense and protection.

I. Introduction

The Mediterranean coast in Spain occupies a large area of land and has great ecosystem interest. It is densely populated and has suffered, in recent years, degradation due to high urban pressure. Thus, there is a population shift from the interior areas of the peninsula to the coastal areas. The Mediterranean area has a high percentage of beaches. The semi-closed sea condition has a decisive influence on its characteristics and accumulation processes frequently occur at the mouth of its rivers. In the Mediterranean, unlike the Atlantic, there are no significant tides, and consequently there is an absence of a low coast with large areas of tidal flooding.

The importance of tourism linked to the sun and beach, flourishing with the energy industry related to gas and oil supply by sea, as well as the growing role of maritime trade are the key economic factors driving this anthropogenic and economic transformation. Most of the Spanish coastal areas have been progressively adapting to these new economic functions and leaving behind, in the background, traditional primary activities such as fishing and agriculture.

In addition to these anthropic pressures, the phenomenon of climate change is added, with all the consequences that this entails (sea level rise, temperatures, acidification of the seas, *etc.*). Faced with this paradigm, the need for efficient and competent management and protection of the Mediterranean coast becomes latent, both nationally and internationally.

II. Insights on coastal protection planning in Tourist Zones

II.1. Application of the directives on coastal protection

Regarding coastal management plans and measures adopted, the aim is to achieve good environmental practices that coexist with the protection of resources and the development of human activities.

The objective is to maintain the Mediterranean coast in the best possible conditions, as this maintains and enhances economic and environmental development.

Achieving the mentioned objective, at the state level, is the responsibility of the “Ministry of Agriculture, Food and Environment (MAGRAMA)”, which is in charge of the management of the maritime-terrestrial public domain. Specifically, it has a department in charge of the planning and competent policies in this matter through the “Dirección General de Sostenibilidad de la Costa y el Mar” (MITECO- DGSCM).

The Spanish coasts, at the legislative level, have the following laws and decrees for management and protection:

1. Law 22/1988, of July 28, 1988, on Coasts.
2. Law 2/2013, of May 29, 2013, on the protection and sustainable use of the coast and modification of Law 22/1988, of July 28, 1988, on Coasts.
3. Royal Decree 876/2014, of October 10, approving the General Coastal Regulations.
4. In addition to these, there is a protection law focused on the marine environment:
5. Law 41/2010 on the Protection of the Marine Environment.
6. From the “Ministry of Ecological Transition and Demographic Challenge (MITECO-DGSCM)”, a series of publications and documents can be accessed that provide guidelines on the anthropic actions that are usually developed on the coast:
7. Following the creation of a working group within the Inter-ministerial Commission for Marine Strategies, this body approved in April 2014 the “Guidelines for the characterization of dredged material and its relocation in waters of the maritime-terrestrial public domain” (a new revised and approved version was available in July 2015).
8. Coastal dunes: as an expression of the Ministry’s interest in the conservation and restoration of dunes, the “Manual for the restoration of coastal dunes” was born.
9. Seabed extractions.

With regard to the protection of the marine environment, the Directorate General for the Sustainability of the Coast and the Sea has met, over the last decade, the objectives

set by European regulations, such as the Water Framework Directive 2000/60/EC (WFD), in addition to the Marine Strategy Framework Directive 2008/56/EC (MSFD) and the Directive on the management and assessment of natural flood risks 2007/60/EC (DEGRI).

II.2. Coastal protection management

With regard to the protection of the marine environment by Europe, there is a protocol on the Integrated Management of Mediterranean Coastal Zones. The impacts suffered by the coastal areas mentioned above, justify the need to adopt an integrated management model that is compatible with the maintenance of ecosystems and the environmental and economic development of the area. To this end, and within the framework of the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention), promoted by the United Nations Mediterranean Action Plan (MAP), the Protocol on Integrated Coastal Zone Management (ICZM) in Spain was signed in 2008 and came into force in 2011. In the countries of the Mediterranean basin, the MAP has been implementing the Coastal Area Management Program (CAMP) for more than 20 years through pilot or demonstration projects of this new management model.

