Macaronesian Maritime Spatial Planning

"CHARACTERISATION OF THE SOCIO-ECOLOGICAL SYSTEM OF THE EUROPEAN MACARONESIA MARINE AREA IN ORDER TO SUPPORT THE MARINE SPATIAL PLANNING PROCESS"

An integrated and ecosystemic approach to promote cross-border cooperation

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D.6.1 Integrated and synthetic diagnosis of the marine spatial planning in the Macaronesia

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Summary

The MarSP project aims to develop concrete actions for the Member States (Portugal and Spain) to build the necessary capacities and tools for the implementation of the EU Directive on MSP (Directive 2014/89/EU) in the region of Macaronesia with especial emphasis on cross-border cooperation. In this sense, the present report seeks to show and generate a common understanding around the fundamental transboundary socio-ecological elements and process that occur across the maritime administrative boundaries and borders of the European Macaronesia. Applying a causal framework based on an integrated and ecosystemic approach, it is shown how ecosystem services link marine ecosystems and human welfare of both Portuguese and Spanish archipelagos. The conclusions enable to identify key issues and important examples of cross-border cooperation that reveal why they are relevant and how they can be addressed through a maritime spatial planning process for this region.

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ABNJ	Areas Beyond National Jurisdiction
AIS	Automatic Identification System
CNUDM	United Nations Convention on the Law of the Sea
CAGR	Componund Annual Growth Rate
CSZ	Canary Islands Special Zone
DPSI(W)R	Driver, Activities, Pressure, State, Impact (on human Welfare), Response
DPSIR	Driver, Activities, Pressure, State, Impact, Response
EC	European Commission
ECS	Extended Continental Shelf
EEA	European Environmental Agency
EEZ	Exclusive Economic Zone
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GVA	Gross Value Added
HDI	Human Development Index
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
INDNR/ IUU	Illegal, Non-declared, Non-regulated fishing/ Illegal, Unreported and Unregulated fishing
MarSP	Macaronesian Maritime Spatial Planning Project
MEA	Millennium Ecosystem Assessment
MSP	Maritime Spatial Planning
NOAA	National Oceanic and Atmospheric Administration
NSI	National Statistical Institute
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic

PLOCAN	Oceanic Platform of the Canary Islands
POMAC	Operational Programme of Territorial Cooperation Madeira-Azores-Canary Islands
POPA	Azores Fisheries Observer Program (Programa de Observação para as Pescas dos Açores)
SCR	Special Canarian Regime
SEO/BirdLife	Spanish Ornithological Society
TS	Territorial Sea
UNEP	United Nations Environment Programme
UPR	Ultra-Peripheral Regions
WWF	World Wildlife Fund

1. INTRODUCTION AND OBJECTIVES

The MarSP project (Macaronesian Marine Spatial Planning) aims to contribute to the marine spatial planning process (hereinafter MSP) in the biogeographic region of the European Macaronesia (the Azores, Madeira and the Canary Islands), in accordance with the provisions of the European Directive 2014/89/EU. Through concrete actions, the ultimate goal is to build capacities and tools to support the implementation of the MSP in the region.

Although they share a similar maritime biogeographic context, the three archipelagos have developed their own planning processes. Each case presents particularities and differences according to the previously mentioned Directive and national legislation and governance frameworks. Thus, each archipelago is currently in a different stage of MSP implementation, as well as the countries to which they belong. Despite this, sharing a bioregion and comparable geographical and socio-cultural elements offer the possibility of including these three archipelagos in the same socio-ecological system. This enables opportunities for collaboration from different perspectives to face the MSP processes, to apply a regional perspective and to address the multiple approaches, problems and situations that arise from the common conditions of insularity and outermost regions, among others.

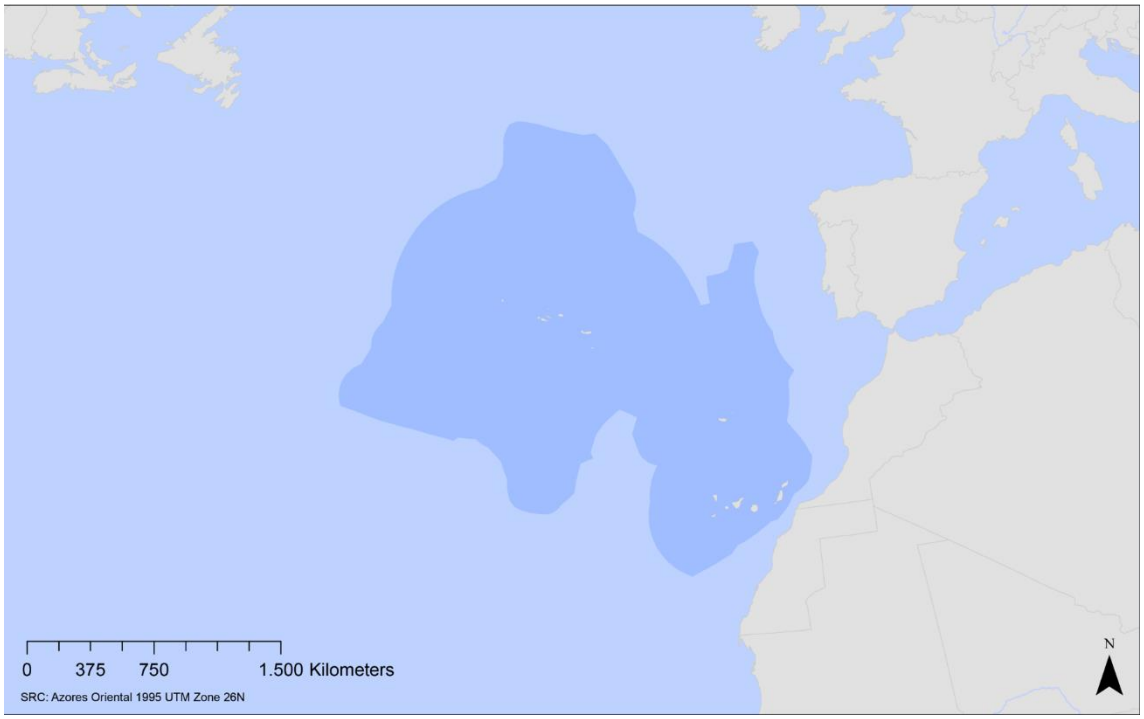
The present work constitutes one of the first results of the MarSP project. It aims to contribute to the comprehension and mutual understanding of marine issues in the area of the European Macaronesia. To achieve this, the current document has been elaborated as a synthetic diagnosis. It highlights the different relationships that exist between the drivers of change and the impact that ultimately these have on the human well-being of this sea basin.

Furthermore, this diagnosis pursues to improve the understanding of stakeholders involved in maritime affairs paying special attention to those aspects that facilitate the cross-border cooperation in the MSP process. For this regard, it has been considered to especially contribute, the recording of the most important socio-ecological interrelations among stakeholders and between these and the good state of marine ecosystems. In this sense, the main objective of this diagnosis is to provide a joint transverse vision for MSP in the European Macaronesia. It avoids deepening, in any case, into sectorial and specific details already made in other research efforts.

2. THE SCOPE OF MACARONESIA

The Macaronesian region within the European Union is constituted by three archipelagos, two belonging to Portugal: The Azores and Madeira; and one to Spain: The Canary Islands (Figure 1). These archipelagos are part of the nine outermost regions catalogued by the European Union.

Figure 1. European Macaronesia and scope of application of the MarSP project

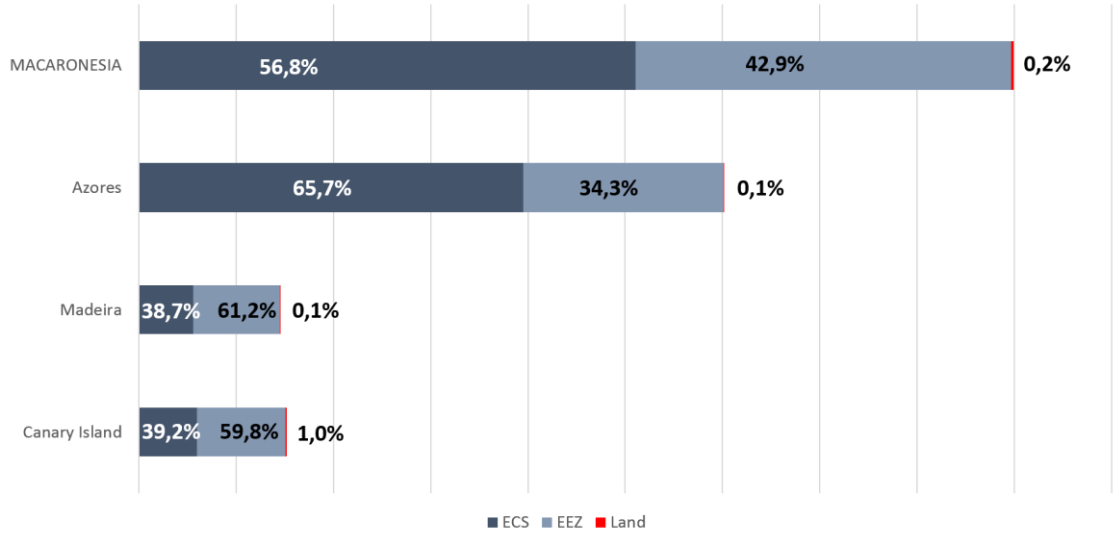


Source: Suárez de Vivero, 2019

In the application of the United Nations Convention on the Law of the Sea (UNCLOS, 1982), the maritime limits of Macaronesia are determined by those established for the Exclusive Economic Zone (EEZ) and the Extended Continental Shelf (ECS) proposed by the States of Portugal and Spain. This supposes a marine surface for the entire European Macaronesia sea basin of approximately 4.319.778 Km² according to the Macaronesia MarSP Atlas (Suárez de Vivero, 2018).

The relative importance of these archipelagos in terms of maritime sovereignty is exceptional. Including the ECS, the maritime surface projected by the Azores multiplies by 1.294 times the insular territory emerged, while Madeira does it by 905 times and the Canary Islands by a 100 times (Suárez de Vivero, 2018. In other words, 3,39 % of the Portuguese emerged territory (the Azores and Madeira) is responsible for 82,68 % of the country EEZ (Suárez de Vivero, 2018. In the Spanish case, 1,4 % of the emerged territory (corresponding to the Canary archipelago) projects 46,6 % of the national EEZ (Suárez de Vivero, 2018) (Figure 2).

Figure 2. Land and sea surfaces of each of the archipelagos of the European Macaronesian region, including the declared Exclusive Economic Zone (EEZ) and the requested Extended Continental Shelf (ECS) declared by both states.



Source: Suárez de Vivero, 2018

In the Macaronesian scope, contacts between the different marine areas of international jurisdiction (between countries) and national jurisdiction (for example, between autonomous regions) generate a wide variety of administrative limits. This translates into different legal and political treatments that will be key to determine the needs of cross-border cooperation in the described scope.

In any case, this project does not aim or pursue to define the exact jurisdictional limits or administrative boundaries and associated borders of the European Macaronesia. In fact, considering the characteristics of the marine environment, the planning efforts must be put on the socio-ecological processes that go beyond any jurisdictional boundary. Their identification will be essential to establish the necessary spaces for cross-border cooperation.

To identify these socio-ecological processes a series of particularities that define the biogeographic characteristics of the Macaronesian scope should be taken into consideration, both in the emerged surface and the marine environment.

The volcanic origin and the Azores and Canary Current (Bruno, 2008; SRMCT, 2014) that is the oceanic circulation of the North Atlantic that dominates in Macaronesia are two crucial aspects that differentiate these three archipelagos from other island groups.

Furthermore, insularity implies a series of attributes of extreme singularity, such as for example, isolated conditions, territory fragmentation, difficult mountainous terrain or resources and space limitation among others. These characteristics are added to the condition of outermost regions (being geographically far from the continent) and together they entail a series of structural limitations that are recognized by the European Union. These elements have received specific attention from national and European cohesion policies, which has made them priority regions for receiving funds.

Indeed, remoteness and isolation are the two factors that differentiate the most these regions from other islands. The outermost regions have to face serious handicaps like being at a

great distance from other densely settled areas and the main economic markets. This often translates into lower development and GDP per capita and higher unemployment rates. It also implies a shortage of infrastructure and access to certain services (Lukic et al., 2018). Remoteness and isolation of the Macaronesian archipelagos must be considered not only with respect to their respective metropolises, but also within the island groups themselves.

This set of limitations makes these territories especially dependent on the external provision of resources. Thus, compensations are needed in order to maintain a level of competitiveness and social welfare comparable to that of other areas. This, in turn, makes the Macaronesian islands exceptionally vulnerable.

However, these factors have also enabled a peculiar historical development and provide unique opportunities. Their distinctive environment has allowed them to develop innovative projects. This is the case of scientific initiatives and high-tech research centers in fields like renewable energies and climatology, which can contribute to the diversification of activities and to a more sustainable development (Lukic et al., 2018). Moreover, the large extension of marine surface projected by the islands along with their geostrategic position in relation to the main maritime or oceanic routes, offer a great development potential for the so-called "blue economy". For instance, this exceptional geographic position facilitates optimal climatic qualities that together with the ecological and landscape singularity make these archipelagos exceptionally attractive for activities such as blue tourism.

In short, the condition of insularity and outermost regions greatly affects human well-being and, therefore, will also determine the necessary marine planning responses for the area. In this sense, at a juridical-administrative level, the twenty-two islands that form the three archipelagos constitute three political units (regions) endowed with a great autonomy in their respective national legal frameworks.

Finally, the relationship between the local administration and the sea is undeniable. For example, about 139 out of 156 local entities ("freguesias") of the Azores and 39 out of 54 of Madeira have some coastline. In the case of the Canary Islands, 77 out of 88 local municipalities are coastal.

The sea is also a geographic condition which influences can be seen on land. This phenomenon of "littoralisation" implies the convergence in the coastline of multiple singularities such as, for example, high densities of population, uses and activities, as well as exceptionally fragile and productive ecosystems and often also conflicting interests among the competent institutions and regulations.

Regarding the Coastal Index[1], the Canary Islands have 0,19 Km of coastline for each Km^2 of land surface. This gives an idea of the strong coastal character of these territories having into account that for the whole Spanish state this value drops to 0,01 Km of coastline per Km^2 of land surface. A similar situation occurs in the Portuguese case. The Azores has a Coastal Index of 0,406 and Madeira of 0,33 Km of coastline for each Km^2 of insular surface (García-Onetti and García-Sanabria, 2007). All of this has an important influence on the surrounding sea and adds to the geographical factors of insularity and the outermost regions to configure an exceptionally complex coastal and marine management framework.

[1] The Coastal Index measures the proportion of kilometers of coastline in relation to the overall surface of a territory.

a. The Azores

The Azores archipelago (Figure 3) is formed by nine islands (Flores, Corvo, Graciosa, Terceira, São Jorge, Pico, Faial, São Miguel and Santa Maria) with a relatively humid climate. The Azores continental platform is the largest of the three Macaronesian archipelagos. Geologically, the Azores comprise a 20–36-million-year-old volcanic plateau; the oldest rocks (composing Santa Maria Island) emerged 8.120 million years ago, whereas the youngest (forming Pico Island) are about 250,000 years old. The geostructural environment of the Azores Plateau, defined by the 2000-m bathymetric contour line, is dominated by the confluence of the American, Eurasian, and African lithospheric plates. It has an overall triangular shape corresponding to a surface area of approximately 400.000 km2 of elevated oceanic crust, roughly underlined by the 2000 m isobaths (SRMCT, 2014).

Figure 3. Archipelago of the Azores

Source: Suárez de Vivero, 2018 from Direção-Geral do Território (Portugal)

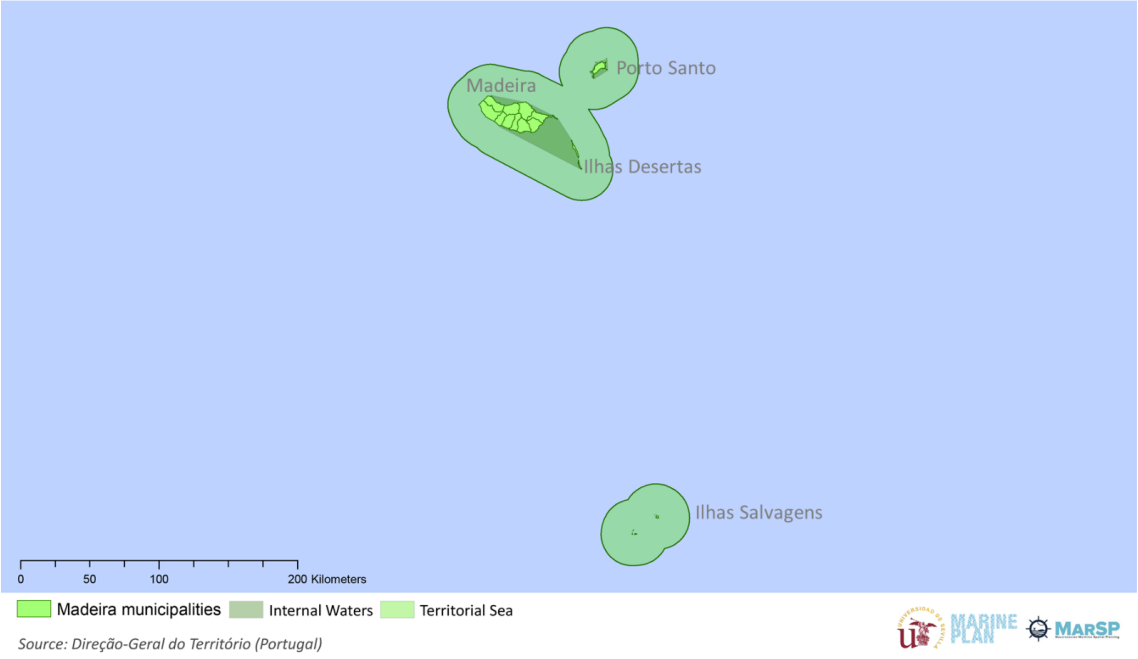
In relation to the environmental characteristics, the Azores presents a diverse marine environment, which is an object of interest and protection through the existence of numerous protected areas. In this sense, both the coastal marine protected areas (MPAs), corresponding to the marine component of the Island Natural Parks, and the offshore MPAs pertaining to the Azores Marine Park, which include 6 protected areas for habitat/species management (Oceânica do Faial, Oceânica do Corvo, Banco Princesa Alice, Monte Submarino Altair, do MARNA, do Monte Submarino Antialtair), 4 protected areas for resource management (Banco D. João de Castro, Banco Condor, Arquipélago Submarino do Meteor incluída, sudoeste dos Açores) and the 5 marine natural reserves (Monte Submarino Sedlo, Campo Hidrotermal Lucky Strike, Campo Hidrotermal Menez Gwen, Banco D. João de Castro e Campo Hidrotermal Rainbow) form a mosaic of high-value ecosystems (SRMCT, 2014).

In the archipelago of the Azores live 243.862 people, representing 2 % of the population of Portugal according to the data of the National Institute of Statistics of Portugal (INE, 2017a). The Azores' population density in 2017 was 105,1 inhabitants/Km² considering its 19 municipalities. In addition, Ponta Delgada hosts the seat of the regional government, serving as the administrative nexus for this Portuguese region with the national scale.

b. Madeira

The Madeira archipelago (Figure 4) is formed by two main inhabited islands, Madeira and Porto Santo, as well as three smaller uninhabited islands called the Desert Islands. It highlights the presence of a continental shelf that extends towards the southeast and gives rise to the Wild Islands (SRA, 2014).

Figure 4. Archipelago of Madeira



Source: Suárez de Vivero, 2018 from Direção-Geral do Territorio (Portugal)

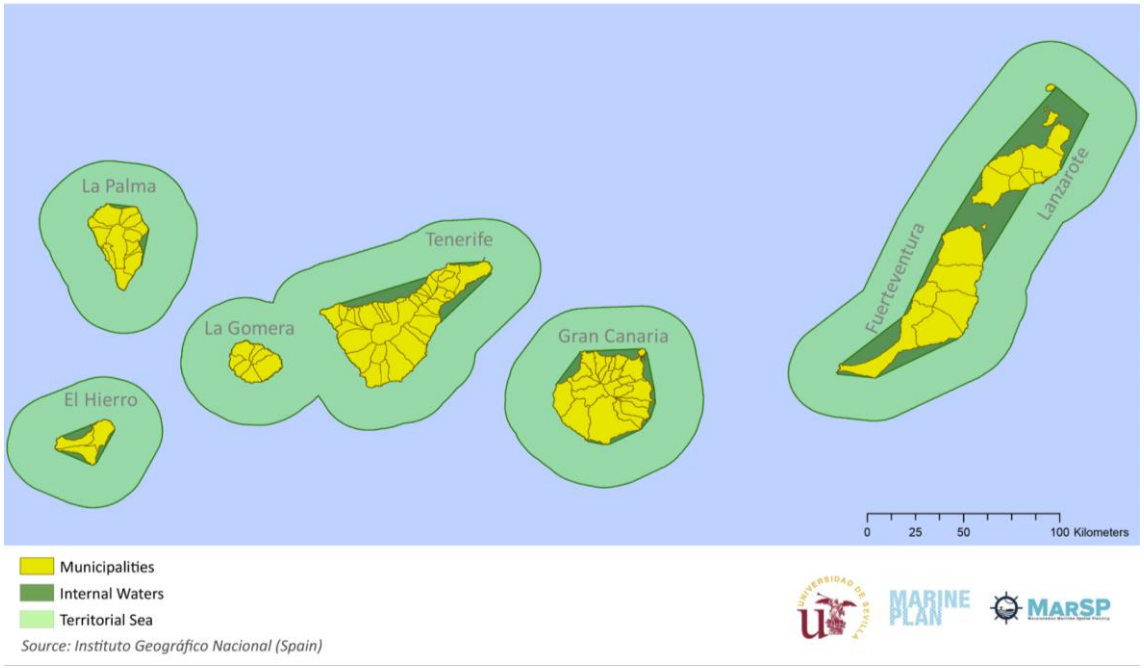
In regard to the marine protected areas, four natural reserves can be highlighted in Madeira (Parcial do Garajau, do Sitio da Rocha do Navio, das Ilhas Salvagens y das Ilhas Desertas) together with the Porto Santo network of marine protected areas. All these areas amount to a protected surface of 265 Km².

Madeira, with its 254.368 people recorded in 2017, presents the highest population density of the three archipelagos with 317,36 hab./Km² (INE, 2017a). This population is distributed through 11 municipalities. Among these, ten municipalities are in the main island of Madeira while the remaining one is located on the island of Porto Santo. The seat of the regional government is in the capital city of Funchal.

c. The Canary Islands

The Canary Islands archipelago consists of seven major islands: Lanzarote, Fuerteventura, Gran Canaria, Tenerife, La Gomera, La Palma and El Hierro; in addition to two smaller islands: Isla de Lobos and La Graciosa; and several uninhabited islets situated at the north of Lanzarote (Figure 5).

Figure 5. Archipelago of Canary Islands



Source: Suárez de Vivero, 2018 from Instituto Geográfico Nacional (Spain)

This archipelago is located on the northwestern margin of the African plate. Regarding the continental shelf, two main groups can be distinguished. The first includes the islands of Gran Canaria, Fuerteventura, Lanzarote and La Gomera which presents a relatively extensive platform. Whereas in the second group, consisting of Tenerife, La Palma and El Hierro, the platform is virtually non-existent and descends sharply to depths of more than 1.000 meters (Hernández et al., 2012). Also, it is important the sum of the marine areas that present some figure of protection. As an example, three of them (El Archipiélago Chinijo, Punta de La Restinga-Mar de las Calmas and Tazacorte) that reaches a total area of 744 Km² (Martín-Sosa and Revenga, 2008).

The seven largest islands of the archipelago are inhabited by 2.108.121 people. This population is distributed in 88 municipalities and account for 5% of the total country's population according to the National Statistics Institute of Spain (INE, 2017b). This archipelago has a density of 281.34 hab / km2 being the national average fewer than 100 hab./ Km². It is administratively divided into two provinces: Las Palmas de Gran Canaria (with 1.119.168 inhabitants) whose capital, of the same name, is the most populated city of the archipelago (383.308 inhabitants); and Santa Cruz de Tenerife (with 1.035.809 inhabitants) whose capital also carries the same name. The seat of the regional government is shared and alternates depending on the legislative periods between the two capitals.