From the thirty-five projects presented in the ICZM program, as examples of good practice in integrated coastal zone management, seven principles that should govern sustainable management can be identified:

- Holistic vision on different aspects, such as consideration of the interdependence between marine and terrestrial parts in coastal zones, a general approach to coastal problems such as erosion, fisheries, *etc.*
- Integrally consider all the systems related to the coast (environmental-ecological, socioeconomic and cultural systems) in order to maximize the common benefit of all within the natural limits.
- Present an ecosystemic approach, that is to say, to propose a management model respectful of ecosystems, promoting their conservation, as well as a sustainable, fair and equitable use of natural resources.
- Consider an adaptive process, so that a modulated management is carried out in a gradual process that facilitates adaptations over time and advances knowledge.
- Promote the participation of all stakeholders (economic and social representatives, organizations of coastal zone residents, non-governmental organizations and the business sector) in the management process.
- Use of a combination of instruments designed to ensure proper coordination between different sectors and administrative levels, as well as facilitate coherence between the objectives of different policies and regulations
- Present a long-term perspective that takes into account the precautionary principle and the needs of current and future generations.

II.3. Tourism management plans

There are three plans, according to the website of the Ministry of Ecological Transition and Demographic Challenge to manage tourism (MITECO-Turismo):

- Nature Tourism and Biodiversity Sectoral Plan 2014-2020: The Strategic Plan for Natural Heritage and Biodiversity 2011-2017, approved by RD 1274/2011, of September 16, deepens and consolidates the concept of sectoral integration as a way to advance in its conservation and sustainable use, and seeks, through one of its goals, to promote the integration of biodiversity in sectoral policies.
- Spain's Sustainable Tourism Strategy 2030: The Government of Spain, through the Secretary of State for Tourism, is preparing Spain's Sustainable Tourism Strategy 2030, a national tourism agenda to address the challenges facing the sector in the medium and long term, promoting the three pillars of sustainability: socioeconomic, environmental and territorial. To this end, a participatory process has been promoted in which the sector and the autonomous communities are being involved.
- National and Integral Tourism Plan (2012-2015): The National and Integral Tourism Plan was created as a set of measures for the 2012-2015 period to boost the competitiveness of companies and our destinations, renew our country's global leadership for the coming decades and contribute to the generation of wealth, employment and welfare of citizens.

II.4. National strategies related to natural risks

Directive 2007/60/EC of the European Parliament and of the Council of October 23rd, 2007 on the assessment and management of flood risks (hereinafter Flood Directive), whose transposition into Spanish law is the subject of Royal Decree 903/2010 of July 9th, on the assessment and management of flood risks, published in the BOE No. 171 of July 15th 2010, aims to generate new tools at Community level to reduce the potential consequences of floods through risk management, supported by hazard and risk mapping. The Directorate General for Coastal and Marine Sustainability is responsible for flood risk assessment along the Spanish coast.

Another natural risk that can damage the Spanish Mediterranean coast is storms. When events occur in a year that damage the coasts due to a strong storm, a coastal plan of repair works for storms is developed (Peña, 2005). They have been developed in 2014 (damage caused on the Atlantic coast and the Cantabrian coast), 2015, 2017 and 2018 (the most recent). The latter, which hit the Spanish coasts in the months of February and March, caused serious damage at various points of the public maritime land domain in which it was necessary to intervene on an emergency basis.

Coastal erosion is the advance of the sea over land, measured over a sufficiently long period of time to eliminate fluctuations in climate, storms and sedimentary processes at the local level (EUROSION Project, EC, 2004).

- Coastal erosion has three types of impacts:
- Loss of surface area, with economic, social and/or ecological value.
- Destruction of natural coastal defenses against storms (mainly dune systems and beaches), which facilitates coastal flooding.
- Deterioration of protection and shelter works, which also facilitates flooding. This phenomenon is the result of a combination of several factors, both natural and human, occurring on different scales and in different ways. These are explained in more detail below:
 - The most important natural factors involved in the coastal erosion process are: wind, coastal currents and relative sea level rise.
 - The human factors involved are usually understood as the direct or indirect consequences of various acts that may or may not take place on the coast, but which have an implication to a greater or lesser degree on the erosion process. These acts include: coastal works, channeling and retention of river transport (especially the construction of dams), dredging operations, among others.

Erosion is a natural phenomenon that has always existed and has contributed to shaping the great diversity of coastal landscapes. However, this phenomenon has intensified in recent decades and has been widely developed in all countries due to human activities. To understand the magnitude of the problem, at the beginning of the 21st century a project was carried out by the European Parliament and the European Commission in which 60 case studies from different European countries were analyzed and some of the results that were reached was that, the total coastal area (including buildings) that is lost in Europe due to coastal erosion is estimated at 15 km² per year. The annual cost of adaptation measures related to combating this process was also determined at 3 billion euros per year (Eurosion Project, CE, 2004).

Coastal erosion can be understood in two different ways depending on the time scale studied. On one hand, there is chronic erosion, explained as a progressive retreat of the coastline derived from a deficit of sediments on the coast that manifests itself in the medium-long term and is not recoverable. On the other hand, there are erosive events that are explained as specific events associated with storms that cause a rapid retreat of the coastline in the short term, but which can normally recover naturally after the passage of the storm.

II.5. General trends in morpho-dynamics and climate change

Due to the high exploitation of resources and in general, the great anthropogenic pressure that the coastal environment has undergone for decades, these areas are seriously affected by natural threats such as erosion and flooding, threats that are seen and will be further enhanced by the effects of climate change. After studying

the different countries selected for this work, it can be observed that the main risks facing coastal countries are erosion and flooding for which they spend most of their efforts to protect their coasts. Nevertheless, it is important to note that the degree to which each risk is affecting, depends on many factors such as: the general typology of the country's coast (in terms of geomorphology), the main activities carried out in the coastal zone, the degree of urbanization and population density that the coastline presents, the availability of sedimentary resources, among others.

Sea level rise According to the Intergovernmental Panel on Climate Change (IPCC) is one of the possible repercussions of climate change with a higher degree of confidence that will worsen over time according to the climate scenarios studied. Rising sea levels cause permanent flooding and damage to infrastructure, which could lead to significant losses for the sun and beach tourism sector, both in terms of damage to tourist infrastructure and to beaches, the main tourist attraction in these areas. But the rise in sea level also increases the impact of occasional flooding caused by storms. Likewise, due to other factors such as sea water intrusion, important coastal wetlands could be damaged, which are also important resources that attract nature tourism lovers.

With regard to flooding, although human action is also a determining factor in this regard, most studies conclude that the rise in sea level and the intensity of waves would greatly affect coastal areas at river mouths and marshes. This would have a direct impact on the loss of beaches, mainly in the Mediterranean.

One of the most significant consequences of rising temperatures would be the loss of *Posidonia oceanica* meadows in the Mediterranean. In addition to regulating erosion, providing shelter and food for fauna and possessing many other properties, this plant favors scuba diving and snorkeling.

According to the IPCC, the risk of climate change impacts is conditioned by the occurrence of extreme and gradual climate events and by the vulnerability and degree of exposure of human and natural systems. As a consequence of climate change, coasts suffer from various impacts such as rising sea levels and ocean temperatures, which can be aggravated by the degree of exposure and vulnerability of both natural systems (beaches, seagrass beds, *etc.*) and human systems, including the proliferation of tourism activities and infrastructure related to the sector in these areas.

II.6. Description of the coastal protection measures: beaches

The General Directorate of Coasts has developed Guidelines on Performances on the beach (Ministerio de Medio Ambiente-Dirección General de Costas). The main objective of these Guidelines consists of offering a guide on what should be the content, approach and objectives of the projects corresponding to the coastal works of general interest, regulated in article 111 of the Law of Coasts and State competition. Within the policy assigned to the Directorate General of Coasts in relation to these works, it must be understood that the following types of actions are included in relation to the beaches:

- Preservation and improvement of the coastal strip as a valuable element of the landscape.
- Beach as a priority element of territorial planning.
- Protection of the beach as a natural space with high environmental values.
- Consideration of the beaches as a renewable natural resource, with restrictions on its use in certain cases.
- To favor the recovery of natural open spaces on the waterfront.
- Recovery of degraded coastal areas.
- Optimization of the uses and resources of the beach according to its function in the territory.
- Guaranteeing public use of the beach.
- Facilitate beach adaptation to climate change.