3. CONCEPTUAL AND METHODOLOGICAL FRAMEWORK

An integrated and synthetic diagnosis of Macaronesia region, seen as a socio-ecological system, requires a prior work to define the most appropriate conceptual and methodological framework.

As a first step, in order to avoid terminological confusion and generate greater understanding, a glossary of key concepts has been elaborated and can be consulted in Annex I. The main references and sources of information used are detailed in Annex II. At the same time, the benchmark principles and the approach followed have been previously defined taking into account the objectives of the MarSP Project[2].

The conceptual approach on which the present diagnosis is based follows the marine spatial planning trends set by the main international organizations. **Ecosystem-based management** is an intrinsic part of the MSP objectives. Subsequently, within the principles associated with this approach, the concept of **ecosystem services** has been incorporated to link directly the good state of ecosystems and human well-being (see Annex I).

Furthermore, it is necessary to add the approach of the **integrated management** which has been widely applied in the administration of the coastal zones. Its principles have also acted as a baseline for MSP. In this sense, the social and physical processes that occur in the terrestrial and marine environment, as well as their land-sea interactions, can be holistically considered in Macaronesia. In other words, what occurs in each archipelago (or on each island individually) interfere with the marine environment and, thus, with the entire Macaronesian scope in different forms and intensity.

A **systemic vision** is required to establish the key socio-ecological relationships of the Macaronesian region. For the marine environment, this is especially important due to ecosystem boundaries are more diffuse and, as in the case of Macaronesia, spaces of multiple administrative boundaries are frequently found. In effect, some flows of services and pressures cross administrative limits making the human welfare on both sides being intrinsically related. At the same time, this should promote a coherence between cross-border decision-making. Thus, with this systemic vision, the identification of the essential spaces for cross-border cooperation is facilitated.

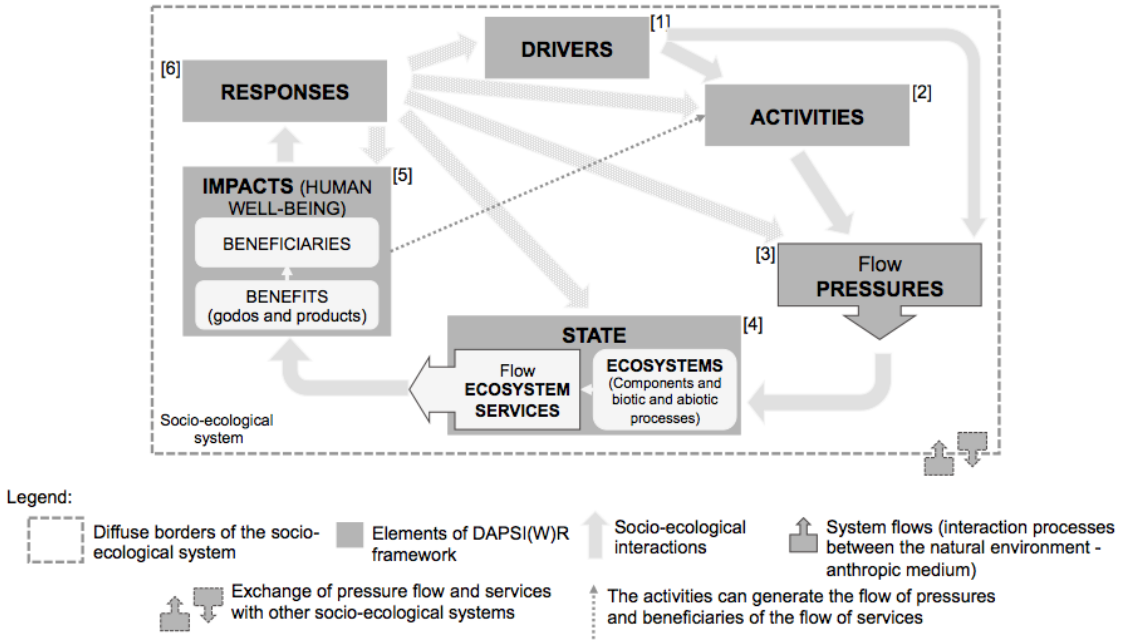
In this sense, the incorporation of the **causal framework DPSIR** (***Driver, Pressure, State, Impact, Response***) (EEA, 1998) to the ecosystem based management facilitates this vision. Following the latest conceptual advances, the present diagnosis will follow the evolution of the DPSIR model to **DAPSI(W)R (*Driver – Activities– Pressure – Change of State – Impact (on Societal Welfare)– Response*)** (Elliott et al., 2017). The application of a conceptual framework based on this causal model pretends to generate a schematic simulation of the socio-ecological system (biophysical, socio-economic and management components) and the processes that interconnect them (ecosystem services and pressures) (Figure 6). It allows to reflect the role of different stakeholders and economic sectors, both in those processes (dependence on ecosystem services, consequences of their activities on other sectors, etc.) and in the governance framework

[2] Web of the MarSP Project: http://marsp.eu/

as co-responsible agents in decision-making. The DAPSI(W)R model is also a useful tool to facilitate interterritorial and cross-border cooperation, while encouraging the organization and multidisciplinary elaboration of available scientific information, making it more useful for decision-making. This is because it offers a more practical vision for the manager by highlighting the relationships between the natural and the human subsystems (Kelble et al., 2013).

The application of the DAPSI(W)R model would contrast with the traditional analysis that makes a segmented description of the physical, biological and socioeconomic components requiring a posterior and always difficult integration (Agardy, et al., 2011; Murawski, 2007). The present diagnosis applies this causal framework to the European Macaronesia. In this case, it is less a question of deepening into the knowledge of each of the causal model elements individually than of emphasizing the importance of visualizing the flows and key interaction processes of the system. The above will also allow giving visibility to the key management and cross-border cooperation issues.

Figure 6. Conceptual scheme DAPSI(W)R



Source: adapted from Elliott, 2017

As seen in Figure 6, in this causal framework **Drivers of Change or Driving Forces [1]** would be the aspects that condition the development of certain **Activities [2]** in the marine environment of Macaronesia. These activities would interact with the environment causing a flow of **pressures [3]** on coastal and marine ecosystems. Consequently, the **State [4]** of the ecosystems would be affected, causing an alteration in the flow of services that these provide. The paradox of this causal framework is that this alteration reverts again to the human well-being of Macaronesian archipelagos as the latter depends largely on the former ecosystem services. That is to say, variations in the flow of ecosystem services cause a variation or **Impact [5]** on the benefits that are obtained from them (including the ones from activities causing some pressures) and thus, an **Impact on Well-being I (W) [5]** of all those beneficiaries of ecosystem services. The latter justifies the development of management measures to **Respond [6]** to the set of associated problems and conflicts. Finally, it should be remarked that due to its great complexity,

the section of "Responses" requires an individualized and deeper analysis by archipelago that will not be tackled in the present work.

In this manner, by understanding these relationships, the main causes and consequences of the most outstanding problems can be established to be addressed in a management process such as the MSP of Macaronesia.

4. DIAGNOSIS OF MACARONESIA

Considering the scope and the causal framework chosen, it is possible to approach the elements that intervene in Macaronesia to understand the main relationships and processes that take place. It is convenient to start by insisting that the entire socio-ecological system is conditioned by the singularities already described associated to the islands of Macaronesia: the insularity, the outermost location and littoralisation.

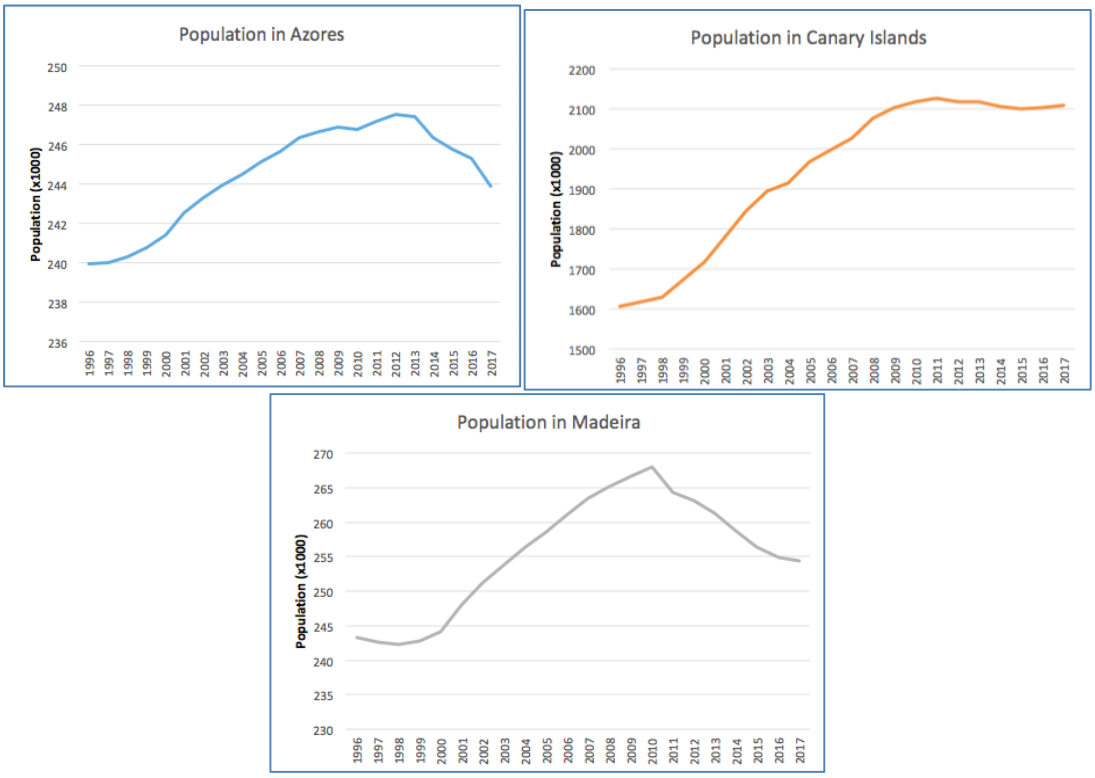
4.1. DRIVERS OF CHANGE

The present diagnosis starts by identifying the main **Drivers or Driving Forces (D)** that originate, in a more or less direct way, the anthropic causal relationships in the socio-ecological system of Macaronesia.

In the first place, it is important to understand that **"culture"** is what determines the type of relationship that will occur between society and ecosystems. It really conditions the other drivers that will be discussed in this section. Culture encompasses the values, beliefs and norms of society and supports its development. The region of Macaronesia presents a common cultural framework. Its outermost position and the insularity that characterize its territory give this region unique features that are accompanied by a specific cultural tradition. For example, one traditional activity that can be highlighted is the artisanal fishing that has historically been an important source of income and food for the region. This common cultural framework that serves as a cultural basis for mutual understanding, can lead to opportunities for collaboration and cooperation between archipelagos.

The previously mentioned elements (geographical and cultural) often determine **demographic changes**. These also have a priority role as a driver of major socio-ecological changes. The archipelagos of the European Macaronesia have experienced in recent years a population increase higher than the average of Portugal and Spain for the same period. Thus, while in 2001 there were 2,1 million inhabitants in the region, in 2017 this number has risen to 2,6 million inhabitants (Figure 7). Factors such as the benign climate, the improvements in transport or the increase in maritime trade have facilitated this increment.

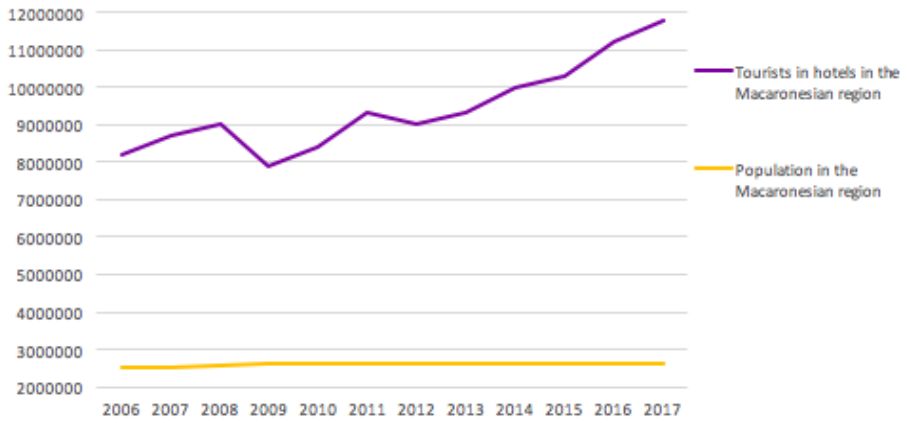
Figure 7. Evolution of the population in the 3 archipelagos of the European Macaronesia



Source: own, based on Instituto Nacional de Estadística de España e Instituto Nacional de Estatística de Portugal (INE, 2018)

The archipelago of the Canary Islands alone contributes with 81 % of the total population of Macaronesia. On the other hand, Madeira and Azores contribute 9 % each. However, the previous data is not illustrative enough as a demographic driver if the important floating population associated with tourism that visits the islands every year is not considered (Figure 8).

Figure 8. Resident population and tourists in hotels in the region of Macaronesia



Source: own, based on Instituto Nacional de Estadística de España e Instituto Nacional de Estatística de Portugal (INE, 2018)

In 2017, approximately 12 million tourists were estimated to stay overnight in Macaronesia (INE, 2018a, 2018b, 2017c). This data is exceptionally high in the Canary Islands, which again contributes with more than 80 % of the tourism that arrives at the region. It should be added that there is a significant proportion of foreigners in the territory, mainly in the Canary Islands (reaching 35 %) and Madeira.

The effect of all the just mentioned is evidenced through an exceptional demand of services and infrastructures and in a unique evolution in the patterns of consumption and production, conditioned in turn by the general process of globalization. At the same time, this consumption level is highly determined by the income received by individuals and families. All of the above has direct consequences on the demand for ecosystem services, that is, both marine and terrestrial resources (very limited in the islands). This especially conditions the need for space, both terrestrial (land) and marine, for the development of uses (including housing) and maritime and coastal activities. For example, during the last economic crisis there has been a significant decrease in consumption, with direct consequences on some of these demands slowing down housing construction, maritime transport or tourism at certain times.

Socio-political drivers, on the other hand, include the forces that influence decision-making. In this regard, aspects related to decision-making will be detailed in the analysis of the Macaronesia governance framework, since the particularities of the region, as well as the national and regional structures and processes themselves require an analysis detail of this question.

In this sense, in treaties such as those of Maastricht, Amsterdam, Nice, etc., specific articles have been prescribed for the Macaronesian region, based on the recognition of the difficulties associated with insularity and the outermost regions. In addition, other regulatory amendments, regulations and directives have proposed measures for their compensation, such as Poseican and Poseima (2001) on agricultural products, Regulation (EC) No. 639/2004 on the fishing fleets management, and others of the Specific Supply Regime (García-Onetti and García-Sanabria, 2007). This is also reflected at the national level. It is worth remembering the existence of regulated free zones in these regions compatible with their inclusion in the Single Market (RegioPlus Consulting, 2014). Thus, the Canary Islands have the regime of the Special Canary Islands Zone (ZEC), modified by N 741/2007 and the Canary Islands economic and fiscal regime (REF), regulated in the State Support N 377/2006. The Azores archipelago, among other measures, counts with a reduction of some products through special tax rates (e.g. State Support N 320/2008). Madeira also has a specific regulation of its free zone (State Support N 421/2006).

Relating to maritime affairs, the European Commission started paying special attention to the possibilities of the so-called "blue growth" from 2011. That is, to the potential of the European seas and oceans as a source of new jobs and the contribution to the current objectives of the Strategy 2030 (European Commission, 2019[3]). This reality is particularly visible in the outermost regions and in the archipelagos like those of the European Macaronesia. In this case, the European Union has also taken into account as a geographical conditioning the exceptional influence of the sea (coastal and eminently maritime character). In fact, maritime activities are the backbone of local and regional economies in this sea basin (EASME, 2017a).

[3] European Commission (2019). The EU Blue Economy Report. 2019. Publications Office of the European Union. Luxembourg. Available in: https://prod5.assets-cdn.io/event/3769/assets/8442090163-fc038d4d6f.pdf

In the Communication entitled "blue growth: Opportunities for a sustainable marine and maritime growth", the European Commission identifies several initiatives that are currently underway with the aim of implementing the Europe 2020 Strategy. Among other issues, a series of activities are highlighted around which future blue growth initiatives could revolve. It is also explicitly stated that marine spatial planning could provide adequate support by generating greater confidence and certainty for investors. Such is the case of the Directive 2014/89/EU (European Union, 2014) which aims to establish a framework for marine spatial planning to allow the promotion of a sustainable blue economy.

Scientific and technological innovation and research have profound implications for ecological systems and human well-being. In the marine environment these advances are of great relevance. In the first place because they allow a greater knowledge of a medium that is still little known. Secondly, because they encourage the development of new activities (stimulated by the aforementioned ambition of the "blue growth") allowing or improving access to ecosystem services. However, this can also lead to a progressive but significant increase in the pressure on the ecosystem, for example, with the increase in fishing effort or oil, gas or mining prospection at greater depths. However, these advances can also lead to a decrease in pressure on ecosystems, for example, through the use of renewable services such as wind. This is the case of the Elisa Project[4] is a project promoted by Esteyco for the installation of the first fixed offshore wind turbine in the sea of Spain. As a result, this project represents an innovative advance in the marine environment. All these technological innovations can also lead to an indirect development of infrastructures, equipment, means of transport, etc. that improve communications, economy and social welfare of populations.

In this sense, in the archipelagos of the European Macaronesia there are some examples of scientific-technological innovations in the marine environment that serve as an international reference. Stands out the installation in 1999 of a wave power plant on the island of Pico: "Central de Ondas do Pico" as a pilot project to obtain energy through the wave movement.

Finally, it should be noted that these archipelagos are true natural laboratories to experiment with new uses and sustainable exploitation of the environment. All this favoured by their special conditions of location, isolation and limited resources.

[4] More information in: https://esteyco.com/projects/elisa/elisa.html

4.2. ACTIVITIES

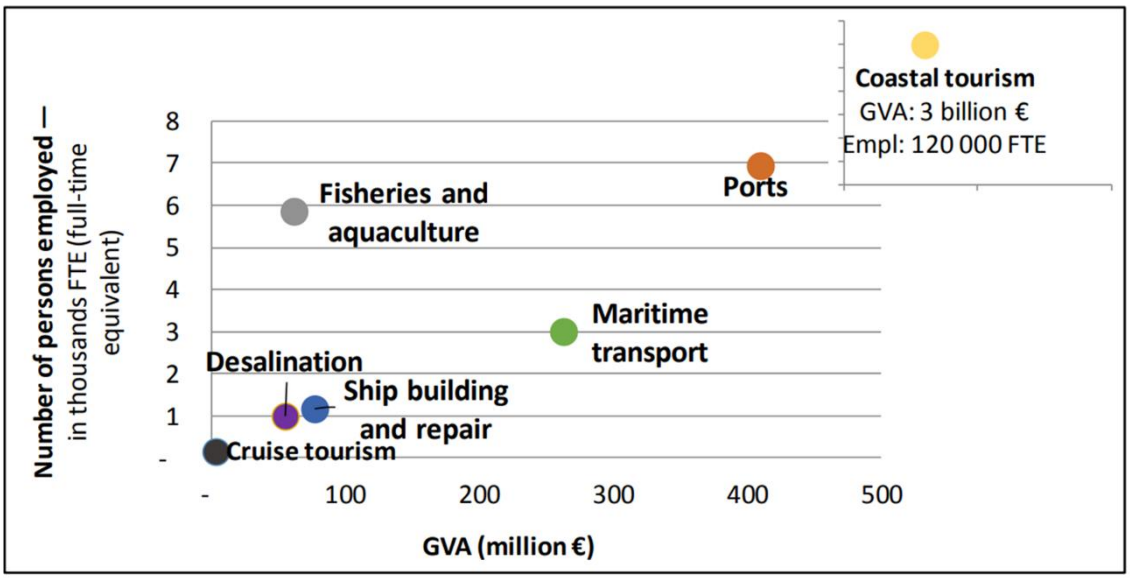
Activities (A) correspond to operations, tasks, techniques and anthropic functions developed by the main maritime economic sectors of the archipelagos and, therefore, of Macaronesia as a whole. Their development is largely originated and/or conditioned by the drivers described above. Hence, depending on how they are carried out, these activities will be the cause of more or less pressures on the marine area of the region.

There have been especially considered those activities that, apart from being relevance for the region's economy, present a spatial dimension in the marine environment that makes them subject to planning. Due to this reason, each of the strategic sectors and MSP processes are analyzed for Macaronesia.

In this sense, there have been specified the most characteristic examples for each archipelago, being able to make comparisons between them, though it is implied, once again, that the purpose of the present document is not to delve into the detail of this section. For this matter, the report of the European Commission "Realising the potential of the outermost regions for sustainable blue growth" and Annexes 7, 8 and 9 for the Azores, Madeira and the Canary Islands (EASME, 2017a) are especially recommended, all of which have also served as references for the present work. According to this report, certain maritime activities especially stand out in Macaronesia (Figure 9). Of these, tourism (both coastal and cruise), ports and maritime transport (of goods and people), fishing and aquaculture have been identified as the activities playing a fundamental role and thus, being more developed in the region.

By contrast, both renewable energy (mainly offshore wind) and blue biotechnology are activities that are underdeveloped. However, they have considerable potential for growth in the near future, may create important new job opportunities and add value to the economy of the sea basin (EASME, 2017a).

Figure 9. Main activities in the European Macaronesia (Azores, Canary Islands and Madeira)



Source: European Commission, 2017

It is important to consider the possible development scenarios of the maritime sectors in the future. Both an increase of the sectors' demand and new technological advances (drivers or driving forces) may have implications for marine spatial planning beyond the normal planning horizon and/or provide new sources of information for planners (Lukic et al., 2018).

Assuming Article 2 of the Framework Directive on Marine Spatial Planning (2014/89/EU) (European Union, 2014), the rule will not apply to activities whose sole purpose is defence or national security. Therefore, these uses and activities have not been analysed, even considering the spatial dimension of these for marine spatial planning of the Macaronesia.

In addition, the uses and activities described here are addressed in general descriptive terms, always from the Macaronesian perspective, and in relation to the socio-ecosystem. For more details regarding the characteristics of uses and activities developed in the regions, consult the results of MarSP Project.

i) Fishing and aquaculture

In the first place, **commercial fishing activity** has a long tradition in Macaronesia, where it is characterized by the predominance of small-scale artisanal fishing activities, with vessels less than 12 meters in length (SRA, 2014; SRMCT, 2014). However, the fleet is in decline, partly due to reconverting plans for the sector and the insufficient generational replacement of the fishermen.

Considering the scarce continental shelf and the oceanic character of the archipelagos, the main species exploited here are those of deep water and migratory pelagic fish, standing out the black sable, tuna and its related species. The archipelagos marine ecosystems and their fish biomass, therefore, are closely related to what happens in other socio-ecological systems elsewhere, where these species feed, reproduce or are fished. In archipelagos such as the Azores, only 0,8 % of its EEZ is at depths of less than 600 meters, being these the "areas with the greatest fishing potential" (Comisión de Pesca de la Unión Europea, 2002). This is why the artisanal fleet mostly fishes near the coast, around the islands and in specific seamounts off them.

In the Azores and Madeira, trawling is prohibited so other more selective fishing gears have been developed. In the case of Madeira, the fleet uses fishing rods or gillnets to fish for swordfish (SRMCT, 2014). In the Azores, longline fishing is important as well as an important sport fishing activity (SRA, 2014). On the other hand, both in the Azores and Madeira, fishing methods such as those using lines and poles are consolidated by tuna fisheries. In the case of the Canary Islands, since 1950 there has been a continuous decline in artisanal fishing as opposed to sport fishing, which has accounted for 70 % of the total catches in 2010 (Castro, et al., 2015). Even so, artisanal fishing with various fishing gears continues to stand for 87 % of the fleet, while the remaining percentages are trawlers and long-liners that operate in waters of third countries (Figure 10).

Figure 10. Artisanal fishing boats in the Azores and the Canary Islands

Source: own

It is worth mentioning that a fishing agreement for the European Macaronesia was signed between 2008 and 2010 in order to allow an agreed number of vessels from the region to access certain fishing species (swordfish and tuna). These vessels would be able to fish those resources within the third countries exclusive economic zones and outside the territorial sea zone (SRMCT, 2014).

Given the distance to the main markets, most of the landed fish is sold fresh, despite in the Azores this economic activity is also supplemented on land with an important tuna **canning processing industry**. In the past, this industry was also really important in the Canaries, but since the late 80s started a rapid decline of the industry practically disappearing by the early 2000s.

With regard to aquaculture, waters of the archipelagos have good conditions for the development of this activity as they have adequate temperatures throughout the year (SRMCT, 2014). However, there are differences between the archipelagos in terms of production. In the Azores, although this sector has not yet been developed on a commercial scale, there are pilot projects for its implementation (De Girolamo, et al., 2017; Ojamaa, 2015). On the other hand, in Madeira, marine aquaculture began to develop at the end of the 90s. However, today it is not very competitive due to the insularity, which is the reason it is a subsidized activity by the government. From its beginnings to the present, the only commercialized species is the seabream. Finally, the Canary Islands is the region's leading archipelago in aquaculture, beginning its activity since 1994. It is mainly based on the cultivation of seabass and seabream fattened in marine cages, though in 2011 the sector also began to produce algae, Senegalese sole and shrimp (EASME, 2017a).

Overall, in the archipelagos of Macaronesia, fishing represents an important sector, both from a socio-economic point of view and as a generator of pressure on the marine ecosystems. Nevertheless, mainly due to its insular nature and low water productivity, the fishing sector is not industrially highly developed. In this sense, an increase in sport fishing compared to artisanal fishing stands out in the three archipelagos. On the other hand, aquaculture is still in an incipient phase, being more developed only in the Canary Islands (Figure 11).

Figure 11: Floating marine cages for aquaculture in the Canary Islands

Source: http://www.gobiernodecanarias.org/agricultura/pesca/temas/cultivos_marinos/

ii) Coastal and marine tourism

Tourism is a well-established activity in Macaronesia. Especially, the Canary Islands and Madeira are well-established destinations in terms of sun and beach tourism highly favoured by their excellent climate. However, the now called "old" sun and beach tourism model is gradually giving rise to a new model of tourism that takes advantage of the marine environment and its resources and coastal culture. The new types of tourism include nautical activities, whale and bird watching, tourist fishing and gastronomy, besides cruise tourism among others.

In the case of the Canary archipelago, in all its islands tourism is an important economic activity, but its type differs from one island to another being sun and beaches the main tourist appeal for Gran Canaria and Fuerteventura, the landscape for Lanzarote and Tenerife, and nature for La Palma and La Gomera. In general, tourism in the islands has experienced several development phases. It started with a sun and beach based model between the 60s and the year 2000, very dependent on the climate and the quality of the beaches, but especially on the urban development of apartments, hotels and auxiliary services (spas, golf courses, etc.). Subsequently, with the current consolidation of the sector, a diversification work is being conducted to expand the range of tourism activities such as experiences in nature, adventure tourism, snorkelling, whale watching and rural tourism, among others. It is worth stressing that these new types of tourism depend more on the good environmental state and on the flow of ecosystem services. To the above must also be added the development of nautical tourism, which has made the archipelago an international reference destination for nautical and water sports.

On the other hand, Madeira's tourism sector mainly relies on its distinctive nature, environment and landscape. The profile of the most common tourism that visits Madeira usually comes from the north of Europe (the United Kingdom and Germany), has an advanced age and a great purchasing power, and normally stay in hotels. However, in the last 10 years there has been a gradual reduction in the average age of tourists visiting Madeira and, therefore, a change in the tourism activities requested. Nowadays, the tourist offering is strongly connected to water sports and maritime recreational activities. In fact, there is a constant growth of activities such as whale watching, diving, surfing, bodyboarding, windsurfing, stand up paddling, recreational fishing, underwater archaeology, navigation, etc.

In the Azores, the tourist offering is more oriented to nature and dominates the traditional hotel accommodation packages. This archipelago is increasingly identified as a recommended destination in the international tourist circles, despite having a greater seasonality than the other two archipelagos as due to its latitude it does not have the same climatic advantages of the other two (EASME, 2017a). In the Azores, it is also highlighted the presence of maritime tourism companies (i.e., provision of services aboard vessels that operate in the sea for tourism purposes).

Regarding the percentage of tourism arrivals to each of the archipelagos in relation to the total national figures, it is clear that the Azores is the archipelago with the lowest percentage of tourism arrivals, assuming 2,5 % of the country's total tourism (SRMCT, 2014). In the case of the Canary Islands, with much less seasonality in tourism than the rest of the archipelagos, the number of travellers accounted for 9,4 % of total tourism in Spain in 2017 (INE, 2017c). Lastly, Madeira received 7, 4 % of total Portuguese tourism in 2011 (SRA, 2014).

Moreover, the **cruise tourism** is an activity of relevance within the sector and for marine spatial planning and presents positive growth prospects for the coming years (EASME, 2017a), especially between Madeira and the Canary Islands. In the last mentioned archipelago, it is an activity of great importance, whereas in Madeira, it compensates for the seasonality of traditional tourism, since most of the scales (85%) are carried out between October and April (EASME, 2017a). On the other hand, the Azores is important for this sector as far as it is a staging post for cruise routes between the Mediterranean and America. Nonetheless, it is also relevant the significant movement of cruises between the three archipelagos. This can be remarked as having a great potential for growth and cross-border cooperation.

Nautical tourism is another subsector of coastal tourism in the region that should be mentioned. The archipelago of the Canaries, for example, is becoming an international reference destination for this type of tourism. In addition, given their geostrategic position, the islands of Macaronesia are a stopping point for long-distance pleasure boats that often divert their routes to pass through these islands. In order of significance, stands out the Canary Islands, the Azores and lastly Madeira (EASME, 2017a).

iii) Port activities and maritime traffic

The range of activities, techniques, operations developed by this sector and their subsequent flow of pressures on the environment, will be closely related and determined by the type of ports found in the region and the activities developed in them and in the sea (what they transport and how they do it).

It should be noted in the first place that the geostrategic position of the Macaronesian islands benefits this sector in terms of transport, especially freight transportation. The large oceanic routes between Europe and Africa, as well as the routes to ports of Central and South America, pass through these archipelagos. In general, the region has made extensive investments in converting its ports into competitive infrastructures capable to seize the opportunity of their strategic location. Also, due to their insular fragmentation, communications of these archipelagos, both to the outside and between the islands, depend heavily on maritime transport. Table 1 summarizes briefly the two types of maritime transport activity that takes place in Macaronesia.

Table 1. Maritime traffic in the European Macaronesia 2016

	Marine Traffic 2016	
	Passengers (people)	Goods moved (Tn)
Canary Islands	7.868.801	28.042.858
Madeira	628.378	1.105.681
Azores	1.109.742	2.182.071

Source: Autoridad Portuaria de Las Palmas, 2017; Autoridad Portuaria de Santa Cruz de Tenerife, 2017; INE, 2016.

Due to the archipelago dimensions in terms of territory, population and economy, the greatest activity of this sector takes place in the Canary Islands. As indicated in CE, 2017, there are more than 75 freight services mobilizing all types of goods (containers, bulk, general cargo, etc.) that connect the Canary Islands with countries of West and North of Africa. Although the merchandise movement has declined in recent years, there are still planned works of expansion, construction of new docks, storage facilities and dredging and improvements for the reception of cruise. In regard to passenger transport, also due to the above-mentioned dimensions, density of maritime traffic is really high in the Canary Islands, especially between the capital islands of Tenerife and Gran Canaria. This is relevant generally for Macaronesia, but particularly in the Canaries case, where 25 % of the total passenger volume is due to cruise (Autoridad Portuaria de Las Palmas, 2017; Autoridad Portuaria de Santa Cruz de Tenerife, 2017).

Thus, it is not surprising that the Canary Islands count with nine relevant ports in total. One per island and two in each of the two largest islands. They have different sizes and specializations, but in general they all have large storage and operation capacity as well as great passenger and cruise traffic facilities. The port infrastructure of the archipelago is completed by a wide variety of **ship repair** companies that cover both the technical and security demands of international companies. The largest ports are those of Las Palmas (Gran Canarias) and Santa Cruz (Tenerife), both multifunctional. In relation to the supply of fuel, as a particularly dangerous cargo for the marine environment, the port of Las Palmas is a large Atlantic service station and the first Spanish fuel supplier. It also assumes an important role in the maintenance activities during the technical stops of oil platforms coming from South Africa. During the last years, the Port Authority of Santa Cruz de Tenerife and Las Palmas have carried out several projects of dredging activities. In the archipelago can be highlighted up to nine relevant ports in total, one per island and two in each of the two largest islands. They have different sizes and specializations.

In the Azores, maritime transport has a great importance for the regional economy as the archipelago is fragmented into nine islands. There are nine main ports, one per island. The biggest port is Porto de Ponta Delgada on the island of São Miguel. This port holds many different activities: fishing, nautical recreation, ferry, cruises and commerce. The second major port is Porto da Praia da Vitoria on the island of Terceira, which has also a facility for roll-on-roll-off vessels and a terminal for cement. On the one hand, transport of passengers between islands is conditioned by climatic conditions and seasonality. On the other hand, around 70 % of external commerce in this group of islands uses freight maritime transport. The Azores is linked to the continental part of Portugal through three companies of container transport with an average

capacity of 530 TEU. The remaining maritime transport is composed of liquid and solid bulk that operates only in some ports. In particular, those of Ponta Delgada (cereals) and Praia da Vitoria (cement), which have the necessary storage capacity (EASME, 2017a). Moreover, due to its strategic geographical position, the Azores is a central region for the international freight maritime transport, especially for the bunkering activity.

In Madeira, there has been done great effort to modernize the maritime transport sector, which has led it to a specialization of its main ports. This archipelago counts with three ports, being the one of Funchal the most relevant even when the port of Caniçal moves more goods (containers and solid bulks). Currently, there are five companies that operate transporting freight to the continent. Transport of passengers in ferry is characterized by the high seasonality of tourism in Porto Santo and its potential of growth is limited. Furthermore, it does not exist transport of passengers between the islands and the continent.

Port potential is also linked to the yacht and sailing activities, so to the latter it should be added the network of small-scale recreational and fishing ports managed at different territorial scales.

iv) Energy, industry and marine mining

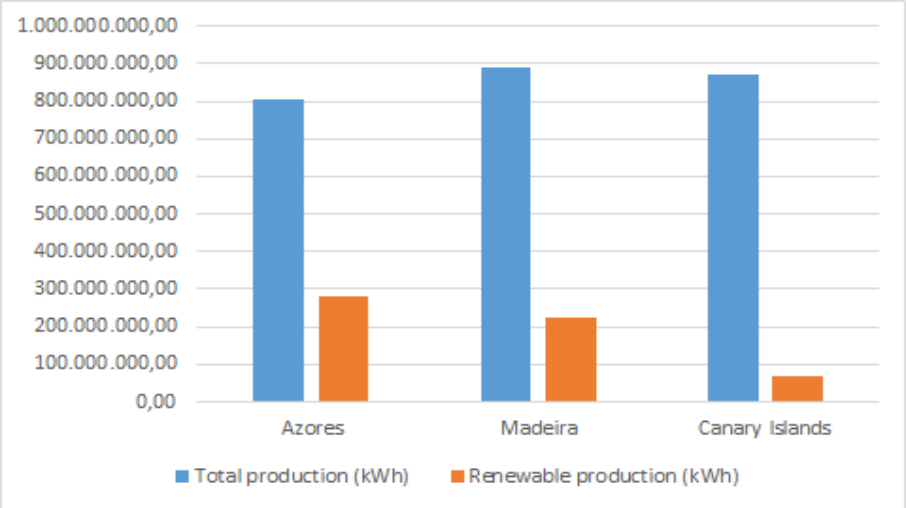
The maritime industry is not a significant economic sector in the Macaronesian archipelagos though, in general, the fish processing industry for diverse uses stands out. Despite this, it is worth noting that industrial activities that take place on land exert pressure on the marine environment, mainly through the discharge of nutrients and polluting effluents. In this sense, the agro-food industry stands out.

As far as the **offshore energy industry** is concerned, there are no facilities in the marine environment of the European Macaronesia that produces energy commercially, partly due to the meteorological and bathymetric conditions of this sea basin (Miguel et al., 2017; SRMCT, 2014).

In regard of **renewable energy**, although it is a sector with potential development in the area, it is still at an early stage of evolution in the marine environment (Figure 12). In the Azores, 35,5% of the energy produced is renewable from land sources, whereas in Madeira this percentage lowers to 25,2 % and in the Canaries drops to 7,8 %. Nevertheless, in the Azores, in 1999, the Pico Wave Power Plant (Pico Wave) was built in the Island of Pico as a result of a European pilot project to obtain energy from the movement of the waves. Its construction was financed by the European Commission, two Portuguese public service companies (EDA and EDP) and by the Portuguese State under the scientific coordination of the Higher Technical Institute (IST) of Lisbon. In 2007, the ownership of the plant was transferred to WavEC (created in 2003), which has been responsible for its operation since then. This plant is currently not functioning, due to its difficult maintenance and lack of funding. Despite this, it has made a valuable contribution to the promotion of research and development and innovation in wave energy, both nationally and internationally[5].

[5] More information: http://www.pico-owc.net/news.php?cat=89&newid=346&wnsid=ffaedab643e41be91f9eecf88f429ee8

Figure 12. Distribution of energy production in Macaronesia by archipelago



Source: Regional Statistics Service of the Azores, Statistic Institute of Madeira and the Spanish Electric System Report 2017.

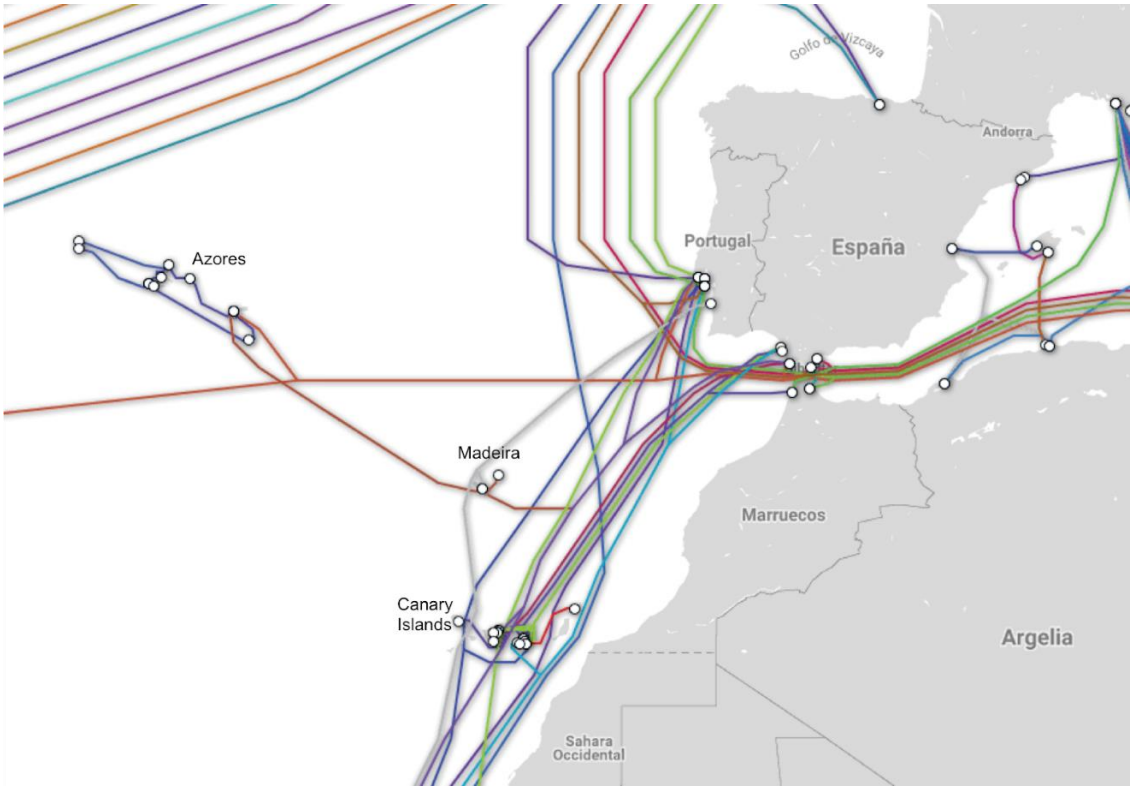
In the Canary Islands, on the other hand, there are recent studies on the possible location and productivity of renewable energy facilities (Schallenberg-Rodríguez et al., 2018). In this regard, stands out a prototype of the Esteyco offshore wind turbine with capacity to generate 5 MW that has been installed in the northeast of Gran Canaria in 2018, within the ELISA/ ELICAN project associated with the Canary Islands Oceanographic Platform (PLOCAN), an infrastructure dedicated to the development and testing of marine technologies. This prototype came into operation in 2019[6]. Apart from renewable energies, in this archipelago, oil exploration has also been carried out in waters off this archipelago. Although these prospecting operations showed inviable exploitation of fossil fuels, they generated great concern due to the pressures that a possible accident of this activity could generate on the marine ecosystems and the economy of the region.

In terms of **biofuel** production, on the island of Porto Santo (Madeira) a pilot project was launched in 2006 consisting of a biofuel production plant based on microalgae. It was a pioneering project to replace the fuel used in the electricity production of the island by biofuel of marine origin intending to convert Porto Santo into a green island. Although the plant still exists, its operation is currently minimal (EASME, 2017a).

Moreover, the telecommunications industry is associated throughout the world with the deployment of **cables in the marine environment** allowing connections between countries and continents. In the case of the islands of the European Macaronesia, its insularity condition makes the installation of underwater cables essential being the three archipelagos connected to each other and to the European continent by the seabed (Figure 13).

[6] More information: http://plocan.eu/index.php/es/portfolio-proyectos/1781

Figure 13. Submarine cables in the Macaronesian region



Source: www.submarinecablemap.com

Finally, **marine mining** is considered one of the activities that may have the most potential within the framework of the European strategy of "blue growth" and there is great interest in its development in the offshore waters of Macaronesia. In fact, the discovery of the possibly largest Telurio world deposit in waters off the Canary Islands has recently been reported, which is very useful for lowering the cost of obtaining solar energy or for mobile telephony[7].

v) Blue biotechnology

Marine biotechnology or blue biotechnology uses marine living organisms for various applications and industrial sectors such as food, cosmetic or pharmaceutical, among others. It is considered by Europe as an emerging sector within its strategy of blue growth, and with great potential to help the regional economy in the creation of new jobs, while contributing to sustainable growth, public health and environmental protection (Lukic et al., 2018).

However, there is no well-developed marine biotechnology activity in Macaronesia. This sector is limited to the production of microalgae and natural extracts of marine macroalgae in Madeira and the Canary Islands. The greatest interest that it currently has, besides the associated growth and economic diversification potential, is the existence of numerous initiatives that are

[7] News published in the newspaper ABC on April 12, 2017. Last access 26/07/2018: https://www.abc.es/espana/canarias/abci-cientificos-britanicos-encuentran-canarias-mayor-yacimiento-mundial-telurio-201704112254_noticia.html

investigating and promoting new technological, medical and marine living resources uses. In the Portuguese islands, stands out the project "Bioprospecção de Macroalgas Marinhas para Cultivo y Uso de Matéria-Prima na Produção de Extractos " (BPMA) funded by the INTERVIR program (EASME, 2017a), aimed at bioprospecting and production of seaweed for obtaining natural extracts. This type of projects associated with the aquaculture sector are creating the necessary bases, in terms of technicians and facilities, for the development of blue biotechnology in the region (EASME, 2017a).

4.3. PRESSURES

Pressures (P) are the processes derived from the activities described (of their operations, tasks and general performance) that cause alterations in the natural environment (in their state). That is, they flow from the anthropic to the natural conditioning the provision of ecosystem services. The pressures on the marine environment come mainly from the following sources:

1) Internal or endogenous pressures, which come from the activities developed within the socio-ecological system and eliminate or place elements from/in the system.
2) External or exogenous pressures, which may come from other socio-ecological systems or from other more general or broad sources, such as global climate change that comes from outside the system (Elliott, 2014).

4.3.1. ENDOGENOUS PRESSURES

Firstly, derived from the uses and activities that will be the object of the Marine Spatial Planning of the region, the following two types of internal pressures can be remarked:

Those that involve the extraction of natural materials from the system, such as fish, shellfish, water, sands and gravel from the bottom of the sea, etc. In a more abstract, but very tangible sense, pressures associated with the consumption of space are also included in this type, for example, occupying the seabed and/or the coastal edge with ports, wind farms, etc.

The pressures that involve the placement of materials in the system, which include discards of fisheries, land (dredged discharges, for example), pollutants (from ships, emissaries, etc.), effluents and fluid discharges, marine debris, etc.

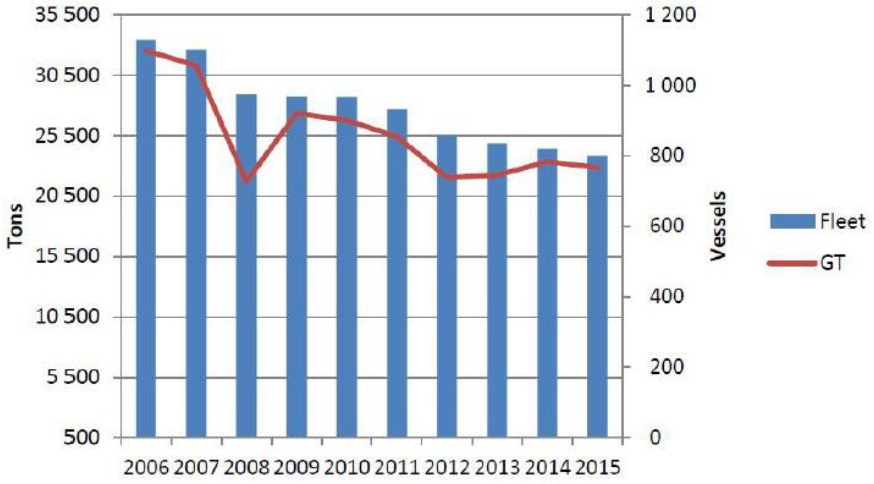
Both groups of pressures are carried out by the interested agents through maritime activities, within the socio-ecological system managed by the MSP process (in this case, the European Macaronesia). It should be noted that these stakeholders are also beneficiaries of the ecosystem services provided by the "pressured" ecosystems. The pressures associated with the main maritime activities previously described in section 4.2 are analysed below.

i) Fishing and aquaculture

Among the pressures to be pointed out by this activity, the extraction of biomass (of fishing interest species, but also of those that are not: discards) stands out. Directly, it would be measured through the fished or extracted tons "in situ", however, given the difficulty of obtaining this information, it is usually measured by approximation through fishing effort or fishing capacity and discharged tons.

In general, the Macaronesian fishing fleet has experienced a significant reduction encouraged by the restructuring process imposed by Europe, which goes hand in hand with a reduction in catches. In the Canary Islands this reduction has been important (Figure 14).

Figure 14. Evolution of the Canary Islands fishing fleet during the period 2006-2015



Source: Comisión Europea, 2017, from Ministerio de Medio Ambiente de España

In the Azores, this reduction has been concentrated mainly in boats of less than 9 meters (Table 2) (EASME, 2017a). In Madeira, the reduction of effective licenses has been of 27 % between 2010 and 2015, with a decrease from 16 % to 18 % in gross tonnage and power of the fleet.