II.7. Coastal protection measures on a Mediterranean scale

The challenge is to ensure human security and promote economic development without compromising ecological integrity. Although ecosystems contribute to human well-being, these services are not always quantified and therefore their benefits are not recognized at the management level. This problem is compounded by a lack of knowledge linked to the contribution of ecosystems to human well-being, such as the ability of salt marshes to reduce wave energy in coastal systems and their potential role as natural buffer systems (Rochelle-Newall et al. 2005). The Commission Communication on ICZM: A Strategy for Europe (COM [2000] 547) recommends integrated coastal zone management with actions at local and regional levels. This management model is inspired and supported by a national perspective and an appropriate framework at that level. The EU should support these actions through the dissemination of information, data and knowledge on coastal zones, defining indicators for them. These indicators would also serve as an example for a more generalized adoption of the principles that make up integrated territorial management throughout Europe. However, although ICZM has been adopted and is recommended as the most appropriate coastal management methodology in Europe, not all countries have yet fully implemented it in their policies.

- To a greater or lesser extent, all countries have coastal risk assessment projects or programs related to erosion and flooding. Many of them have helped to diagnose these problems along the coast and thus determine which areas are currently the most affected.
- With respect to legislative capacity, it has been found that the administrative levels with competencies and responsibilities in coastal management are totally varied, from the local to the national level.

- Some countries have strategies or plans for coastal management and/or protection at the national level. On the other hand, others do not have strategies at the national level.
- Regardless of whether a country has decentralized coastal management competencies or not, it has been observed that such strategies or plans at the national level are necessary for effective coastal management. Considering the countries studied, these strategies usually emanate from compliance with binding domestic regulations.
- The most common problems observed in coastal management that do not present national strategies are the lack of coordination and management throughout different public institutions, the high fragmentation of responsibilities between different administrations and the lack of participation of all the main actors, among others.
- Practically all countries present national strategies or plans for adaptation to climate change.

II.8. Coastal protection measures adopted in different countries

There are several case studies of coastal erosion actions and management in Europe. Some of these cases will be cited below:

1. United Kingdom - England

The United Kingdom has a long coastline, 17,381 km, making it the European country with the longest coastline (EC, 2009). It is bounded by the Atlantic Ocean, the North Sea and the Irish Sea. The country is organized into 4 administrative divisions: England, Wales, Scotland and Northern Ireland.

The main coastal threats in the United Kingdom are erosion and flooding.

The competencies and responsibilities in coastal management are decentralized, specifically at the local level.

The most relevant coastal management bodies at the national level are the Department of Environment, Food and Rural Affairs (DEFRA) and the Environment Agency.

In the United Kingdom there are different coastal management plans (Shoreline Management Plans) to regulate and manage the coast. In addition, they have a regulation in their legal framework, the Flood and Water Management Act of 2010, a tool on which the National Strategy on Flood and Coastal Erosion Risk Management of 2011 is based, and from which the Local Flood Risk Management Strategies emanate.

2. The Netherlands

The Netherlands is located in north-western Europe, bordered to the north and west by the North Sea, to the south by Belgium and to the east by Germany and has a total of 1,275 km of coastline (EC, 2009). The territory is divided into a total of 12 provinces, where 3 municipalities are located on islands in the Caribbean Sea.

Due to the country's physiographic characteristics, the main coastal risk in the Netherlands is flooding.

Competencies in coastal management are shared between the national and regional levels, although it is at the national level where the main coastal legislation is issued.

The most relevant figures in coastal management are, at the national level, the Rijkswaterstaat, and at the regional level, the provinces and the Water Boards.

In the Netherlands, coastal management is based on the conceptual frameworks presented, which are, on one hand, the Dynamic Preservation and, on the other hand, the Frame-of-Reference, with which the objectives are set and the methodology to carry them out is established.

An annual flood management plan is drawn up, which is included in the Delta Program. At the multiannual level, the National Water Plan is carried out.