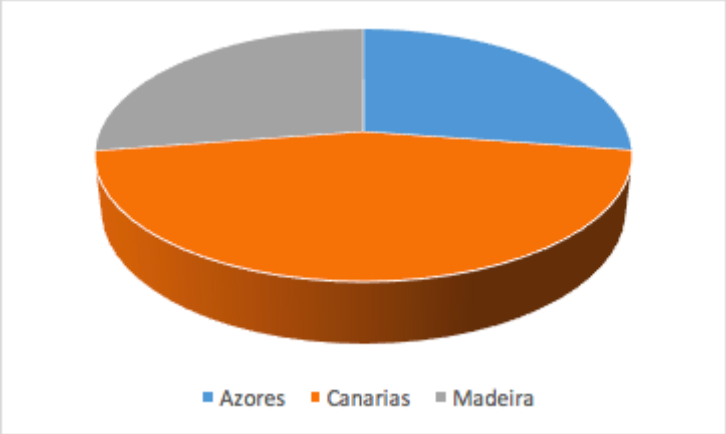
Table 2. Evolution of the composition of the fleet in the Azores

	2010	2011	2012	2013	2014
Vessels (No)	692	696	672	622	599
<9m	469	466	435	394	361
9m<=<12m	149	156	161	155	156
>12m	74	74	76	73	82

Source: Direção Regional das Pescas in CE, 2007

As for the landed fish, comparatively the Canary Islands is the archipelago with the largest volume of fresh fish landed with 9.499 tons in 2016 (Autoridad Portuaria de Las Palmas, 2017; Autoridad Portuaria de Santa Cruz de Tenerife, 2017), followed by Madeira and the Azores with a very similar fishing volume of 5.765 and 5.746 tons respectively for 2016 (INE, 2016b) (Figure 15).

Figure 15. Distribution of the tons of fish landed in 2016 in each of the archipelagos of the European Macaronesia



Source: based on Autoridad Portuaria de Tenerife and Las Palmas, 2017; and INE of Portugal (2017)

However, as noted in European Commission (2017), the lack of effective monitoring and control in the sea basin difficult the accounting of this pressure. This is especially serious with regard to the prevention of illegal, unreported and unregulated fishing (IUU). This problem also affects the traceability of recreational fishing (which receives a high number of licenses especially in the Canary Islands), and the use of prohibited nets or fishing in prohibited areas.

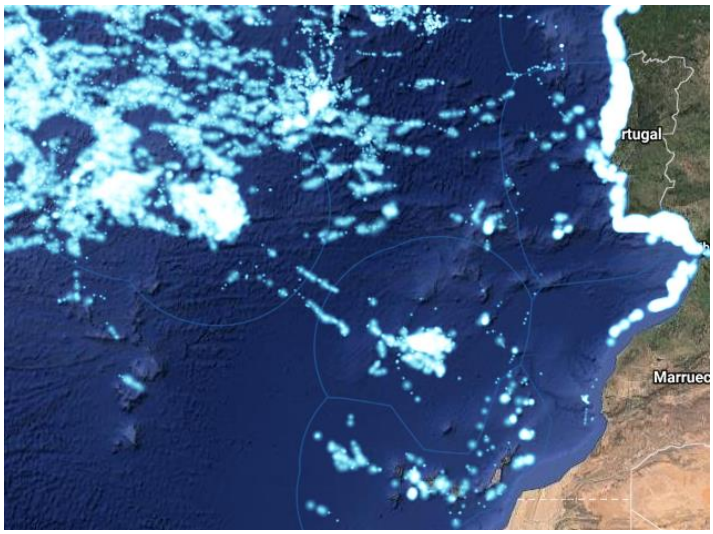
There is also a lack of adequate information about discards and accidental fishing of species without commercial interest. Despite this, it is worth mentioning that especially some of the canning industry of the Azores has made a significant effort to reduce this extractive pressure, through the Azores Fisheries Observer Program (POPA). To do this, it has certified its production with the label "Dolphin safe" and "Friend of the sea", which implies the use of more selective fishing gear in the capture of tuna.

In addition to the extractive pressure, this activity also generates other pressures such as marine noise, air emissions (CO^2) and marine disposals (garbage, fuel, discards, etc.), fishing lines or aquaculture cages densities that occupy maritime space (competing with other species and other uses) and deep-sea bottom trawling, etc. Regarding bottom trawling, as has been anticipated before, this type of fishing is not allowed in the region, but this must be treated with caution, as there is a trawler fleet based in the Canary Islands and the aforementioned difficulties of controlling the sector. Trawler vessels, as well as others of large tonnage, are authorized to operate in third countries, transferring the pressure on the ecosystem to those remote socio-ecological systems. This in an example of spatial decoupling in the cost-benefit ratio. It is paradoxical in this sense that the sector has been suffering at a local level the consequences of pressures exerted by intensive fishing activities in remote reproductive areas of pelagic species. Such is the case of tuna overfishing in the Gulf of Guinea, which is estimated to have been one of the causes of the sector crisis in the Azores (7.695 tons were landed in 1998 compared to 1.479 tons in 2001) (Comisión de Pesca de la Unión Europea, 2002).

To quantify the rest of the indicated pressures is very complex, but as an approximation it can be affirmed that these will be more intense where more fishing activity occurs (including the transport of ships in addition to fishing). As a mere indication, it might be of help the

visualization of the areas with higher fishing density that facilitate initiatives such as the Global Fish Watch project (Figure 16) can help.

Figure 16. Accumulated density of fishing vessels between the months of April and July 2018 for the area of European Macaronesia

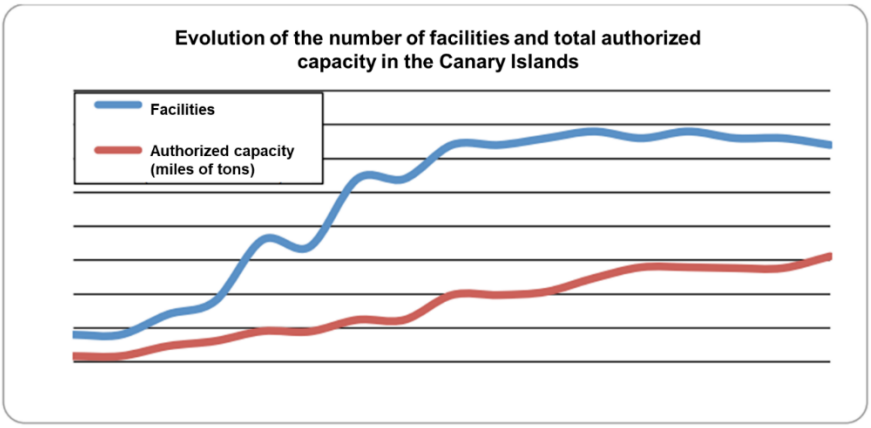


Source: Global Fish Watch, 2018 (http://globalfishingwatch.org/)

It is important to highlight from a socio-ecological perspective that not all the fishing pressure (extractive and non-extractive) exerted on the Macaronesian system is measured by surveying only the catches landed in the archipelagos or boats present in the islands. Indeed, much of the effort is made by vessels with base ports in other countries or in the continent. This is a clear example of the difficulty of quantitatively sizing the real interaction that the sector exerts on marine ecosystems, causing alterations in their status.

On the other hand, regarding the **aquaculture activity**, which develops a technical use of the provisioning service, stands out the direct pressure exerted by the infrastructure installation on land or the occupation of space at sea. In this sense, as noted, the case of the Canary Islands should be highlighted as it experienced a vertiginous increase in the number of aquaculture facilities with a subsequent stabilization (Figure 17).

Figure 17. Evolution in the number of facilities and authorized production capacity in the Canary Islands between 1996 and 2012



Source: Informe sobre la Evolución del Sector de los Cultivos Marinos de peces en Canarias, marzo 2012 (CANAEST), cited on Plan Estratégico de la Acuicultura en Canarias PEACAN (2014-2020) (Gobierno de Canarias, 2012)

Also, aquaculture is an activity that introduces nutrients into the marine environment through the effluents of its facilities. The largest discharges of dissolved chemical compounds released in aquaculture are carbon (C), nitrogen (N) and phosphorus (P), derivatives of the metabolism of fish and molluscs and the decomposition of solid waste. In water around the sea cages there is a large consumption of dissolved oxygen, due to the respiration of fish and the fauna and flora associated with aquaculture farms. Conditions of limited water renewal can cause a high concentration of nutrients and a high consumption of oxygen, which can lead to hypoxia. Despite the extent of the effects caused by marine farms is generally limited in space (Pearson and Black, 2001). The effect of local hydrodynamics (dispersing forces) must be taken into account (Sarà, et al., 2006). It should also be remarked the attraction of certain species or, above all, the accidental release of cultivated species.

ii) Coastal tourism and population density

The pressures associated with **tourism** are multi-vector, making it more difficult to isolate the pressures caused directly or indirectly by the sector. The most obvious is related to the increase in population density. This entails the development of infrastructure and associated facilities that must respond to the new population demands. In addition to this process of space occupation and direct transformation of the territory, other aspects must be pointed out. Such is the case of resources consumption (water, food, energy), generation of garbage, wastewater discharges, atmospheric emissions, extraction of biomass for recreation. (sport fishing, mollusc collection, etc.) and other interactions (sea bottom trawling by the anchors of nautical sport boats, interaction of divers with marine species, marine noise, alteration of visited ecosystems, etc.).

The evolution of tourism in the Macaronesian region since the 1960s shows a remarkable growth in the pressure of the sector. Specifically the Canary Islands, which was the fastest growing archipelago in that period, went from receiving 100.000 tourists in 1960 to more than 13 million in 2015 (Hernández Luis, et al., 2017). In this region as a whole, according to the National Statistics Institute of both Portugal and Spain, this translates into an average density of more than 1.100 tourists per km² considering tourists staying in hotels in 2017. Furthermore, as coastal tourism still predominates, if the coastline is considered in terms of pressure on the territory, population density rises to more than 4.500 tourists per km of Macaronesian coast. In relation to

socio-cultural pressure, the amount of visitors results in approximately 4,5 tourists per inhabitant of the islands. Although obviously these tourists are not all at the same time on the territory, but are distributed throughout the year, this data gives an approximate idea of the oversized urban services, transport infrastructures, hospitals, etc. that require administration. More detailed data on maritime activities associated with coastal tourism could also help to better determine pressures and services that this sector can demand from ecosystems.

In the Macaronesian archipelagos, distribution of pressures by islands is unequal depending on the load of tourists that each of them absorbs during a year and the type of tourism. In this sense, the territorial and socio-cultural pressure by islands or, at least, by archipelago, makes it possible to differentiate to what extent might be the ecosystems affected by this activity. In this sense, the Canary Islands and Madeira are the ones that obtain the highest values in 2017, with 6.321 and 5.479 tourists per km of coastline and 4,6 and 5,6 tourists per inhabitant, respectively. Meanwhile, the Azores have a greater margin to absorb this type of pressure, with 630 tourists per km of coastline and 2,4 tourists per inhabitant.

In addition, to this pressure on the territory must be added the already exercised by the local population. The region has an unequal density by archipelagos, with high values in Madeira (317,36 inhabitants/km²) and the Canary Islands (281,34 inhabitants/km²) and lower ones in the Azores (105,1 inhabitants/km²). However, local population density varies widely from island to island.

Regarding **nautical tourism**, there is a high traffic density of recreational boats in the three archipelagos. In the Azores, according to the Government of the Azores[8], in 2019, there were 164 licenses related to maritime tourism activities and 253 vessels. Regarding **cruises**, in Madeira, cruise tourism in 2015 had 40 % more passengers than in the previous year (EASME, 2017c). Also, for 2015, in the Canary Islands the number of cruise passengers was 2,19 million, accounting for 16 percent of the total number of tourists in the archipelago (EASME, 2017d), which must be added to the number of tourists counted in the density data. In the Azores, this activity is concentrated in the main islands. In 2015, the ports of the Azores registered 138 cruise scales and 117.784 passengers, around 40 % more than in 2014 (EASME, 2017b).

Direct pressures related to the construction or expansion of ports will be detailed in the next step regarding the construction of marinas and cruise terminals.

iii) Port industry and maritime traffic

The pressures exerted by this sector on the ecosystems of Macaronesia are as diverse as they are relevant. They range from the installation of associated infrastructures, which require the transformation of large terrestrial and marine spaces and associated ecosystems, to that associated with port activity and operability and maritime transport itself. It should be noted that, in this sense, the size of the ports on land is not always proportional to the pressure exerted at sea since it depends on multiple factors (activity, location, etc.). The port of San Sebastián de La Gomera, for example, despite its small size and low activity, has a pier protected by a breakwater of 400 meters in length.

[8] Source: http://www.azores.gov.pt/Portal/pt/entidades/srtop-drt/textoImagem/Actividade_Mar%C3%ADtimo-Tur%C3%ADstica.htm

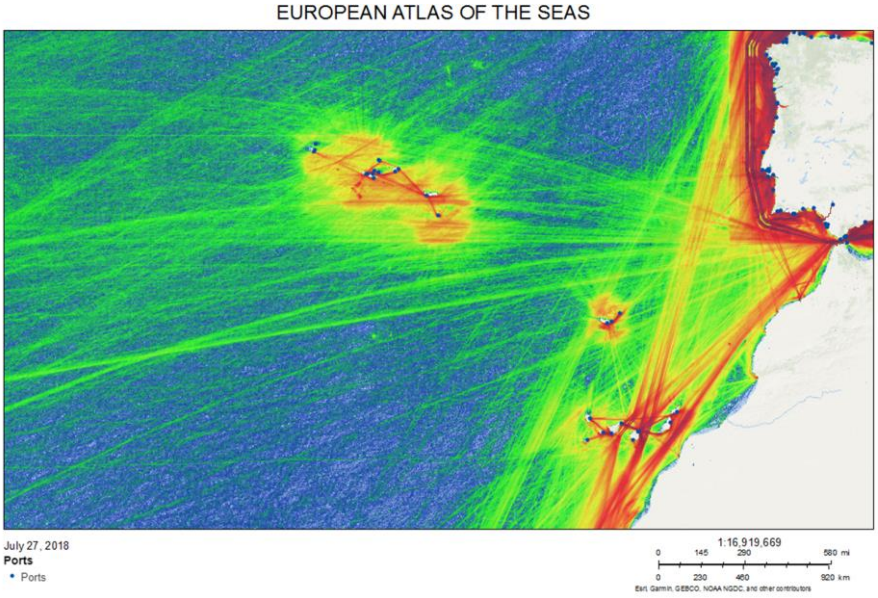
In relation to the pressure associated with **port facilities**, there is a significant demand for space in the coastline where this resource is very limited. This implies replacing the present ecosystems or uses that compete for that same location. Soil sealing is one of the main pressures produced by the artificial structures build on the coast such as these port and coastal defence infrastructures, either longitudinal or perpendicular to the coast. In recent decades, socioeconomic needs have led to an increase in the size of the vast majority of commercial ports, also in Macaronesia. For example, approximately 8,3 % (140,49 km) of the total length of the Canary Islands coast, including the perimeter of the port infrastructures, is affected by structures that produce soil sealing (Hernández et al., 2012).

The demand for marinas and its number have also rapidly increased. An approximation could be made in terms of supply with regard to the 260 inhabitants for each mooring in the Canary Islands (without considering tourists and the associated floating population). This means, in terms of pressure on the territory, 5,2 moorings per km of coastline that must be supported by its corresponding infrastructure. In the case of Madeira, it would mean a relative offer of 233 inhabitants per mooring and a pressure of 4,2 moorings per km of coastline, whereas in the Azores, in terms of relative supply, there would be 140 inhabitants per mooring resulting in a pressure of 1,8 moorings per km of coastline (National Tourism Authority of Portugal, 2013).

The **anchorage of boats**, on the other hand, is concentrated in the so-called anchoring zones, which are generally safe areas for their depth and protection against waves and winds. The repeated anchoring of boats in one place can be a source of pressure, causing abrasion problems especially when anchors are used. Even if it does not affect large areas, this pressure can be significant in some points due to its intensity, as it occurs in some parts of the Canaries region (Hernández et al., 2012). In this archipelago, 88 anchoring zones have been identified, with a total area of approximately 24,5 km². These anchoring zones are predictably used by merchant ships and fishing boats. In addition, the areas in front of the large commercial ports are considered potential mooring areas for these vessels, occupying a total area of 164,7 km² for the Canary Islands. However, the anchorage of sports boats is difficult to control, usually taking place outside the designated areas. Anchoring structures (anchors, chains, ropes, cement or iron structures, etc.) are distributed throughout many places on the Macaronesian coast and occasionally pose a danger to sensitive ecosystems such as sea-grass meadows.

Port and berthing facilities and anchoring areas provide services for an activity that is reflected in the maritime traffic of vessels. Thus, there is a direct relationship between their location and the distribution of pressures associated with maritime traffic (Figure 18). This traffic presents certain intensity in the region, mainly between the islands and between the archipelagos and the great navigation routes. The major routes between Europe and Africa pass through the Canary Islands (EASME, 2017a).

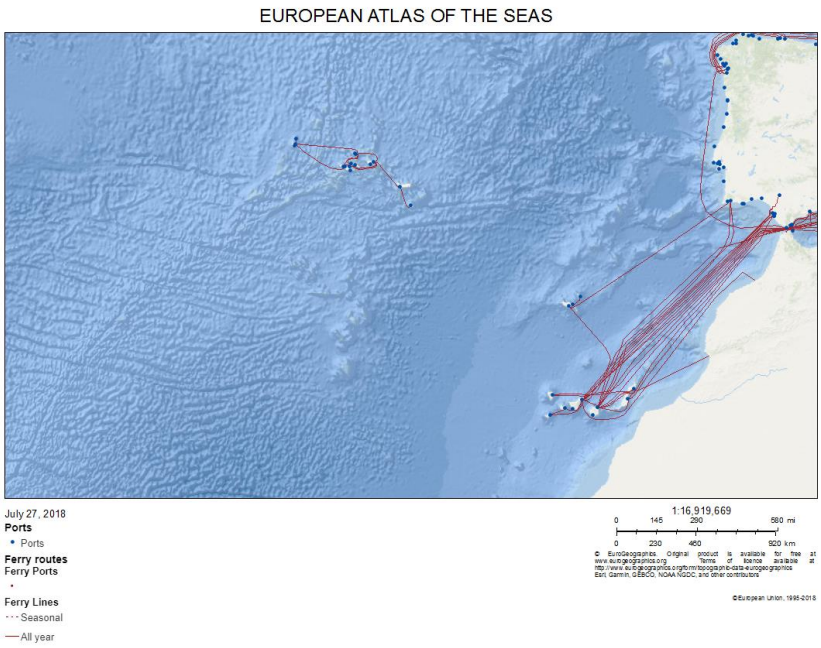
Figure 18. Ports and density of maritime merchandise traffic in Macaronesia



Source: Maritime Affairs: http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas visited on 19 July 2018

For this reason, maritime traffic is particularly intense (as they will also be the associated pressures) from the European continent and the Strait of Gibraltar in a north-south direction going through the Canaries. The traffic between Europe and the American continent that passes through the Azores is also important though less intense than in the previous case. Finally, it is worth highlighting the internal routes that occur between the islands of the archipelagos because they are very specific and precise associated with both freight and passenger traffic (Figure 19).

Figure 19. Ports and ferry lines in Macaronesia



Source: Maritime Affairs: http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas

The traffic associated with maritime transport exerts by itself a pressure on the **availability of maritime space** and competes with other activities, especially near the coast (fishing, nautical tourism, etc.). However, it also exerts other relevant direct pressures such as **atmospheric emissions** and **noise**. In general, the acoustics produced by a ship increases in proportion to its size, displacement, speed and age. Oil tankers and solid bulk vessels are among the main producers of noise. These sources of noise are the most frequent ones near the large ports and along the most used navigation routes and can spread over very long distances due to their low frequency. This leads to an increase in underwater noise even away from the hot spots of emission. Small recreational and fishing boats, cetacean observation boats, and passenger transport boats, such as ferries or high-speed ferries also generate noise, which characteristics depend as well on the before mentioned considerations, but with considerable individual variation between ships of comparable classes. The fishing vessels of the Canary Islands have an average age of more than 35 years and of more than 20 in the case of Madeira. Propeller cavitation is generally the predominant source of sound in all boats, and small and fast boats tend to create higher frequencies sound, due to the higher rotation speeds of the propeller (Hernández et al., 2012).

Associated to this activity, must be remarked the pressure due to the **dumping of ballast water**, one of the main vectors for the introduction of **invasive species** together with the individuals attached to the hulls. As an example, in a study carried out in the port of Las Palmas de Gran Canaria, 11 exotic species were recorded whose origin coincided with the origin of the oil platforms (Pajuelo et al., 2016). This issue is the cause of a very serious change of state of the marine ecosystems, as it will be developed further in this document.

iv) Energy, industry and marine mining

Maritime activities associated with these sectors are currently scarce, but with a great growth potential. Despite this, the pressures associated, for example, with the installation and maintenance of **submarine cables and pipelines** can be considered. As in the set of activities, it is the technique of laying cables and pipes on the seabed that most influences the type of pressure that can be exerted in this environment. Pipelines and emissaries can be anchored to the bottom, for example, with cement blocks or a concrete tubing. These infrastructures seal the sea bottom and can be an obstacle for the transport of sediments. Hence, they end up being buried by the action of the currents and producing a permanent modification of the seabed profile. The dimensions of the pipelines in these cases will be those that determine the magnitude of the alteration.

In the case of laid cables, there is no modification of the sea bottom profile, but it can exert a barrier effect on the benthic fauna. On other occasions, cables and pipes must be buried so as to not interfere with other human activities that take place in the same waters, such as fishing. These cases entail the digging of ditches with the associated earth movements. The affection to the seabed will depend on the methods used and the dimensions of the duct. The removal of lands during the construction phase will cause temporary variations of the sea bottom profile, the loss of habitats and benthic organisms both by excavations and burial, as well as the temporary increase in the turbidity of the water column due to the movements of materials during the installation. If there are dangerous substances or nutrients in the seafloor sediments, these could be dispersed becoming bioavailable for the trophic chain as ingested by organisms.

Aggregate extraction involves the extraction of sediments from the seabed (dredging, regeneration or nourishment, etc.), which usually occurs within the continental shelf in areas relatively close to the coast (Hernández et al., 2012). Despite these activities present a significant decrease in Macaronesia, they are still developing in some parts, even being banned in most cases. The unloading in ports of aggregates extracted from the ocean floor is an activity that requires prior authorization. The maximum amounts are established annually by regional regulations. In the case of the Azores, in 2016 a total of 59.553 tonnes of aggregates with marine origin were unloaded[9].

4.3.2. EXOGENOUS PRESSURES

Among the pressures that threaten the state of the marine ecosystems of Macaronesia, we can consider those that come from the natural system itself, and that some authors have come to call "disservices". Brief reference must be made, therefore, to natural risks, which are difficult to predict and do not have a direct origin in the socio-ecological system of Macaronesia. However, they are not elusive from the management system as adaptation responses and damage prevention measures might be undertaken.

In the first place because of its exceptional importance for the islands given its oceanic location, it is worth noting the climate change. This factor is the cause of pressures on the environment such as warming of the oceans, acidification of the marine environment, alterations in rainfall patterns or in the frequency of large storms. This combination of factors often aggravates the effects of other pressures. Likewise, the alteration will come both from the intrinsic components of the system and from the limitation of inputs necessary for the current archipelagic scenario like water and other products that in turn will be affected by climate change.

On the other hand, there are other natural disturbances such as plate movements, volcanic activity, etc. Since all the Macaronesian archipelagos are of volcanic origin, changes caused by tectonic or volcanic activity are likely as there are numerous volcanoes still active in the archipelagos that can alter the state of ecosystems. For example, the recent eruption in 2011 on the island of El Hierro in the Canary Islands.

In general, in this block of exogenous pressures, that is, originated outside the social-ecological system of the Macaronesia, all those pressures that develop outside the limits of the scope could be added. This could include maritime accidents and discharges that would eventually reach Macaronesian waters and other examples of spatial decoupling of causes or driving forces/activities and the consequences or impacts on the well-being of the region. It has already been pointed out, for example, the pressure exerted on pelagic species of fishing interest in very distant waters.

[9] Source: Portos dos Açores, Relatorio de Contas 2016 https://www.portosdosacores.pt/documentos/RC_2016.pdf

4.4. CHANGE OF STATE

Some of the pressures to which the socio-ecological system of Macaronesia is subjected can lead, in isolation or in combination, to changes in the State (S). That is, alterations in the characteristics and natural functioning of marine and coastal ecosystems. These alterations can be manifested, for example, in a greater presence of pollutants in the ecosystem that can alter it physically and chemically. In turn, these changes of state directly affect the capacity that these natural systems will have to provide ecosystem services. Such services may decrease or increase, with consequences (impacts) on human welfare.

In Macaronesia, there are some problems of availability of information about the state of ecosystems. On the one hand, because of the vast surface area, but also because of the difficult access and the high cost of generating information (EASME, 2017a). For example, through the analysis of the archipelagos' Marine Strategies[10] a lack of generalized data on the presence of marine litter and inconsistent information related to the coverage or health status of some deep marine ecosystems can be detected. This situation has caused evidence to be limited and of difficult comparison between archipelagos.

Most of the data refer to changes of state motivated by pressures of anthropogenic origin, with more or less direct or indirect incidence. In this sense, for example, studies suggest that the tropicalisation of waters due to climate change is producing changes in the marine communities of fish in the Azores (Afonso et al., 2013) and in the Canary Islands (Brito et al., 2017). However, there are also studies that indicate changes in ecosystems motivated by pressures of natural origin. For instance, according to Martín-García, et al. (2015), after the eruption of the submarine volcano off the island of El Hierro (Canary Islands), there has been a significant change in the distribution of species (especially black coral).

In fact, according to EEA (2015b, 2015a), the Macaronesia marine area is the European regional sea with the least information available about its state, with approximately 50 % of its habitats unknown. The same report also highlights that it is the European sea with the lowest percentage of protected areas (0,8 %). Nevertheless, these aspects are exceptionally important in offshore waters.

In any case, after 2015, the states of Spain and Portugal have made a significant effort to collect information and have proposed new conservation areas. Although there was already some evidence of the important biodiversity and ecosystemic richness of these areas, the new marine protected area proposals, as well as others carried out by different institutions (WWF, Oceana, SEO / BIRDLIFE), confirm the urgency to improve the information available. In fact, through a better knowledge of these ecosystems, the real or potential flow of ecosystem services, from which the Macaronesian society and its future generations could benefit, will be better understood.

Figure 19 relates, in a schematic way for the specific case of Macaronesia, the main marine activities with the benefits they provide and, at the same time, these with the ecosystem services that allow their collection. The main conclusion that can be reached is clear: benefits from the main activities that sustain the marine economy in the archipelagos of Macaronesia

[10] Its elaboration responds to the application of the Directive 2008/56 / EC, of the European Parliament and of the Council, of June 17, 2008, establishing a framework of Community action for the marine environment policy (Framework Directive on the marine strategy). It establishes that Member States must take the necessary measures to achieve or maintain good environmental status of the marine environment by the year 2020 at the latest.

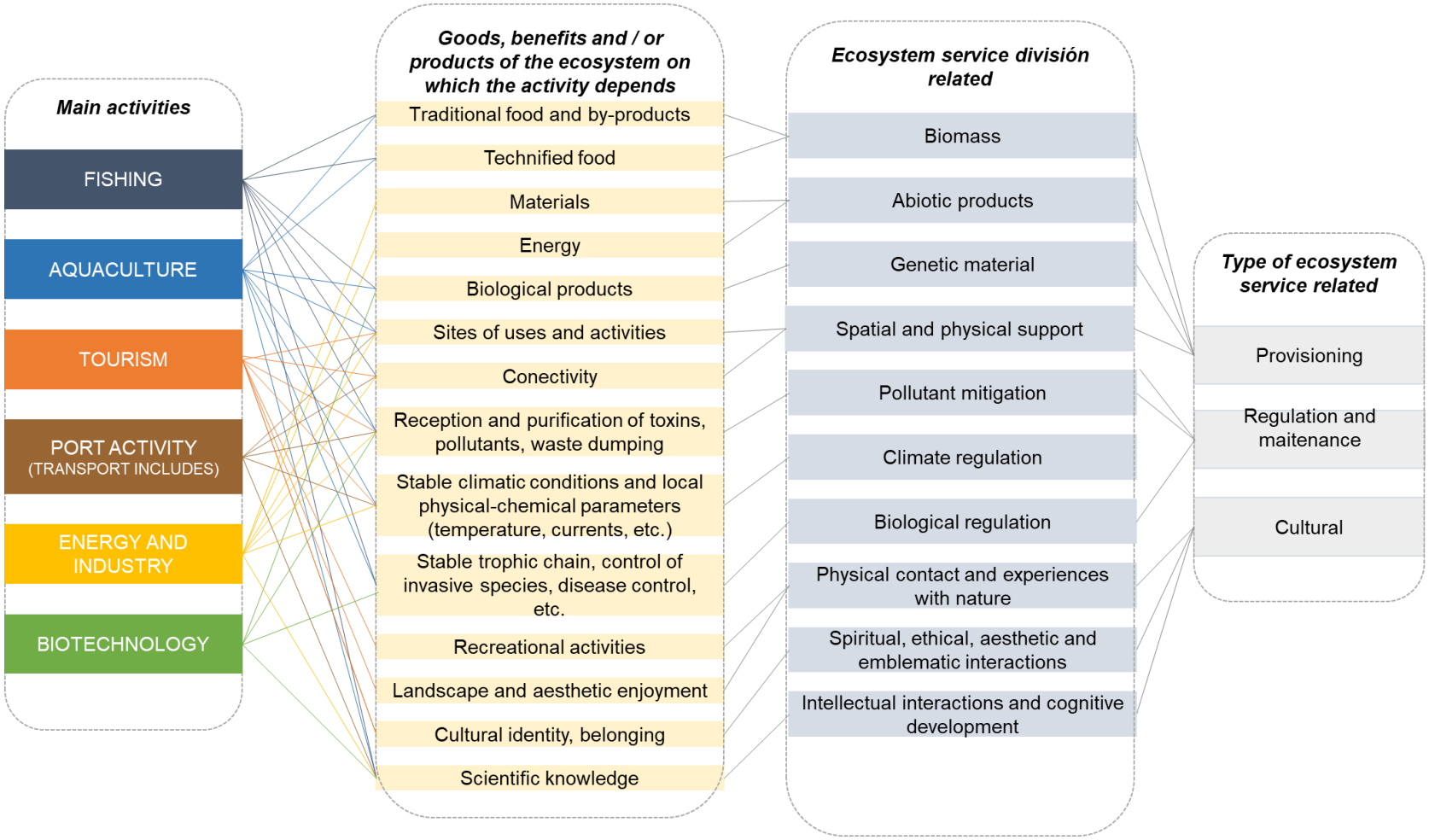
depend extensively on the ecosystem services provided by the marine ecosystems present in the region. For this reason, a better knowledge of them becomes increasingly urgent. This turns even more important when considering the high growth potential of the maritime economies of the region, which sometimes are based on new scientific and technological advances that allow the development of new activities or the increase of their intensity.

The term “ecosystem services” has been more and more frequently used over the last decades. This concept can be understood as those natural processes capable of generating a benefit to society, both to specific economic activities and to the population in general. The central idea is to recognize that an ecosystem function becomes a services when the human being obtains from it some types of benefits those results in their well-being. However, this reasoning also implies observing those ecosystem services that human beings can lose that imply net losses for their well-being.
As the current scope has large dimensions, three categories of direct services will be considered in a general way:

- *Provisioning or supply services*. In the case of Macaronesia, those related to obtaining food from fishing and aquaculture activities stand out, but also others such as those related to biological products or the extraction of minerals or oil and gas from seabeds. It has been added to this category the “space” as a resource that is used for the development of some activities.
- *Regulating services*. Correspond to the benefits obtained indirectly from the proper functioning of ecosystems. In Macaronesia, there can be named the mitigation of pollutants (wastewater purification, etc.), climate regulation (recurrence of storms, water temperature, etc.), and those of biological regulation (control against invasive species, etc.).
- *Cultural services*. Correspond to the intangible or immaterial benefits derived from personal experiences. In Macaronesia stands out those related to landscape and aesthetic enjoyment, the sense of belonging and cultural identity or scientific knowledge.

The development of some of these activities is causing alterations of ecosystems on which they depend. This makes it essential to visualize and manage the relationships shown in Figure 20.

Figure 20. Relations between main activities, benefits and ecosystem services in Macaronesia



Source: own, based on qualitative analysis sector by sector and ecosystem services classification CICES V5.1 (2018)

In regard, for example, to fishing activity, several studies link overfishing as a cause of change in the structure of the benthic communities of algae, invertebrates (sea urchins) and fish in Macaronesia. This change in the state of the benthic ecosystems of rocky bottoms has been widely studied in the case of the Canary Islands (Hernández, et al., 2008; Sangil, et al., 2013; Sangil, et al., 2013; Sangil, et al., 2014) and southeast of Portugal (Fernández, et al., 2016)

This change is induced, mainly, due to the direct relationship between the predators' community that control the community of herbivores, especially that of sea urchins (Rustici, et al., 2017). In this sense, the aforementioned authors point out that overfishing on species that predate on these herbivores favours the appearance of the so-called barrens. However, it is necessary to indicate that the existence of these barrens is a natural phenomenon affected by a multitude of physical and biological processes of different nature that act at different spatial and temporal scales. That is to say, barrens are a natural environment in the rocky sea bottoms of the Macaronesian islands (Buhl-Mortensen et al., 2017) that seem to have experienced a dramatic increase in the last decades in the Canary archipelago (Tuya, et al., 2004).

In Macaronesia, other activities such as maritime transport or population growth and tourism, have favoured the accidental or deliberate movement of organisms and along with it a massive alteration in the ranges of species. For instance, in the Canary Islands, the transit of oil platforms has proven to be an important entry point for non-native species (Pajuelo et al., 2016). These biological "invasions" cause ecosystem changes that can have short- or long-term ecological consequences. In fact, in some ecosystems of the Macaronesian region, invasions of exotic species, which can carry new diseases and sometimes have competitive advantages over the original species, are one of the main causes of extinction of native species and, on occasions, also the cause of a great loss of ecosystem services (Nelson et al., 2006).

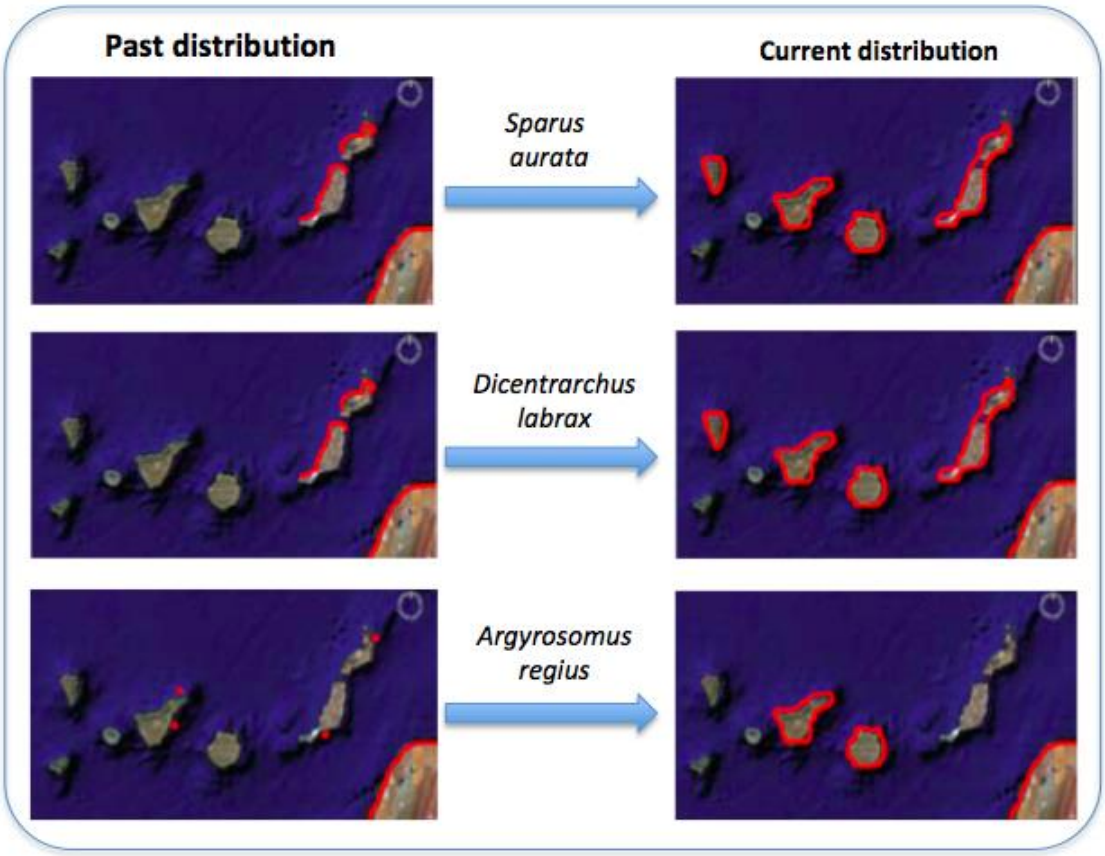
Macaronesia, due to its particular conditions (insularity, remoteness, isolation, etc.) presents a special sensitivity to the introduction of invasive species. Unfortunately, the region also presents a high risk due to its geostrategic position for maritime traffic and its high dependence on imported products and tourist activities, which can act as entry points for invasive species and diseases.

The aquaculture activity has also contributed to this phenomenon by introducing new species of fish, which have ended up establishing themselves and competing for the resources available in the environment with the native species of the Canary Islands (Toledo Guedes, et al., 2009). In this sense, Figure 21 is particularly revealing showing the colonization of the Canarian marine environment by species cultivated by aquaculture in recent years.

Regarding the activities related to biotechnology or marine energies, despite having a great potential in Macaronesia, as already has been mentioned, they are still at a very early stage of development, which does not allow to evaluate the effect of their pressures and state change on marine ecosystems.

In this sense, the changes described in the state of marine ecosystems of Macaronesia cause alterations in the flow of services they provide influencing directly on human welfare of the islands' population. However, if there is little information available on the state of the Macaronesian ecosystems, greater problems would be found to evaluate the flow of services that these provide for human well-being.

Figure 21. Distribution of the three fishes species cultivated in the Canary Islands before and after the development of aquaculture in the archipelago. The areas of known distribution are shown in red and the points indicate occasional captures



Source: Marine Strategy of the Canary Islands elaborated by the national environment competent authority, 2012, from Toledo and Brito, 2009

Although these three broad service categories are developed in more detail in Table 3, the lack of information for Macaronesia leads to more general comments for each category presented. The illustrated information is based on available evidence, but also on a qualitative and deductive analysis that has considered the existing pressures and impacts on human well-being identified. This document has mainly considered the utilization of the flow of services in terms of evolution and tendency. It only pretends to introduce the characterization of the problems detected by analysing the different relationships represented in the conceptual map (Table 3). On the other hand, the present diagnosis does not pretend to perform a quantitative, rigorous or precise analysis of the flows of ecosystem services of the Macaronesia region. A more throughout analysis would be necessary when the different archipelagos of the region address the realization of their marine plans.

Table 3. The ecosystem services in the marine environment of Macaronesia

TYPE OF SERVICE		BENEFIT	BENEFICIARY AND / OR MAIN TRANSFORMER*	IMPORTANCE AND EVOLUTION OF THE SERVICE
Provisioning	Biomass	Traditional foods and by-products	Fishing	↓
		Technified food	Aquaculture	↑
	Abiotic products	Materials	Energy and industry (oil and mining)	↑
		Energy	Energy and industy (non renewable)	→
			Energy and industry (Renewable)	↑
	Genetic material	Biological products	Biotechnology	↑
	Spatial and phisical support	Location of uses and activities	Ports and transportation	↑
		Connectivity (communication and approach of entities, people and products)	Ports and transportation	↑
Regulation and maintenance	Mitigation of pollutants	Reception and purification of substances, toxins, pollutants, garbage, etc..	Fishing and aquaculture	↓
	Climate regulation	Stable climatic conditions (temporary recurrence) Local physical-chemical parameters: temperature, currents	Tourism	↓
	Biological regulation	Stable trophic chain, control of invasive species, disease control, etc.	Fishing and Biotechnology	↓
Cultural	Physical contact and experiences with nature	Recreational activities-tourism	Tourism	↑
		Landscape-aesthetic enjoyment		↓
	Spiritual, ethical, aesthetic and emblematic interactions	Cultural identity, belonging	Local community and Tourism	↓
	Intellectual interactions and cognitive development	Scientific knowledge	Biotechnology, Energy and Industry	↑

Low importance	Medium importance	High importance	Very high importance

Worse service: ↓	The service is maintained: →	Improve the service: ↑

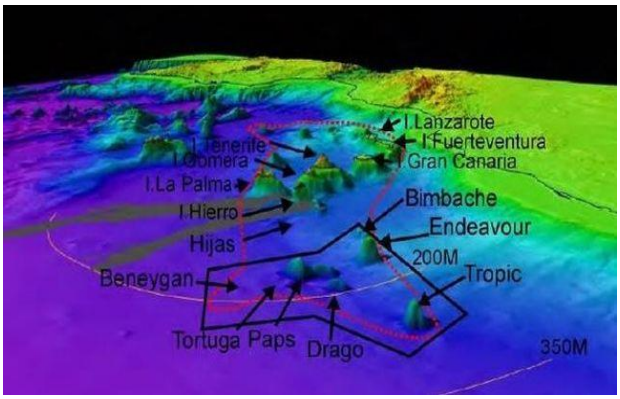
*Main activities and transforming uses of the state and that intervene in the use of the ecosystem service and give rise to the benefits for the population in general, at the same time that they benefit from the added economic value (GVA and jobs). The sectors of activity developed in section 4.2 are considered although it is interpreted that the ultimate beneficiary of the flow of all services is the **general community** (in addition to other sectors involved to a lesser or indirect extent).

Source: own

In general terms, among provisioning services of the marine ecosystems of Macaronesia, the biomass extraction through fishing and aquaculture is the one that has the greatest importance. Although there are important differences between the archipelagos and existing data must be taken with great caution, everything seems to indicate that the service remains stable in relation to obtaining biomass (fishing), but it increases in the case of its technical production (aquaculture) though the latter is only taking place in the Canary archipelago.

In the case of mineral extraction or energy (either from fossil or renewable sources) and biological resources (for biotechnology), the importance of the service is still very scarce in Macaronesian waters. Nonetheless, these activities have an important potential value in the region and there are currently several projects aimed at achieving a better use of these services. It is expected that the importance of this service will increase significantly throughout the forthcoming years. In fact, the discovery of the largest world deposit of Tellurium in waters off the Canary Islands has recently been reported. This could lower the cost of obtaining solar energy or telecommunication, among others. The finding is specifically located in the "Tropic" seamount (Figure 22).

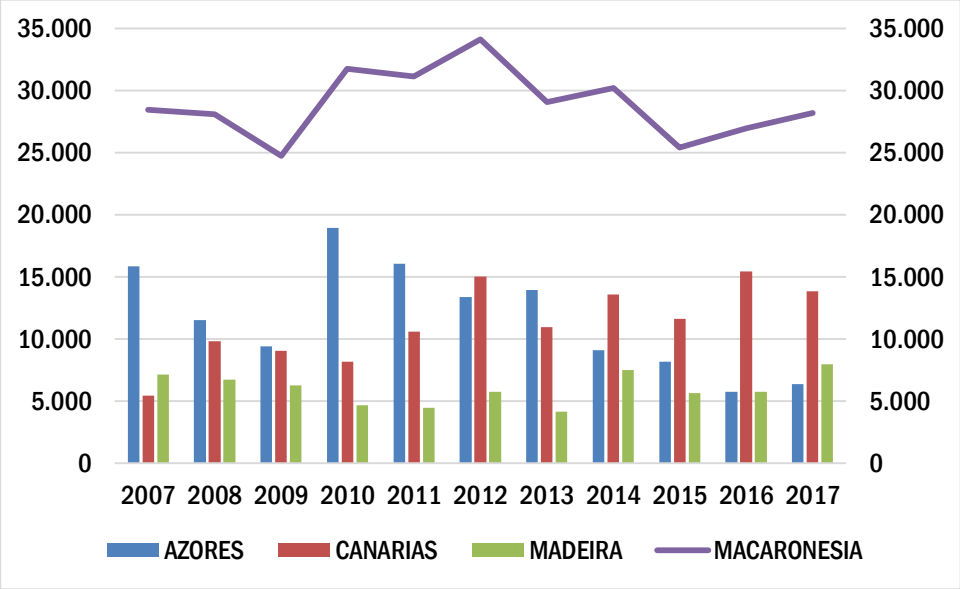
Figure 22. Underwater mountains south of the Canarian archipelago



Source: Instituto Español de Oceanografía de España, en Diario de Avisos (17/04/2017)

Considering the whole region, the tons of fish landed in ports of the three archipelagos has remained stable in the last ten years (see Figure 23). However, the situation is very different in each archipelago. In the case of the Azores, the volume of fish landed has decreased significantly in the last decade while in the Canary Islands total fish landings have increased by more than double compared to 2007. In any case, it is very difficult to exactly determine the provisioning service of fishing. It is well known that the Canarian fleet often fishes in Moroccan waters, hence, the increase in the provisioning service may be due to a transfer of pressure exerted by the fleet over ecosystems that are outside the waters of the European Macaronesia. A similar situation occurs with the Portuguese fisheries. Even other fleets, such as the Galician, often fish in waters off the Azores or the Canary Islands. On the other hand, it is also known that transhipment at sea, the offloading of the catch from a fishing vessel to a refrigerated vessel far from port, takes place in the European Macaronesia. This adds even greater difficulty to the determination of the flow of this provisioning ecosystem service.

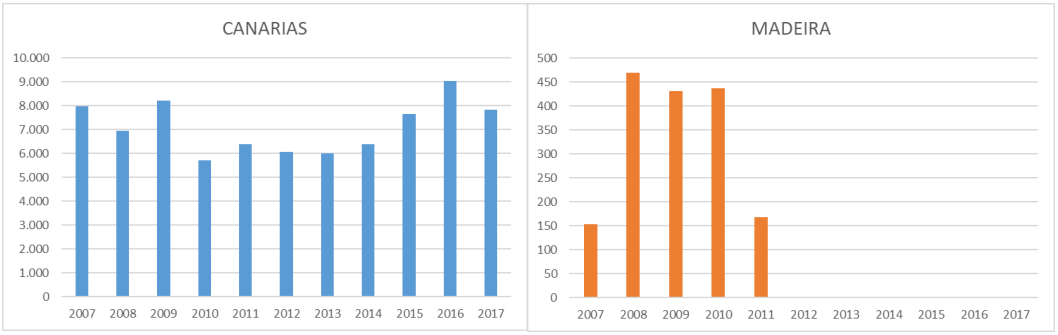
Figure 23. Tons of fishing landed in each of the archipelagos along with the general trend of European Macaronesia



Source: own elaboration based on statistic data from the Regional Government of the Canary Islands and the Regional Statistical Institutes of the Azores and Madeira.

In the case of aquaculture, the differences between archipelagos are important since virtually all production is concentrated in the Canarian waters (Figure 24). In fact, in the Canary Islands the provisioning service increased from a production of 5.700 tons in 2010 to 9.000 tons in 2016 of aquaculture products (MAPAMA, 2017a, 2017b, 2017c). A clear predominance of the Canarian sector in the general trend of aquaculture production in the European Macaronesia can be also observed, together with a modest production in the Madeira archipelago with data only until 2011 and the non-existence of this sector in the Azores.

Figure 24. Tons of aquaculture production in each of the archipelagos

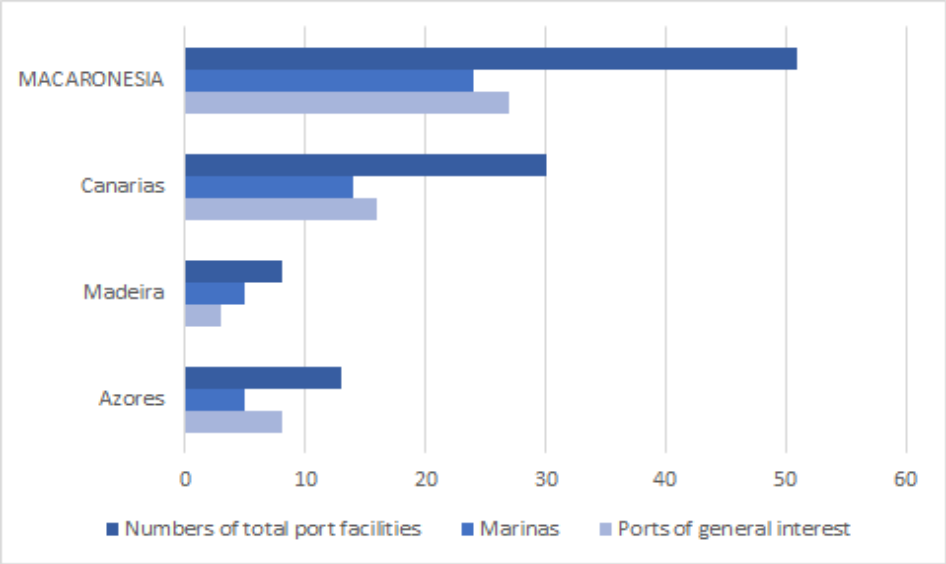


Source: own based on statistic data of Gobierno de Canarias and Statistical Regional Institutes of Azores and Madeira.