3. France

France is made up of two factions, the regions within the European territory, commonly called metropolitan France or continental France, and the overseas regions located mainly in the insular territories of the Pacific Ocean, Indian Ocean and Caribbean Sea. The French metropolitan coastline totals approximately 8,245 km (EC, 2009) and has 3 maritime facades, one for the Mediterranean Sea in the south-eastern part, the Atlantic Ocean for the western part, and the North Sea for the northern part. The country is organized into a total of 18 administrative regions, 13 of which are located in metropolitan France and the remaining 5 in overseas France. Coastal erosion is the most relevant threat to France. Coastal management competences are national, although for the last 10 years decentralization at regional level has been promoted for this issue.

At the national level, the main authorities and important representatives in coastal management are the Ministry of Ecological Transition and Solidarity, the Centre d'Etudes et d'expertise sur les Risques, l'Environnement, la Mobilité et l'Aménagement (CEREMA) and the Observatoire National sur les Effets du Réchauffement Climatique (ONERC). At the regional level, the main figure is the Interregional Directorate for the Sea.

Since 2012 they have presented a national strategy concerning ICZM. In addition, they also have a national strategy for flood risk management. Finally, they present a national strategy for the sea and the coast, which is included in the legal framework, specifically in the Legislative Decree 2017-222.

4. Italy

Italy is located in southern Europe bordered by the Mediterranean Sea. The country consists of a long peninsula with two large islands, Sicily and Sardinia. Its coastline length is 7,468 km (EC, 2009). The territory is divided into a total of 20 regions of which 15 have coastlines. Although part of the same sea, the Mediterranean, Italy has 4 distinct seas: the Adriatic, located in the northeast; the Ionian, located in the east; the Ligurian, located in the northwest; and the Tyrrhenian, located in the west.

The most important coastal threat in Italy is erosion.

Competencies in coastal management are at the regional level.

Italy does not yet have any national plan or strategy for coastal management in the country. It is the regional authorities who decide how to develop coastal management in their territory without any common and coherent framework at a national level. A national round table has recently been set up to coordinate actions and measures for adaptation to coastal erosion, although it has no binding character.

5. Ireland

Ireland is a country located in north-western Europe, bordered to the north by Northern Ireland, a region belonging to the United Kingdom. It has a coastline length of 4,557 km, with sea fronts to the Irish Sea in the east, to the Atlantic Ocean in the north and east and to the Celtic Sea in the south. The territory is divided into 4 provinces: Leinster, Munster, Connacht and Ulster (this one shares part of the province with territory of Northern Ireland), within the provinces, the territorial division is organized in counties, in a total of 32. The main coastal hazards in Ireland are erosion and flooding. Competencies in coastal management are shared between the national and local (county) levels.

At the national level, the main authority is the Office of Public Works. At the local level, the main figure is the county leaders.

Although Ireland does not yet have a national strategy or plan for coastal management, since 2007 there has been a subprogram of the National Development Plan dealing with coastal protection. This Plan also includes the Coastal Protection Strategy Study for Ireland, which characterizes and analyzes coastal erosion and flooding risks throughout the country.

6. Portugal

Portugal is located in the southwest of Europe, in the west of the Iberian Peninsula, its territory also includes two autonomous archipelagos, Madeira and Azores. The country is bordered on the north and east by Spain and on the south and west by the Atlantic Ocean. Its coastline length is 1,187 km (EC, 2009). The territory is divided administratively, mainly in districts, with a total of 18, of which 10 have coastline. However, at the level of coastal management (and in other areas, such as Nomenclature of Territorial Units for Statistics, NUTS II, classifications) the country is divided into 5 regions. The main coastal threat in Portugal is erosion.

Coastal management competences are fully centralized in the government of the country.

At the national level, the main body responsible for this matter is the Ministry of Environment and Energy Transition, although the Portuguese Environment Agency (APA) is the most important body for water and coastal management.

Since 1993, Portugal has presented a series of plans detailing coastal management at the regional level. They are currently undergoing a process of structural-administrative reorganization. Since 2007, there has been a national strategy based on ICZM, which is still in force.