Finally, availability and use of maritime space is a fundamental service for activities such as maritime transport, tourism or fishing. In this sense, in recent decades the service has greatly increased related to improvements in transport and port infrastructures (Figure 25). In this regard,

more than 9.5 million passengers were transported through the ports of the different islands in 2016.

Figure 25. Density of port facilities by archipelago and for the whole of the Macaronesia region



Source: own, based on the annual reports of the port authorities of the Azores, Madeira and the Canary Islands (https://www.portosdosacores.pt/entradasesaidas.html y http://www.marinasazores.com/, http://www.apram.pt/site/index.php/pt/, https://puertoscanarios.es)

The use of space by recreational boats is also important in Macaronesia. Thus, in the Canary Islands there is a total of 8.108 berths for recreational boats (Lloret et al., 2012). In the Azores, recreational vessels accounted for a total of 3.710 boats in 2016 (Portos dos Açores, 2016), but the archipelago only has a total of 1.855 berths (EASME, 2017a). In Madeira there is a total of 1.092 permanently occupied berths with a long waiting list for them (EASME, 2017a).

In addition to all the above, there is the transport of goods that is constantly raising due to the parallel increase in needs that come along with the tourism and population growth in the islands.

In relation to the **regulating services** provided by the marine ecosystems of the European Macaronesia, the mitigation and purification of pollutants service and the climate and biological regulation services can be highlighted. However, in all the considered cases, the service appears to be deteriorating. In fact, "extraordinary" cases of a proliferation of algae or cyanobacteria in the Macaronesian waters are becoming more frequent. As an example, in the summer of 2017 there was an alarm in the Canary Islands for the proliferation of the cyanobacterium Trichodesmium erythraeum (Figure 26). According to the team led by Professor Javier Arístegui[11], the increase in ocean temperature, the contributions of Saharan dust and the unusual absence of the Trade Winds, have favoured the formation of rows of cyanobacteria grouped in the open sea, which currents drag to the coasts where they arrive dying, already in terminal phase.

[11] Javier Arístegui et al 2017. Informe disponible en: http://www.gobiernodecanarias.org/opencmsweb/export/sites/medioambiente/piac/galerias/descargas/Documentos/informacion_ambiental/Informe-VMA-Bloom-Trichodesmium_SITMA-reducido.pdf

This fact also demonstrates that the socio-ecological systems of Macaronesia are interconnected and their limits can be crossed by physical-natural processes (Figure 27).

Figure 26. Cyanobacteria reaching the coast of Tenerife

Source: local newspaper "El Dia".

Figure 27. Saharan dust in suspension

Source: NASA

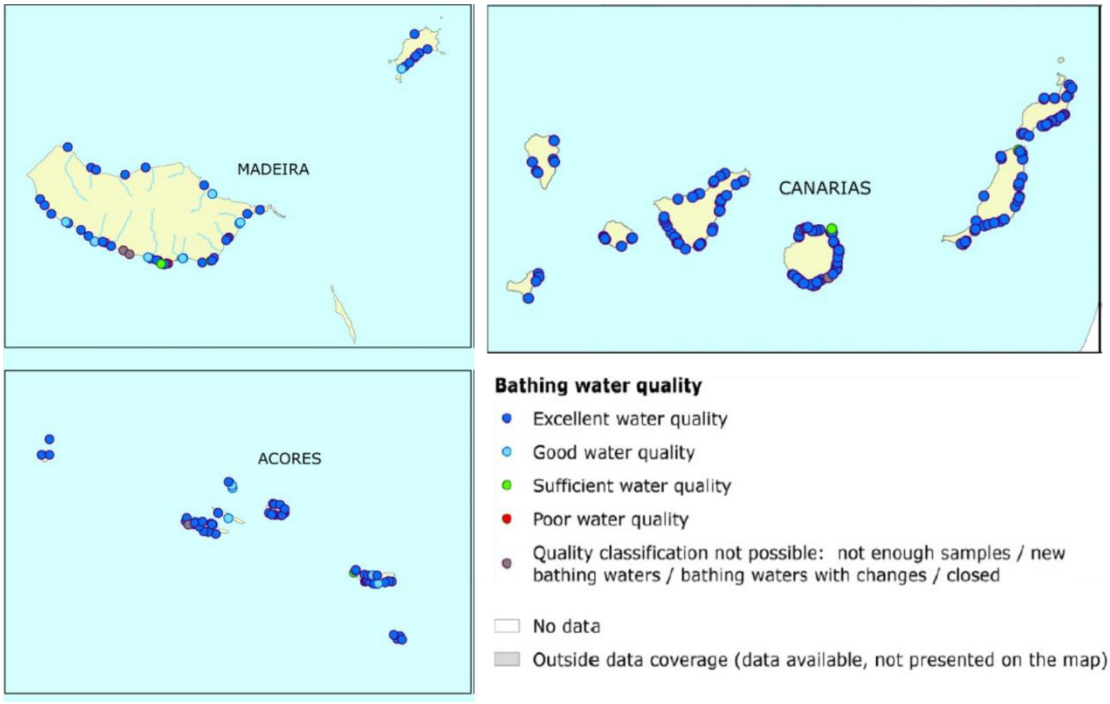
The pollution of the marine environment by untreated waters on the islands is a remarkable issue to increase the information available, as well as to reinforce the inspection and better understand the consequences of these untreated waters. Indeed, on July 24th of 2018 the national press reported a fine worth millions that Spain will have to face for not purifying its urban waters properly as required by the European Union guidelines. In the same sense, the "European Environmental Agency" indicates in its 2018 report (European Environmental Agency, 2018)[12] the lack of information in some of the bathing waters of the Macaronesian archipelagos (See Figure 28).

Another example of interest is jointly related to biological and climatic regulation. This is the case of the disproportionate proliferation of the *Diadema Antillarum* (sea urchin) in the Canary Islands. It seems clear that declining of its predators' population has destabilized the trophic balance of ecosystems. This has also been accentuated due to the increase in temperatures

[12] European Environmental Agency. European Bathing Water Quality in 2017. EEA Report. Nº2/2018

experienced in the surface waters of the islands that favours the expansion of this herbivore by increasing its breeding success rate (Hernández Pérez, 2006).

Figure 28. Quality of bathing water in Macaronesia



Source: European Environmental Agency, 2018

Biological and climatic regulation are closely related having confirmed cases where impacts on climate regulation have affected the biological regulation service. In a study published by Clemente, et al., (2014), an event of massive mortality of the sea urchin *Diadema africanum* was documented from October 2009 to April 2010 covering a distance of more than 400 kilometers, which extended from Madeira to the Canary Islands, and reducing its population by 65 %. According to the study, a marine bacterium called *Vibrio alginolyticus* was the cause of death. Apparently, the high seawater temperatures recorded in these two archipelagos at that time allowed the infection of *Diadema africanum* by this pathogenic bacterium. The authors also point out that the two archipelagos (Madeira and Canary Islands) are connected by the "Canary Current", which could suggest an increase in the temperature conditions of this cold-water current that flows from the north to the south parallel to the African coast. This could have allowed the spreading of the bacteria to such an extensive marine area.

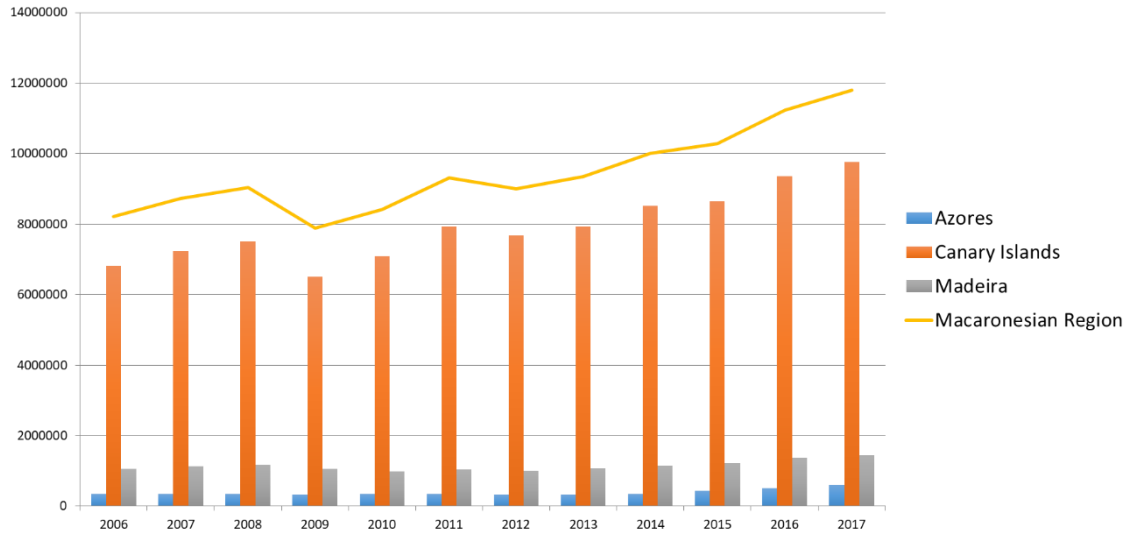
This process of temperature increase is well documented. The temperature of the Canary Islands sea surface has risen due to climate change, with an increase of 0,28 ºC per decade between 1982 and 2013 (Velez et al., 2015). This phenomenon has had an important effect in the coastal communities, which have undergone a process of tropicalisation since the late 80's and early 90's (Brito, et al., 2005; Falcón, 2015; Falcón, et al., 2015). It seems evident that the increase in temperature in the Canarian marine waters (Velez et al., 2015) is contributing to the colonization by species of tropical origin. This can also explain the expansion of native species with affinities for warmer waters from the western islands towards eastern ones (Brito et al., 2005; Espino et al., 2014; Falcón, 2015).

In the Azores, there are also cases that originate from a loss of biological regulating service. For example, in less than 10 years the invasive algae *Caulerpa webbiana* has caused significant alterations of the benthic landscape in areas off the coast of Faial Island. Some even located within the boundaries of marine protected areas (Abecasis et al., 2015). In the case of the Canary Islands, Brito et al. (2017) warn about the colonization and expansion of two potentially invasive corals (of the genus Tubastraea and Oculina) introduced by oil rigs. They also highlight the increase of temperature due to climate change as being a facilitator of colonization and expansion in the case of Tubastraea (thermophilic species).

In relation to **cultural services**, an important improvement in some and a deterioration in others can be observed. In Macaronesia, both the cultural service related to contact and experiences with nature and the one associated with the creation of a sense of belonging and identity of the resident population with its insular territory, are of great importance. The first one is closely related to the high increase of the tourist sector in the islands, which is very developed in the Canary Islands and also acquires great importance in Madeira. In this Portuguese archipelago, cruise tourism continues to decline since the economic crisis of 2008 (EU, 2015). Thus, it could be interesting in this case to seek alliances with the other archipelagos allowing this destination to be more competitive. On the other hand, the Azores is still at an early stage of tourism development although the inclusion of the archipelago among the destinations of some low-cost airlines can boost this sector in the coming years (EASME, 2017a).

Although there are important differences between archipelagos, the evolution of tourism in the Macaronesian region between 2006 and 2017 shows a remarkable and continued growth of this sector (Figure 29). This entails the development of infrastructure and equipment associated to tourism that is carried out at the expense of the consumption of other resources or services (energy, water, etc.), including space (provisioning service), which is especially limited due to insularity. More concretely, only the Canary Islands received 100.000 tourists in 1960, as opposed to more than 13 million in 2015 (Hernández Luis et al., 2017).

Figure 29. Evolution of the number of travelers in hotels in the European Macaronesia



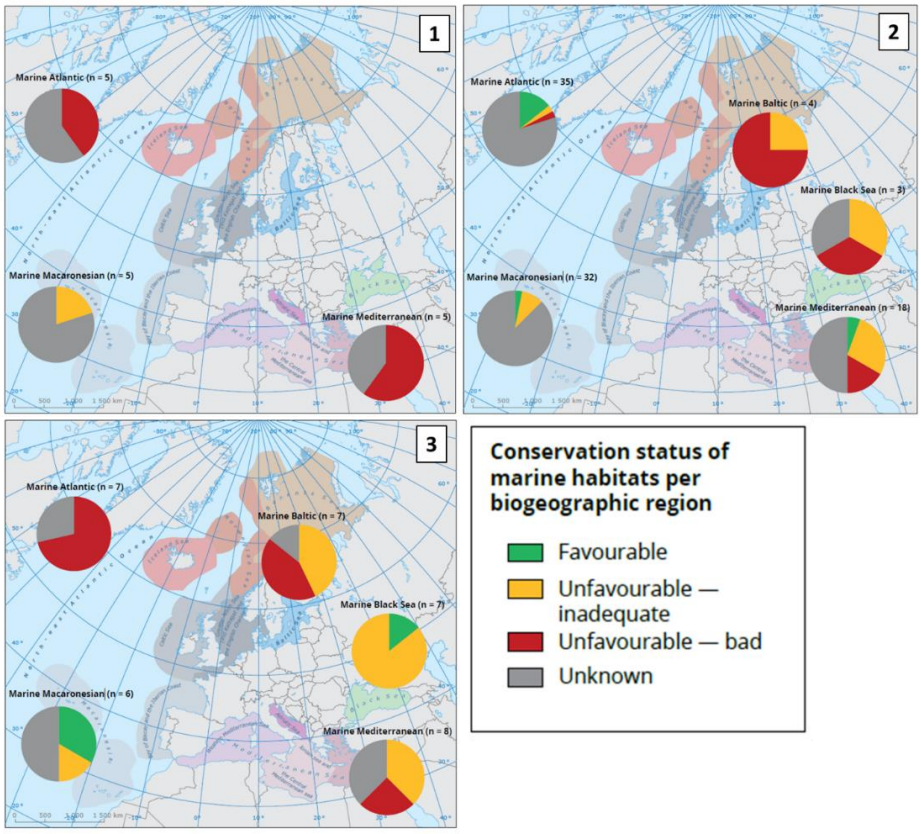
Source: own, based on statistic data of Instituto Nacional de Estadística de España and Instituto Nacional de Estatística de Portugal

Regarding the service related to the spiritual enrichment or emblematic interactions of the resident population, it is necessary to consider that islanders have a high sense of belonging and identity with their island territory. The welfare of the population of Macaronesia depends to a great extent on its conservation, understanding and respect. This service has been decreased and continues to be threatened by the processes of cultural homogenization, which are closely associated with urban development and the general commitment to the sun and beach type of tourism linked to large tourist resorts. This model has been prevailing on some islands for decades.

Among the cultural services, stands out the little importance of scientific knowledge as a derived service from intellectual interactions with the environment of the Macaronesian region. Indeed, in Macaronesia there are still huge gaps of information on topics of interest to the marine environment. Despite the above, there is no doubt about the positive trend of this service. The importance of the natural environment for cultural services is evident in the European Union. In recent years there have been important efforts related to European initiatives such as the Marine Natura 2000 Network or the application of the Marine Strategy Framework Directive, which has managed to boost, to a large extent, a coordinated gathering of information and comparable results for the entire region. Even so, information gaps are still very important.

This situation is well reflected in the "State of European Seas" report of the European Environmental Agency (EEA, 2015a). As already mentioned, the report indicates that for the case of Macaronesia the conservation state of 50 % of the marine habitats is unknown, with significant gaps of information on species of marine fauna, such as turtles or marine mammals (Figure 30).

Figure 30. Conservation status of marine turtles (1) and marine mammals (2), by European biogeographical region; general conservation status of European marine habitats, reported under the Habitats Directive (3)

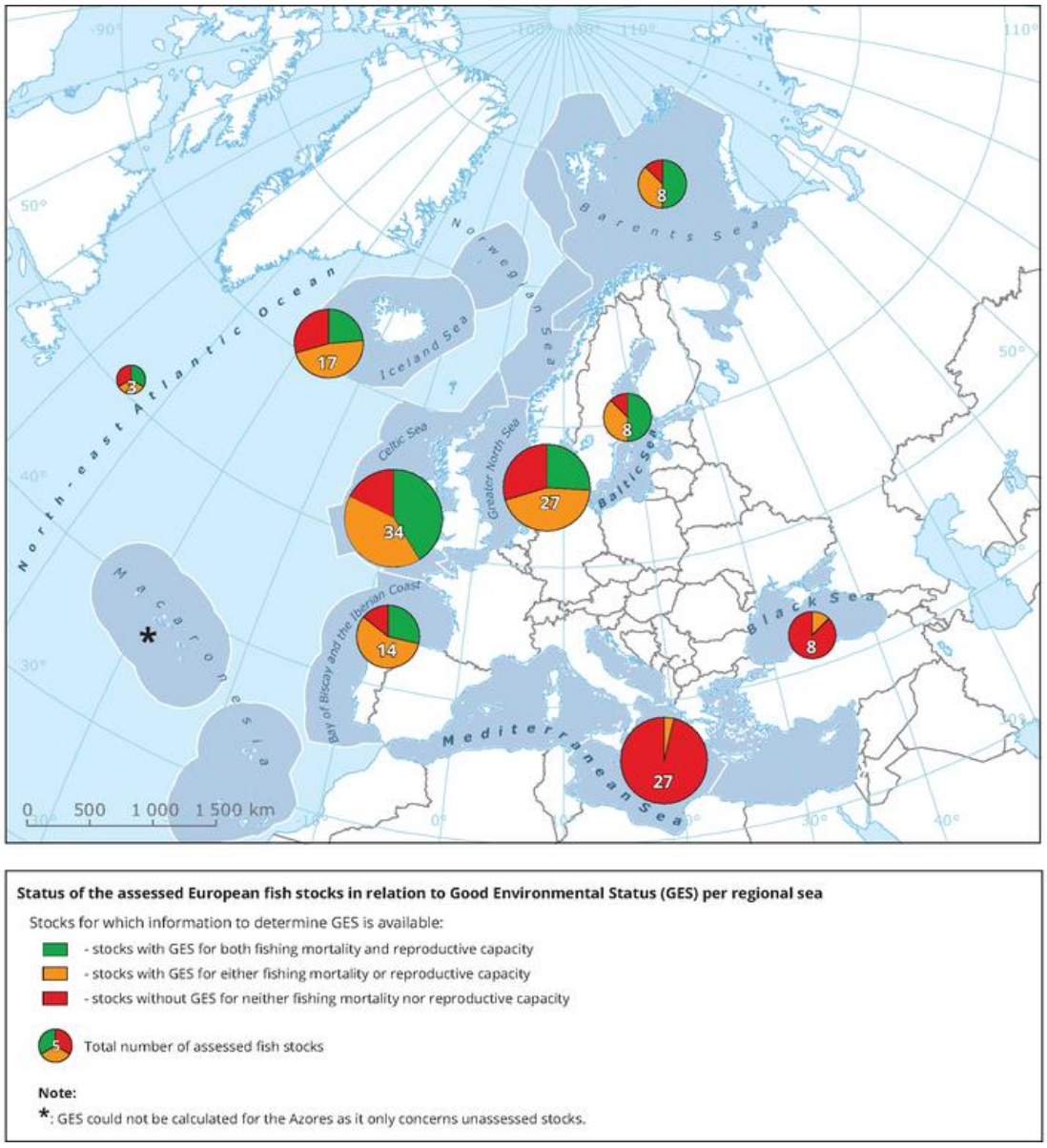


Source: EEA, 2015b

This lack of information related to the ecosystems has led, for example, to difficulties in calculating the good environmental status of fish stocks in the Macaronesian region (GES, in its English acronym), being the only one from Europe in which the indicator could not be calculated (Figure 31).

It is also worth mentioning that the positive evolution of some of the ecosystem services discussed above is likely to explain the deterioration of others. Hence, those linked to local ecological knowledge, cultural identity and sense of belonging, the landscape and aesthetic enjoyment could be suffering the success of those related to touristic and recreational activities and provisioning services in general. This would not be surprising if one takes into account the difficulty of conserving such a rich and varied natural and cultural heritage, but highly sensitive to disturbances, such as that linked to Macaronesia.

Figure 31. State of European fish stocks by regional sea in relation to its good environmental status



Source: EEA, 2015b

In this sense, it is necessary to make a final reflection that arises from relating the dependency of one type of service with another (trade-offs). Thus, it could be interpreted that the improvement of a service is closely related to the improvement or worsening of another. For example, an increase in the provisioning service could be due to overfishing of certain predatory species of sea urchin, which in turn can cause a large population increase of this herbivore, producing a worsening of the biological regulation service. Also, an improvement of the tourism and recreation activities related service can lead to a worsening in the cultural identity, the sense of belonging of the residents or the aesthetic enjoyment.

4.5. IMPACTS ON THE WELL-BEING

As the ultimate goal of the MSP is to improve human well-being, it is essential to establish the link between this well-being and the state of the ecosystems in order to maintain the "ecosystem approach".

The concept of human well-being according to the Millennium Ecosystem Assessment (PNUMA, 2003) must be remembered. It recognizes the following as determinants and components of it:
Safety, understood as the capability to live in an environmentally clean and safe house; and the capacity to reduce vulnerability to extreme collapses and natural events (tsunamis, hurricanes-typhoons, coastal-marine floods, major storms, etc.).
Basic material goods needed for a good life, understood as the ability to obtain income and access resources that allow sustainable livelihoods.
Health linked to adequate nutrition, freedom from avoidable diseases and have access to adequate water, clean air and energy.
Good social relationships, associated from the cultural point of view with enjoyment and learning.

In this regard, each region and area will have their own standards of quality of life, influenced in part by some of the driving forces or drivers of change, especially cultural. Hence, changes or impacts on human welfare will be defined as positive or negative according to the general and particular standards. The relevance of these impacts, in turn, will be highly conditioned by the various socio-economic aspects that determine the situation of a society at a specific time.

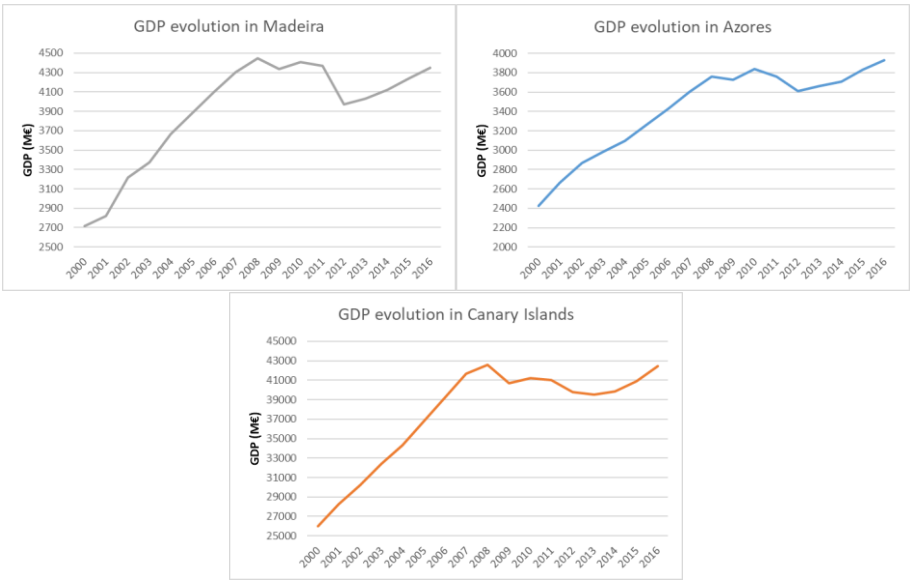
Thus, a society will be more vulnerable to impacts on benefits it obtains from nature if it is in a situation of economic crisis or high unemployment. In the same way, as far as ecosystem services are concerned, the productive structure that characterizes an economy will be essential. For instance, an economy based on productive primary sectors (agriculture, livestock, fisheries, etc.) will be more vulnerable to changes in the state of ecosystems. In other words, the aforementioned society based on primary sectors will suffer greater impacts on its well-being than others based on more diversified economies and/or those that obtain its primary resources from other economies (dependency on the environmental state of distant ecosystems). Globalization, already indicated as a conditioning factor or driving force, reduces the impact on the welfare of a society regarding resources supply, but will not replace jobs and income that can be lost due to the degradation of an ecosystem.