III. Analysis and recommendations for coastal protection strategies and management options

III.1. Coastal management in the context of climate change and sustainable tourism

The evidence is clear, the Intergovernmental Panel on Climate Change (IPCC), which brings together scientists from 195 countries, concludes in its Fifth Assessment Report (2014) (AR5) that climate change is unequivocal; since 1950, unprecedented changes have been observed in the climate system, accelerated by anthropogenic modifications in the atmosphere and changes in land use. The negative consequences of climate change are beginning to be felt in both natural and human systems, putting at risk various economic activities, including tourism. Rising temperatures and sea levels, as well as irregular rainfall and loss of biodiversity are just some of the impacts that are beginning to be felt in our country and that will worsen as CO₂ emissions into the atmosphere, among other factors, are not reduced (Fig. 1).



Figure 1. Chronology of adaptation to climate change in the tourism sector at international, European and national levels. National Plan for Adaptation to Climate Change: Impacts, vulnerability and adaptation to climate change in the tourism sector (Ministry of Agriculture, Food and Environment (PNACC))

The World Tourism Organization (UNWTO) is the United Nations agency in charge of promoting responsible, sustainable and universally accessible tourism. The UNWTO, as the leading international organization in the field of tourism, advocates for tourism that contributes to economic growth, inclusive development and environmental sustainability, and offers leadership and support to the sector to expand its knowledge and tourism policies throughout the world. Among the UNWTO's lines of work is sustainable tourism, in which various activities have been carried out in climate change.

Spanish coastal areas are densely populated and much of the tourism and marine farming concentrates there, which makes the coast a strategic resource of crucial importance for the country (Orts Nebot, 2016). The challenge is to achieve a balance between a high level of coastal protection and environmentally friendly activities. In order to protect and preserve beaches, wetland and coastal dune systems, the Ministry of Agriculture, Food and Environment has implemented new regulations. It studies to know the situation of the coast; and programs with solutions to protect it; and has developed a Climate Change Adaptation Strategy for the Spanish Coast. In this sense, the Ministry is working on prevention and adaptation measures, amongst others (Orts Nebot, 2016).

III.2. Management strategies to address coastal erosion and tourism development

With respect to coastal erosion management, there are two main options wherever necessary to keep the coastline stable. The first refers to the use of “hard” engineering works, where structures such as breakwaters or dikes are normally used, which, although they serve to retain sedimentary transport and increase the width of the beach in a given area, normally, in storm conditions, may not be a complete solution to the specific erosion event. It should be noted that, in addition, opting for the construction of structures that interrupt coastal transport can lead to erosion problems downstream of the structure. The other option for keeping the coastline secure refers to a “soft” alternative, based on periodic sediment recharge that allows the beach to maintain a certain width for a certain period of time. Normally a combination of the two options is used.

III.3. Coastal protection measures and sustainable tourism planning

Coastal management, as in other areas, is normally based on plans or strategies. These plans or strategies are documents that provide the mechanism for rationalizing political action, i.e., how a given public administration should act in a given area during a specific period of time. The plan or strategy is the document that is finally approved as a result of the planning procedure foreseen for its preparation. The principles of participation (the involvement of all the agents involved) and coordination (to avoid contradictory decisions between different administrations) are fundamental for the plan or strategy finally approved to be effective in relation to the objectives pursued.

The main structure of a plan or strategy is as follows:

- Diagnosis
- Determination of objectives and principles
- Description of measures or actions
- Description of monitoring and review mechanisms
- Provision of funding

The protocol on Integrated Coastal Zone Management in the Mediterranean reflects the following sections of interest (EU, 2009):

- Tourism, sports, and leisure activities:
 - Sustainable coastal tourism, respectful of coastal ecosystems, natural resources, cultural heritage and landscapes, should be encouraged;
 - Specific forms of coastal tourism, in particular cultural, rural and ecotourism, should be promoted, while respecting the traditions of local populations;
 - The practice of various sports and leisure activities, including recreational fishing and shellfish gathering, should be regulated and when necessary, prohibited.
- The Parties shall use and strengthen existing appropriate monitoring and observation mechanisms, or create new ones, as required. They shall establish and regularly update national inventories of the coastal zone, which should cover, to the possible extent, information on resources and activities as well as institutions, legislation and planning that may influence the coastal zone. In order to promote the exchange of scientific experience, data and good practices, the Parties shall participate, at the appropriate administrative and scientific levels, in a Mediterranean coastal zone network, in cooperation with the Organization. In order to facilitate regular observation of the state and evolution of the coastal zones, the Parties shall establish an agreed baseline form and process for collecting appropriate data in national inventories. The Parties shall take all necessary measures to ensure public access to information from monitoring and observation mechanisms and networks.