The Macaronesia region, as mentioned in the scope description, already has a set of structural geographic constraints associated with its insularity, ultra-periphery, littorality and its eminently marine nature, which all intervene directly in the productivity and competitiveness of its economic activities by making it difficult to achieve economies of scale.

In addition to this complex situation, 95 % of the region’s business fabric is made up of micro-enterprises, which does not favour the development of an auxiliary productive network around it. Without a sufficient mass of large local producers, it is difficult to produce a boosting effect on the regional economy as a whole (RegioPlus Consulting, 2014).

Moreover, the three archipelagos are currently in a situation of significant socio-economic vulnerability. They have a lower income than the average European community and a similar situation is observed with the Human Development Index (HDI), being only Madeira (both cases) exceeds its national average. The Azores on the other hand, is the archipelago that has the lowest HDI. Although the Canary Islands have the greatest HDI improving its score since 1980, its distance from the national average has increased (Herrero, et al., 2013; Silva & Ferreira-Lopes, 2014). The economic crisis has aggravated this situation, as it has been especially noticeable in the territories of Spain and Portugal, two of the countries of the EU-27 that have suffered it the most (Interreg, 2017). However, in recent years there has been a positive trend in the region's Gross Domestic Product (GDP) (Figure 32).

Figure 32. Evolution of GDP (M €) in the three archipelagos of the European Macaronesia



Source: based on statistical data of the and Regional Statistics Service of the Canary Islands and the Regional Statistics Service of the Azores.

The number of employed people has fallen sharply increasing the long-term unemployment, which together with low employment rates are the main factors of social exclusion and poverty. The long-term unemployment has reached values of 46,3 % in the Canary Islands, 49,7 % in the Azores, and 59,5 % in Madeira (European Commission, 2017). The unemployment percentage has increased especially among young people and those over 45 years of age. Nevertheless, differences between genders have been reduced since the beginning of the crisis (European Commission, 2017). This is why the development of the traditional maritime sectors and the empowerment of the new booming sectors are a priority for the region.

i) Fisheries and aquaculture

As it has been pointed out, fishing mainly benefits from the provisioning ecosystem services, but biological regulation is also important. Sizing the well-being directly associated with the use of these services is complex. It includes aspects of food or income improvement, but also socio-cultural benefits that are difficult to measure.

According to the Ministry of Agriculture, Livestock and Fisheries, in the Canary Islands, the fishing and aquaculture sectors were together responsible for only 0,06 % of the GDP in 2015. In the Portuguese archipelagos, where activities such as tourism have less relevance, the weight of the fishing sector is higher. In Madeira, it corresponds to 0,5 % of the GVA and 0,9 % of the overall employment. In the Azores, where the associated processing industry is also added, this sector accounts for 2 % of GVA and 3 % of total employment (EASME, 2017a).

As shown in Figures 33 and 34, between 2008 and 2014 the GVA tendency varies from archipelago to archipelago, but it there seems to be a similar trend in the loss of employment. In the Canary Islands, both the overall fisheries and aquaculture GVA and the employment decrease 0,55 % and 0,3 %, respectively. However, viewed separately, whereas the marine fishing production decrease 6,22 % (increasing 0,17 % the employment), in the same proportion as the fish processing industry (though for this sector the employment decreases 2,2 %), the aquaculture increase 19,73 % (decreasing 2,35 % the employment). In Madeira, whereas the overall GVA of the sector increases (0,62 %) the employment decreases (3,4 %). A detailed analysis in Madeira reveals that both the marine fishing production and aquaculture show an increasing trend of both their GVA and employment rate while the processing industry decrease. Nevertheless, it is remarkable in this case the great increase of the employment in the aquaculture sector (25,74 %) compared to its low growth (0,11 %); and the 18,91 % decline of the processing industry. Moreover, in the Azores the increase of the sector's GVA (2,46 %) results in reductions of employment (3,89 %). In this case, the aquaculture sector is non-existent; both the GVA and employment of the marine fishing production increase (3,73 % and 1,22 % respectively); and the processing industry despite its positive growth trend (0,7 %), shows a negative employment trend (3,12 %). This might be due to the drastic reduction of tuna resources at the beginning of the 2000 decade which led to a crisis that concerned, besides tuna fishing, also canning industry. Nonetheless, the activity still plays a major role in the Azores blue economy, since it is the most important one (EASME, 2017b).

This impact on the fishing benefits of the region has several reasons. The main one is associated with problems with bilateral fisheries agreements with countries such as Morocco, which had conditioned access to the flow of this provisioning ecosystem service from African fishing grounds (Mauritania, Morocco and Guinea Bissau). However, this may enhance overfishing in these remote African ecosystems.

Regarding aquaculture in the Canary archipelago, it already outweighs the benefits of fishing. Aquaculture generated around 34 million euros of production compared to the 25 million associated with fishing, despite suffering a severe financial crisis in 2008 that reduced the number of companies from 34 to 18, therefore, decreasing its production and employment. In the Azores, the canning industry is highly developed. Once the tuna fishing crisis was overcome, the tuna processing industry started employing more workers than the fishing sector. On the other hand, the canning industries of Madeira and the Canary Islands had to close their facilities, with the consequent impact on the local economy, due to the non-renewal of the bilateral agreements with the northwest African countries, especially Morocco, and the EU.

Figure 33. Evolution of Gross Value Added (GVA) for fisheries, aquaculture and associated processing industry in the archipelagos of European Macaronesia

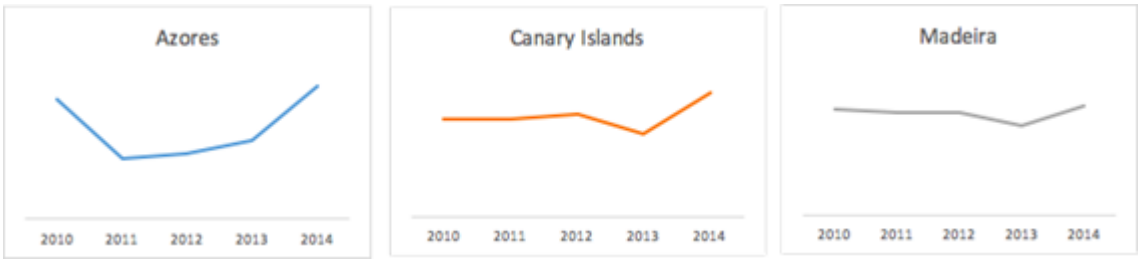
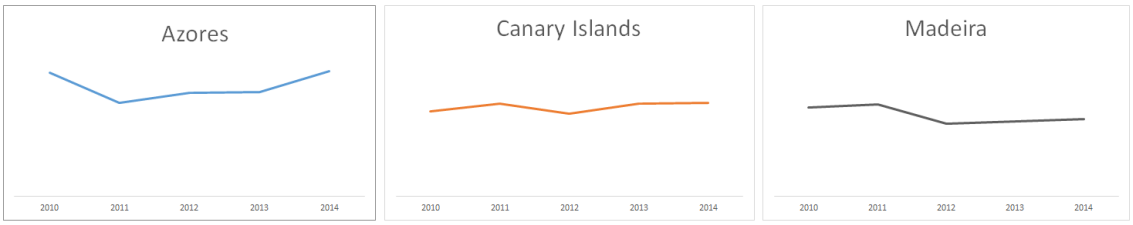


Figure 34. Evolution of the number of jobs generated for fishing, aquaculture and associated transformation industry in the archipelagos of the European Macaronesia



Source of Figure 33 and 34: own elaboration based on the data available in Annexes 7, 8 and 9 of the report of the European Commission for the blue growth of the Azores, Madeira and the Canaries, respectively.

As shown in Figures 32 and 33[13], the observed benefits trend in the three archipelagos of all the sectors associated with the provisioning service of fishing is uneven.

Among these benefits are not considered the ones associated with illegal, unreported and unregulated fishing (IUU) or with recreational fishing, which catches can also reach the consumer outside the formal marketing channels (directly to restaurants and hotels) (EASME, 2017a). These "benefits" can be punctually highlighted for certain species and places. It is noteworthy that the tourist or recreational fishing is booming so is a type of vector to be considered for more detailed analysis.

ii) Coastal and marine tourism

In terms of income and employment, tourism is the sector that generates more benefits for the population of Macaronesia. Many of these benefits are related to the state of the flow of the following ecosystem services, from which the local population also benefits to a great extent: climate regulation, quality of beaches and bathing waters, scenic wealth and biodiversity and in general, diversity of alternative leisure and recreational activities directly related to nature. It is difficult to quantify how all these ecosystem services contribute to the tourism activity, but there is no doubt that a significant alteration in any of their flow would have a serious impact on its

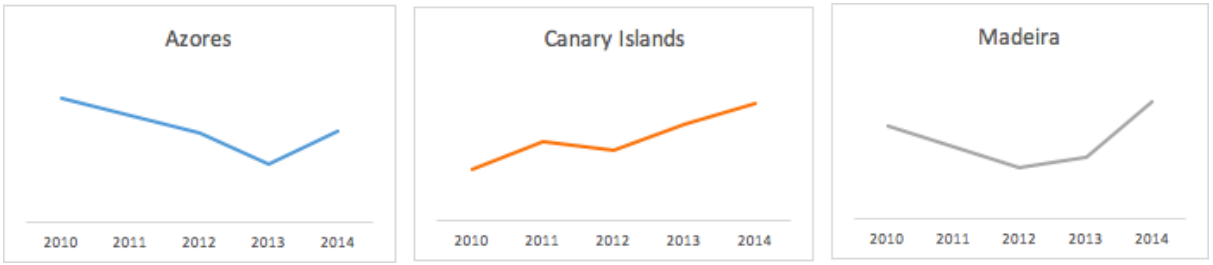
[13] This type of figures aims to reflect only tendencies and therefore data should not be compared between archipelagos in quantitative terms (the Y axis is different in each case, taking into account the relevance that data represents for each archipelago). This point must be equally considered for the rest of similar graphics present in the document.

benefits and, therefore, on the welfare of the island population. In this regard, it should be also noted the great interconnectivity of this sector with the economy as a whole, so that an impact on its benefits would have an important knock-on effect on other subsectors such as housing, food and beverages, transport, construction, etc.

Tourism is an especially strategic activity for the economy of the Canary Islands and Madeira. It is of great relevance for the GVA and employment. For Madeira, it represents almost 21 % of the GVA and 20 % of employment, while for the Canary Islands it represents 31,4 % of the total GVA and 34,5 % of total employment (EASME, 2017a). The Canarian case accounts for 30 % of all Spanish tourist VAB (EASME, 2017a). On the contrary, growth of the tourism activity is quite recent in the Azores, being the archipelago in which tourism has the least impact on the general economy. However, it is also the one with the greatest growth potential in terms of the use of coastal-marine ecosystem services (nature tourism). To this development potential is added that the traditional problems of tourist arrivals to the islands are being alleviated by the appearance of new low-cost airlines.

Regarding tendencies, the contribution of tourism to the GDP has generally increased in recent years, especially in the last decade, which has helped offset the effects of the economic crisis. In the Canaries it is where this growth has been more accentuated, but it is also noticeable in Madeira and Azores (Figure 35). Regarding the Azores archipelago, in this figure can be seen a decrease reaching -7.44 % despite an average growth in the number of visiting tourists of 5 % between 2010 and 2014. This is due to the inclusion, in this case, of data associated with other subsectors such as housing, food and drink that are not exclusively linked to the tourism activity, and on which the economic crisis has had greater impacts.

Figure 35. Evolution of GVA for coastal tourism in the archipelagos of the European Macaronesia

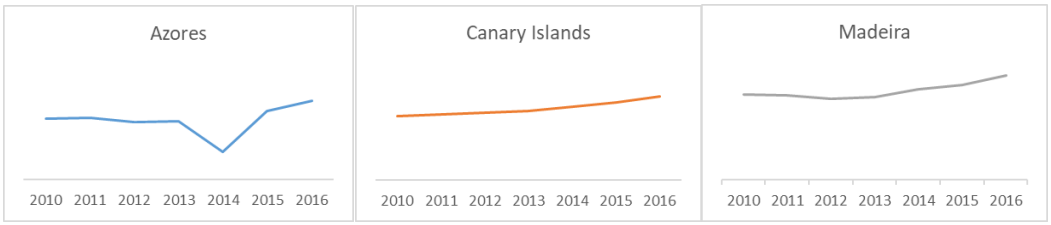


Source: European Commission (2017)

In a similar way, the employment generated by coastal and marine tourism has been increasing in recent years (Figure 36 and 37). As in the case of the number of tourists, the Canary Islands is the archipelago that has the greatest number of employees in the sector, followed by Madeira and the Azores. Additionally, in all the archipelagos there is a growing trend in the number of workers.

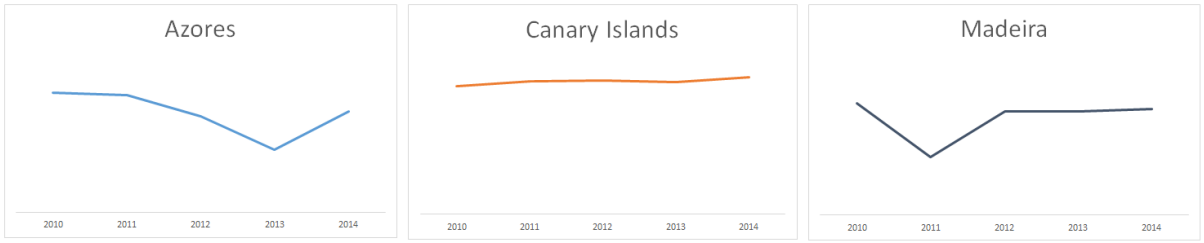
Moreover, cruise tourism in the Canary Islands accounts for an increase in the number of employees of 3,21 % in the period of 2008-2014. However, the GVA and the turnover of the subsector in this archipelago and Madeira have decreased slightly in the same period (EASME, 2017a). In the case of the Azores, the GVA of the subsector increased between 2010 and 2014 (EASME, 2017a).

Figure 36. Evolution of workers in hotel establishments in the European Macaronesia



Source: own, based on data from the National Statistics Institute of Spain and the National Statistical Institute of Portugal

Figure 37. Evolution of the number of jobs generated for coastal tourism in the archipelagos of the European Macaronesia



Source: own, based on the data available in Annexes 7, 8 and 9 of the report of the European Commission for the blue growth of the Azores, Madeira and the Canary Islands respectively

Cruise tourism also has a positive indirect impact on the local economy. On the one hand, the expenditure of cruise tourists during their short stay generates revenues in the area visited. On the other hand, the short stays stimulate the will of cruise passengers to return on their vacation and, thus, becoming promotional tourism agents of the destination (EASME, 2017a). In the Azores, although the activity currently does not generate direct jobs, it does create indirect ones.

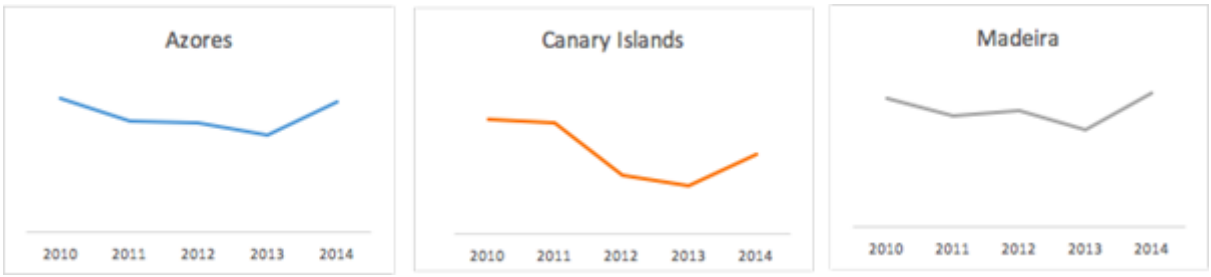
iii) Ports and maritime traffic

In this case, benefits of the sector are strongly linked to the provisioning service of space for infrastructures, operations and transport routes and, to a lesser extent, to the regulation service (obtaining natural shelter and protection against waves and winds in some cases).

Maritime traffic is a key factor in the economic and social development of the archipelagos of the European Macaronesia. It allows reducing the geographic constraints such as isolation and remoteness, with the arrival of goods and access to international markets, but also the territorial fragmentation associated with their archipelagic character.

Although transport of passengers is not economically profitable and it is subsidized by governments to ensure a public service in the archipelagos, transport of goods responds to the market demands without receiving any financial assistance (EASME, 2017a). In this sense, the economic crisis has affected the impact of the sector on the local economy (Figure 38).

Figure 38. Evolution of the GVA for maritime transport in the archipelagos of the European Macaronesia

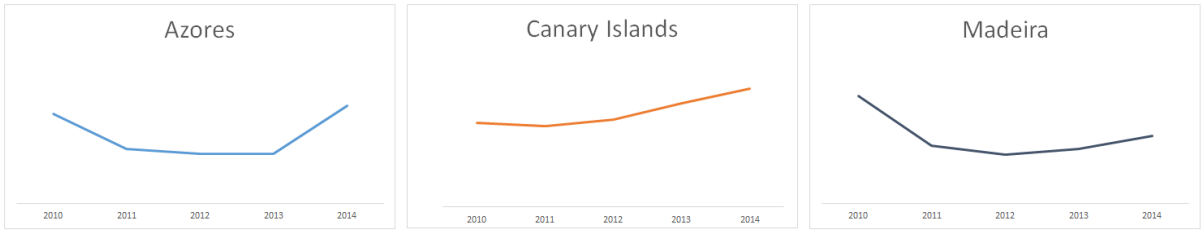


Source: European Commission (2017)

In terms of employment, the sector employs around 202 people in the Azores, 139 people in Madeira and about to 2.658 in the Canary Islands (data corresponding to 2014 according to European Commission, 2017). In relation to employment in the Canary Islands, passenger transport showed a positive trend of 3,21 % for the period 2008-2014. On the other hand, employment of the maritime transport of goods decreased by 5,77 %. Finally, turnover in this period decreased in both subsectors by 2,55 % respectively (Figure 39).

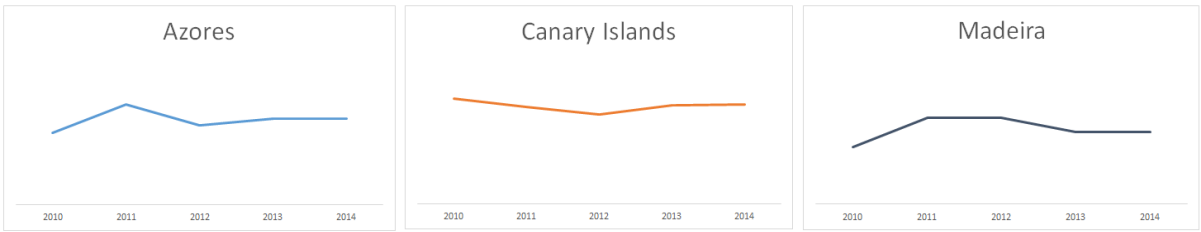
As far as the activity in port is concerned, both the number of jobs in the region and the combination of activities that operate in their docks have fluctuated (Figure 40).

Figure 39. Evolution of the number of jobs generated by maritime transport in the archipelagos of the European Macaronesia



Source: own, based on the data available in Annexes 7, 8 and 9 of the report of the European Commission for the blue growth of the Azores, Madeira and the Canary Islands respectively

Figure 40. Evolution of the number of jobs generated by ports (including dredging activity) in the archipelagos of the European Macaronesia



Source: own, based on the data available in Annexes 7, 8 and 9 of the report of the European Commission for the blue growth of the Azores, Madeira and the Canary Islands respectively

vi) Synthesis of the relationship between marine activities, pressures, ecosystem services and benefits in Macaronesia

As a conclusion to the analysis done so far, an attempt to synthesize the importance for Macaronesia of ecosystem activity-service relationships, as well as to what extent the benefit of those depends on the good state of the ecosystems has been made. This makes it easier to understand how and with what intensity is manifested the dependence of a certain activity with the good environmental state and normal functioning of the natural components and processes that give rise to the provision of ecosystem services.

Each activity will have a minimum requirement on the good condition of the ecosystem from which it provides benefits. This is closely related to the sector's resilience to the state of the natural environment. A sector that withstands greater variation in the state of an ecosystem will be more resilient or, in other words, its benefits will depend less on that ecosystem. This relationship of dependence is influenced by other aspects and administrative and economic conditions for the activity to develop. Some already discussed in the chapter of "driving force" and others closely related to the "response" section five below.

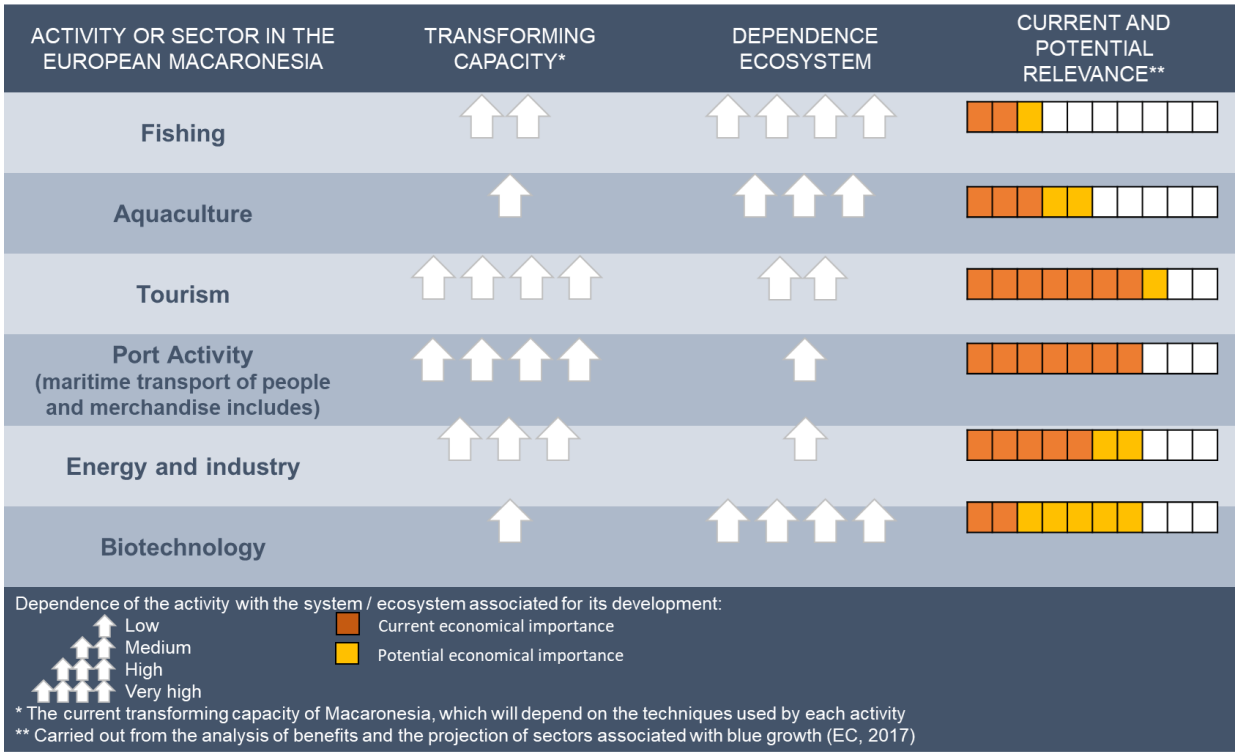
This resilience or dependence of an activity to certain conditions of the ecosystems will be decisive when carrying out the marine spatial planning process with an ecosystemic base. Figure 41 shows a qualitative outline of this relationship established from the information available of each sector and their characteristics in terms of type, location and requirement of different resources or ecosystem services within the European Macaronesia. It is closely associated with the scheme already advanced in Figure 19. It results, therefore, from the abstraction of the analysis by sectors carried out for the Macaronesian region.