IV. Selection of parameters in CoEvolve4BG

IV.1. GIS database

Geographic Information System (GIS) is applied to computer systems aimed at managing spatial data that visually allow us to analyze, manage and interpret geographic data. The methodology of this study has consisted of searching and processing shapefile layers, and their subsequent GIS analysis. Shapefile layers have been downloaded from official national statistical platforms (Ministry of Ecological Transition and Demographic Challenge, MITECO) and from European platforms such as the European Marine Observation and Data Network (EMODnet).

The Spatial Reference System has the ETRS89 datum with UTM projection in the 30 North zone, with EPSG code: 25830. In addition, they are based on official statistical platforms or rigorous studies, which guarantee the soundness of the information expressed. The GIS results were expressed by NUTS administrative boundaries from the EU (EUROSTAT <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-gq-20-092>).

The NUTS classification subdivides the economic territory of the EU Member States into territorial units (regions; Fig. 2). The classification is made up of three hierarchical levels: each Member State and the UK are divided into NUTS 1 regions, which in turn are subdivided into NUTS 2 regions and then further divided into NUTS 3 regions. Each of these regions is allocated a specific code and name. Since several different regions within Europe have the same name, a distinction has been made by adding to each of these the abbreviation for the country concerned.

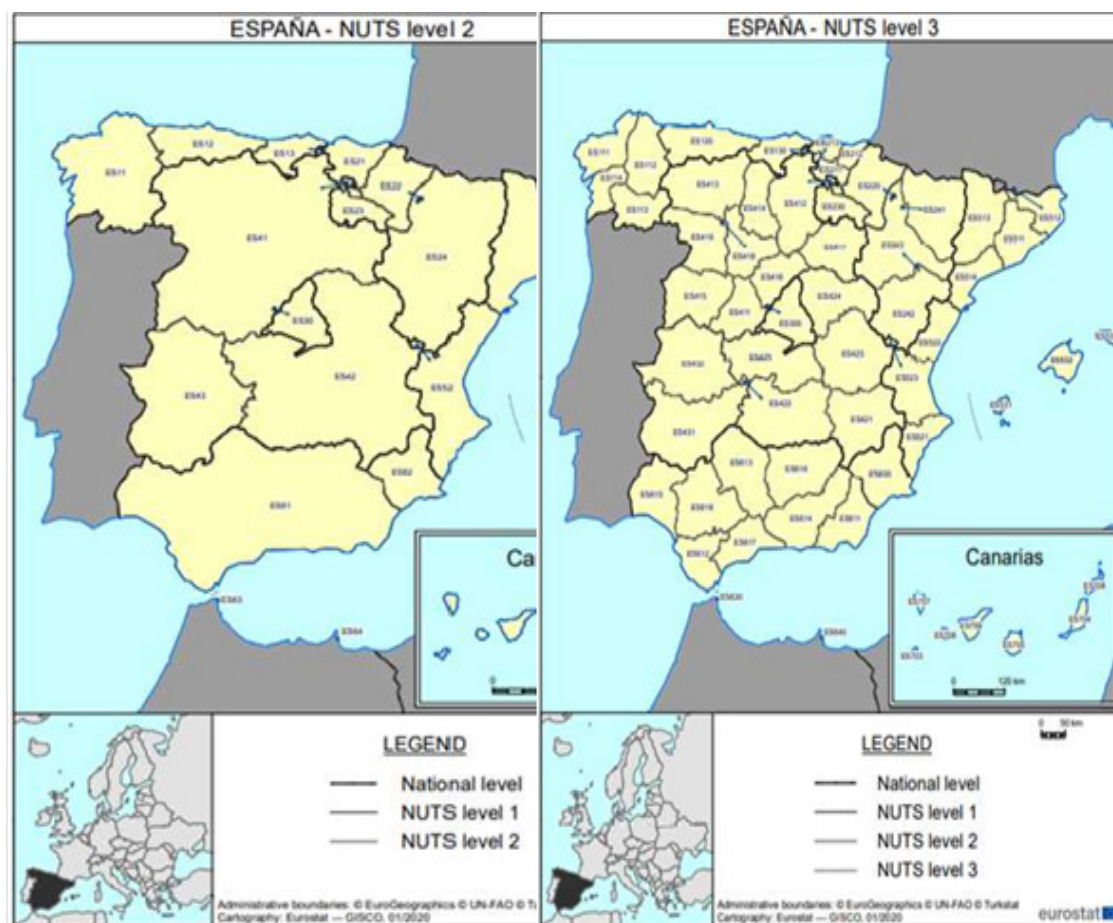


Figure 2. Spain (España): NUTS level 2 and 3(EUROSTAT (2021))

IV.2. Data Records

The developed Spanish Mediterranean coastal database described in this report is available through the figshare repository of results. We have included a csv file with all the information at Nuts 3 level into the repository. The database will be updated and expanded as soon as new and improved data become available. The database presented here has been created using several publicly available datasets, which are thoroughly documented and described in reports or scientific articles (Table 1). Thus, these datasets have undergone rigorous quality controls and/or validation. In addition, for those parameters where consistent information for the studied area did not exist, new datasets were generated.

IV.3. Coastal protection measures

A panel of external experts and the working group at the Mediterranean level of the Co-Evolve4BG project has selected the following parameters of Coastal protection measures which will be analyzed to National and Mediterranean scale (Table 1). In the supplementary material is located the excel table with the values of the parameters selected at the level of Spain.

Table 1. Coastal protection measures parameters

Parameters	Variable	Description	Source
Reasons for installing coastal protection measures	Possible values: protection of buildings, creation of beaches	Specify the reasons for installing the coastal protection measures	MITECO-DGSCM https://www.miteco.gob.es/es/costas/temas/proteccion-costa/actuaciones-proteccion-costa/
Duration of Coastal protection measures	m	Indicate the duration of the coastal protection measures	MITECO-DGSCM https://www.miteco.gob.es/es/costas/temas/proteccion-costa/actuaciones-proteccion-costa/
Coastal defense type	BreakWater, Groin, Revetment, Seawall, Sand bags, Sand nourishment, Sand by-passing, Beach drainage, Dune fencing, Designed Artificial Reef, Vegetation planting, stabilization, Seagrass meadow planting, Mudflat recharge, Beach scraping	Indicate the type of coastal defense for the stability of the coastline	MITECO-DGSCM https://www.miteco.gob.es/es/costas/temas/proteccion-costa/actuaciones-proteccion-costa/
Beach access	Yes/No	Indicate if beach is easily accessible	MITECO-DGSCM https://www.miteco.gob.es/es/costas/temas/proteccion-costa/actuaciones-proteccion-costa/
Restored beach after coastal measures implementation	ha	Indicate the estimated area of the beach restored after installing the coastal protection measure	Own data

V. Conclusions

- **T**he main conclusions of this work are:
 - The Mediterranean coastal zones are threatened by strong anthropogenic pressures, tourism and coastal overcrowding. In addition, they are subject to major natural impacts such as erosion and flooding. Spain and the countries studied have focused their efforts on mitigating and managing these major impacts with assessment projects or programs. This has served to carry out precise diagnoses of the problems they present and to determine the areas most affected or potentially at risk.
 - Coastal protection measures must adapt to future changes associated with climate change. In order to protect and preserve beaches, wetlands and coastal dune systems, the Ministry of agriculture, Food and Environment has implemented new regulations, studies to know the situation of the coast and programs with solutions to protect it and has developed a Strategy of Adaptation to Climate Change for the Spanish Coast.
 - Coastal management plans or strategies exist, depending on the country, at different administrative levels with disparate competencies (from local to national level). While it is true that plans at the national level are optimal for effective coastal management. Failure to present a national strategy often leads to a lack of coordination in coastal management between different administrations and lack of participation of all key stakeholders, among others.
 - The emergence of the ICZM as a coastal management strategy in the different Mediterranean countries is a great solution to create synergies between the different participating countries in terms of knowledge, study and approach to problems and search for solutions when managing the coast. ICZM has been adopted and is recommended as the most appropriate coastal management methodology in Europe, although not all countries have fully implemented it in their policies at present.

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