In this sense, stands out the activity of fishing (and associated processing activities) with a very high dependence on ecosystem services, as has been demonstrated with the various crises in the sector associated with collapses of some kind (such as tuna) or lack of access to some fishing grounds (lack of agreements with third countries). This means that it is less resilient to changes in environment status or that its benefits are more vulnerable to them. Regarding the example of fishing, without the production of biomass the benefit of the activity is impossible. Aquaculture is considered to have an average dependence (see the description of these sectors and how they depend on the physical characteristics of the environment for their development). Despite being two of the groups of activities with the greatest economic weight in the region, on the one hand, tourism presents a medium dependence compared to fishing activity and, on the other hand, port activity and marine traffic have a low dependency in comparison. This does not mean that they do not depend on ecosystems, but that they have greater resilience to changes in the state of the ecosystems than other sectors. Thus, under a situation of deterioration of ecosystems and their services, the effects on these sectors will tend to be seen in the long-term.

In the case of tourism, a process of pollution of the bathing water will have very negative consequences for tourism; still, its resilience will be greater than in the case of fishing (displacement of tourists to other areas, other recreational leisure alternatives, etc.). The intrinsic characteristics or ecosystem services of the archipelagos of Macaronesia (landscape, beach, possibility to accommodate cruises, location, etc.) are hugely appealing for tourists, which, in the first instance, makes them heavily dependent on these services. Even so, a proportion of tourism activity can also occur without all of these services being provided. For example, when it comes to choosing the tourist site some important motives are the hotel services (quality, availability,

etc.), which normally depends more on the type of tourism than the quality of the landscape. In addition, the tourism sector depends on other factors unrelated to ecosystem services, such as facilities and equipment, architectural quality, promotion of supply, security, catering services, etc.). In any case, the fact that Macaronesia is a prominent destination for coastal tourism invites to think that the environment and its environmental quality continues to provide fundamental benefits for the sector.

Figure 41. Relationship of the most important maritime activities of European Macaronesia with the well-being of the region, based on its ability to transform ecosystems (through pressures), its dependence on services or sensitivity to changes in the state of ecosystems, and of the current importance in terms of economic benefit (income and employment)



Source: own

In respect of port activity and maritime transport, they benefit to a large extent from ecosystem services associated with the availability of space (provisioning service) such as navigation routes and appropriate sites where ports can be located, which must be taken into account for the MSP processes. However, the environment is often completely transformed (regardless of its state) or forced to allow the expansion or development of the activity (through dredging, fillings to gain land to the sea, etc.).

Moreover, it should be noted that greater or lesser dependency does not imply a greater or lesser relative economic weight in the Macaronesian socio-ecosystem. A sector whose dependence is very high can have low economic implications (proportionally speaking). This is observed when analysing the current state of fishing. However, this relationship is very conditioned by the type of management response. That is, an activity can increase or decrease its ecosystemic dependence, its capacity of environment transformation or the importance of its final benefits obtained if certain decisions are made. It is worth noting, for example, the recommendations on blue growth for the ORs indicated in European Commission, 2017.

In the case of developing activities with great growth potential such as biotechnology, it depends highly on the presence and status of biodiversity and its genetic variability, which is the provisioning service for this sector. Even with the adequate response to promote the boom of this sector and drive a huge investment in technology, it would be necessary in turn to improve the conservation of the natural elements needed for this activity (for example, a type of benthic community). Something similar can occur in other sectors such as marine mining or renewable energy.

Finally, the transforming potential of the different activities should also be considered. That is, depending on the sector's response the activity will exert more or less pressure on the environment and will have greater or lesser potential to impact other beneficiaries. In the previous examples, promoting tourism activities in which hotel services are prioritized will imply important pressure vectors: space consumption, not allowing the development of other activities; degradation of the landscape, damaging the sector itself, etc. It will be, therefore, a generator of more conflicts (trade-offs) than other activities or other ways of carrying out this activity leaving a set of "winners" and "losers" in its development. In the Canary Islands, there are important samples that reflect the consequences of the indicated example. The installation of a port, for instance, has an important transforming potential as well as it can transfer costs that interfere in the development of other activities. An example could be the consumption of coastal space itself that involves the installation of a port and that does not allow to value this coastal area from the tourist point of view due to the loss of ecosystem services of physical support, landscape, quality of bathing waters, place of recreation, etc.

This analysis allows considering the main sectors and their relationship with the environment from a regional perspective. That is, it also offers interesting information about the socio-ecological connectivity between the different archipelagos and, therefore, the potential for cross-border cooperation directly associated with the state of the ecosystems. As an example, the fishing sector in Macaronesia is developed using different gears, but migratory pelagic fish are caught in all the archipelagos. Despite the possible differences in terms of the target species, art and distribution of the activity, the sector shares its dependence on the state of the same service, which depends on distant natural processes. In the same way, an increase in fishing effort in one of the archipelagos can have an impact on the effort of the other (trade-offs). This includes vessels fishing in international waters or ABNJ (areas beyond national jurisdictions or high seas). These and other matters should be the subject of attention in the responses given by the different competent institutions.

5. RESPONSES: AN APPROACH FOR THE MARINE GOVERNANCE OF MACARONESIA

In the present section, a general analysis of the **response (R)** management initiatives that have been approved for the region as a whole and that have some interest related to the marine affairs of the area is carried out. It is not intended here to perform an exhaustive or detailed analysis of the different management measures approved by each of the archipelagos. This would require an in-depth study that goes beyond the purposes of the present diagnosis. On the contrary, it seeks to identify and characterize the existing relationships in management issues. On the other hand, the analysis of the marine management of each archipelago should be carried out at the moment in which each autonomous region begins its marine planning process.

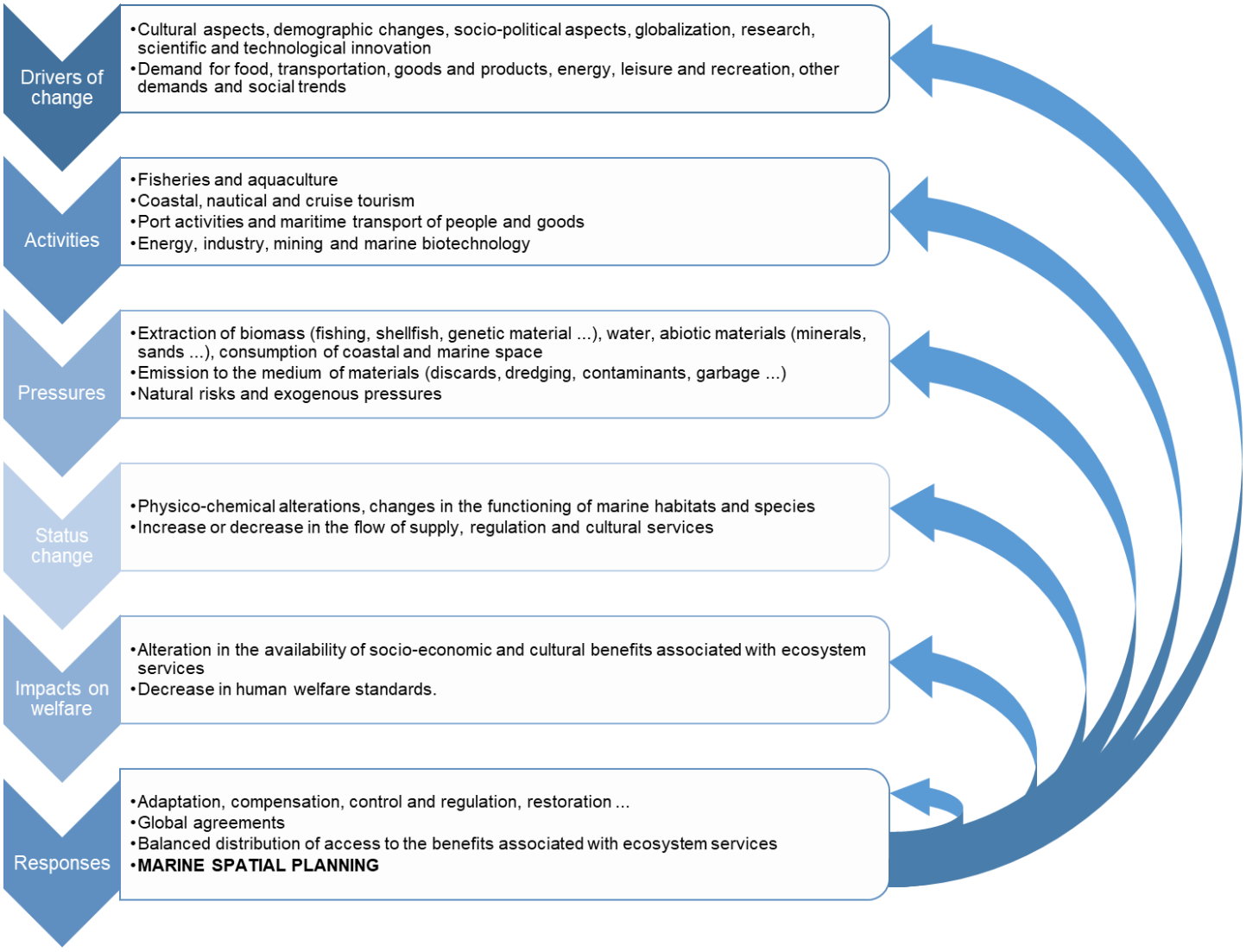
The importance of the analysis of the "Responses" is indisputable as it implies influencing the distribution of public resources, the division of attributions between the private and public sector (and also within it), the orientation of the efforts of institutions and public officials, the social distribution of the benefits of ecosystem services, etc. Hence, it affects in a considerable way both the present and future human welfare in Macaronesia (Figure 42).

These responses can be directed to some of the priority issues identified in this document: drivers or driving forces, activities, pressures, changes in status, impacts on human well-being (Figure 38), but often these can also be elaborated thinking about improving the management and administration process itself (García-onetti et al., 2018). In fact, very often the origin of the problems detected is in deficiencies of the management system. For example, one response in this regard could be the creation of an instrument to improve cross-border coordination in the management of the Macaronesian marine affairs. How this management and administration is carried out for the marine environment is analysed in detail in specific studies, since this topic implies a search for information and specific diagnosis to understand the state of each country, in the archipelago and in the whole of Macaronesia since a more strategic point of view (for more information, see results and reports of the MarSP project).

In any case, regardless of the approach, responses can never lose sight of the fact that marine management is designed to protect and improve the natural structure and functioning of oceans. At the same time, the marine processes that provide ecosystem services, from which society obtains goods and benefits must be ensured (Elliott, 2011). This objective or ultimate goal must always be present in all the instruments and initiatives that can be developed.

There are several institutions and international organizations that have proposed management initiatives for the marine area of Macaronesia. Some of them are not specific to the region, but they do affect it. Thus, FAO, in its 1995 Code of Conduct for Responsible Fisheries, establishes in its Article 9.2.3 that states "should consult neighbouring countries, whenever appropriate, before introducing non-native species into transboundary aquatic systems".

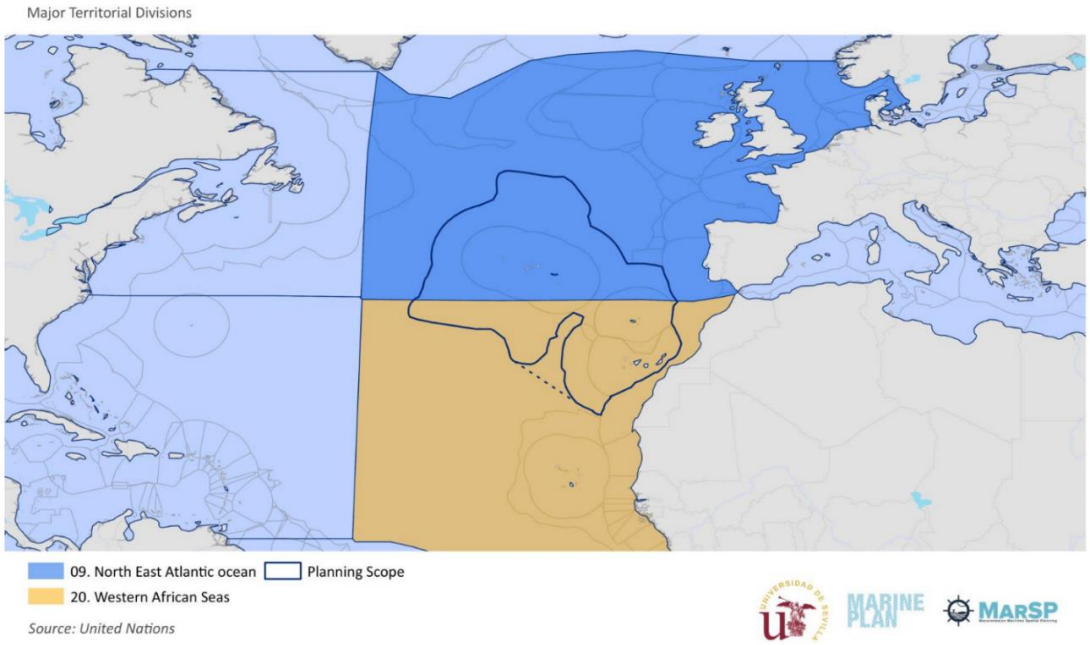
Figure 42. Scheme-summary of causal relationships and responses to MSP in Macaronesia



Source: modified from Elliott (2014)

It is curious to see how the United Nations, despite recognizing the ecosystemic continuity of the Macaronesia bioregion, tends to compartmentalize it when implementing its initiatives. This institution, in its "Assessments of Assessments" study, divides the Macaronesian region into two by including the Azores in region 9 "North East Atlantic Ocean" and Madeira and the Canaries in the 20 "Western African Seas" (Figure 43).

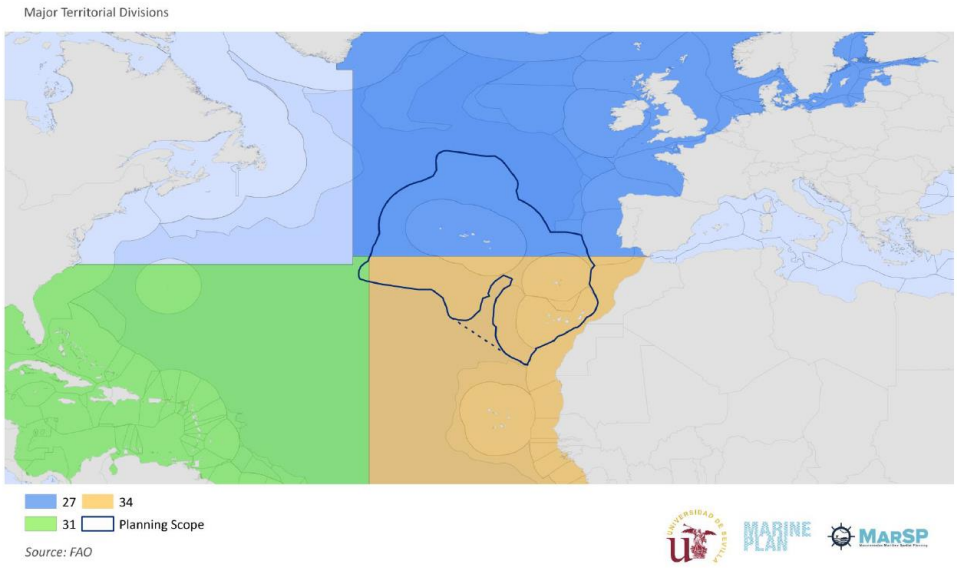
Figure 43. Distribution of the regions established by the United Nations



Source: Suárez de Vivero, 2018

The same applies to the UNEP Regional Seas Program (UNEP), which includes only the Azores in the "Northeast Atlantic Region". The Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR) also leaves Madeira and the Canary Islands out of its scope of action. The same situation is repeated with the FAO when it divides the fishing areas on an international scale without considering the continuity existing in the biogeographic region of Macaronesia, which has species that migrate between archipelagos (Figure 44).

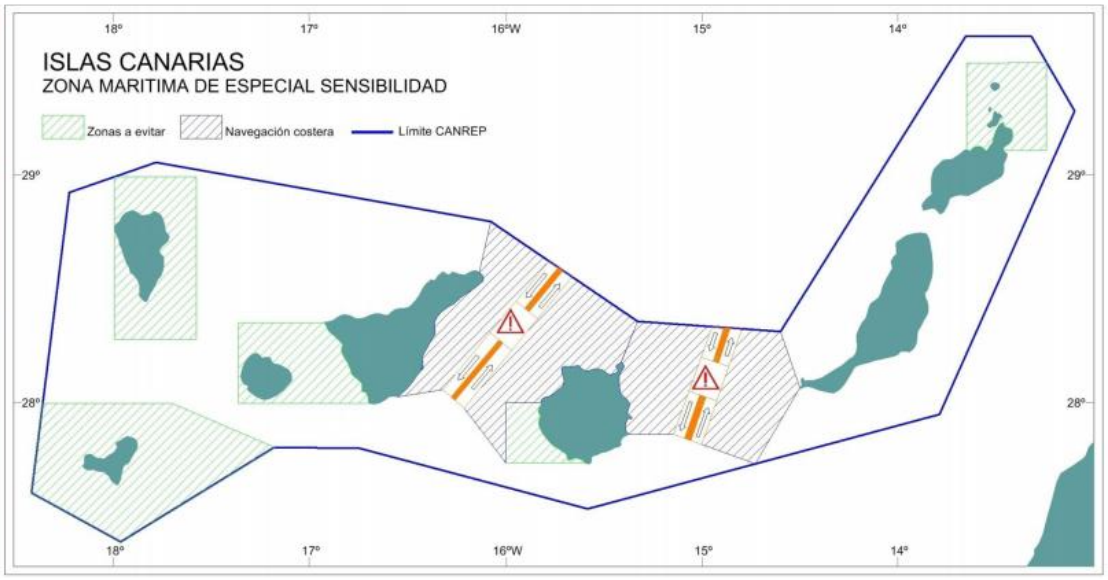
Figure 44. FAO Fishing Areas



Source: Suárez de Vivero, 2018

The IMO (International Maritime Organization) has approved an interesting instrument in the area of Macaronesia. In it, the Particularly Sensitive Sea Areas (PSSA) of the Canary Islands, an area of 7.000 km² was declared by the IMO in order to regulate maritime traffic between the islands and thus reduce its impact on marine mammals (Figure 45). At present, maritime traffic is channelled through two corridors between the islands of Tenerife and Gran Canaria and between the latter and Fuerteventura.

Figure 45. Maritime Area of Special Sensitivity of the Canary Islands



Source: Ministry of Development of Spain. Available on: https://no0ilcanarias.files.wordpress.com/2012/11/zmes-dossier.pdf

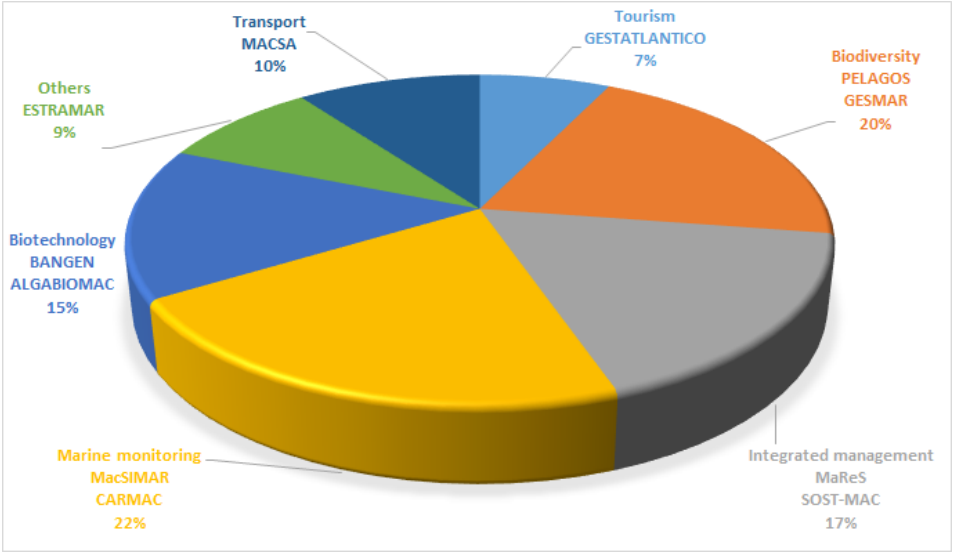
Contrary to what occurs in other international instances, the European Union has recognized the region of Macaronesia as a management unit. Thus, both the Framework Directive on the Marine Strategy and the Water Framework Directive recognize the whole region in the application of its measures.

European regulations follow the principles of subsidiarity (no intervention by the EU when an issue can be effectively regulated at a national level) and proportionality (EU actions must not go beyond what is necessary to achieve its objectives). However, in cross-border areas is where the regulatory role of supranational entities becomes more relevant. This is especially important for the marine space of the European Macaronesia.

In addition, the EU's objectives are framed by policies that are developed through community regulations and the financial instruments available to achieve them. In particular, the Operational Program of Territorial Cooperation Madeira-Açores-Canarias is the main financial instrument available to the outermost regions of Spain and Portugal to offer an effective response to the common challenges they face in terms of innovation, competitiveness, internationalization and sustainable development

Thus, in the current INTERREG-MAC 2014-2020 call, there are 15 projects associated to topics and with specific objectives that relate to the marine environment in the region of Macaronesia, while in the previous INTERREG-MAC 2007 -2013 call the number reached 11 projects (Table 4 and Figure 46).

Figure 46. Budget percentage of all INTERREG-MAC projects 2007-2013 for the main issues in the marine environment



Source: own

As seen in Figure 45, the EU's investment priorities in Macaronesia for the period respond to some of the weaknesses identified in the field, such as the lack of information and monitoring of marine habitats, or biodiversity, which combined account for 42 % of the budget of the total projects approved for the marine environment. Other investment priorities are also very appropriate, such as integrated management, biotechnology, maritime transport or tourism. These include the high budgetary percentage that goes to biotechnology and integrated management, which together amounts to more than 30 % of the total.

The new INTERREG-MAC funding period 2014-2020 (considering only the first call), has meant an increase both in the absolute number and in the relative weight of initiatives (15 of the 56 projects) related to the marine environment (Table 5). Likewise, the total budget that sustains these initiatives have also been increased, further strengthening the trend towards those initiatives that focus on the marine environment of Macaronesia: € 19,217,643.8 in total for the INTERREG-MAC 2014-2020 compared to € 7,401,027.68 in total for the INTERREG-MAC 2007-2013.

Table 4. List of approved projects in the INTERREG-MAC 2007-2013 related to the marine environment

Theme		Projects approved in the period 2007-2013	Azores	Madeira	Canary Islands	Others	Budget (in thousands of €)
Blue Growth	Biotechnology	**BANGEN** *Red BANGEMAC: Banco genético marino de Macaronesia*	■	■	■		792,16
		ALGABIOMAC *Desarrollo de industrias Biotecnológicas a partir de la explotación de macro y micro algas marinas de las regiones de la Macaronesia (y país vecino)*		■	■	■	304,17
	I+D+i	**ESTRAMAR** *Estratégia Marino-Marítimo de I+D+i en la Macaronesia*	■		■	■	648,05
	Tourism	**GESTATLANTICO** *Gestión y explotación sostenible de las zonas costeras del litoral euroafricano*			■	■	532,00
	Commerce and transport	**MACSA** *Programa para Fomentar el Desarrollo Sostenible en los ámbitos del comercio y el transporte marítimo en África Occidental (COMERCIO Y TRANSPORTE)*			■	■	747,71
Environmental Observation		**MacSIMAR** *Incorporação do Sistema Integrado de Monitorização Meteorológica e Oceanográfica da Macaronésia na estratégia de inverstigação marinha/marítima Europeia*	■	■	■		760,05
		CARMAC *Mejora de la calidad de las aguas recreativas y costeras de la Macaronesia*	■	■	■		840,67
Biodiversity		**GESMAR** *Gestión Sostenible de los Recursos Marinos*	■	■	■		827,58
		PELAGOS *Un modelo para la gestión coordinada de los recursos naturales marinos en la Macaronesia*			■	■	
Integrated Management		**MaReS** *Macaronesia Research Strategy*			■	■	549,72
		SOST-MAC *Cooperación y Sinergias en actuaciones Sostenibles en Espacios Naturales Protegidos de la Macaronesia*			■	■	731,87

Source: own, based on published data in INTERREG-MAC program:https://www.mac-interreg.org/

Table 5. List of projects approved in the INTERREG-MAC 2014-2020 related to the marine environment

Theme		Projects approved in the period 2007-2013	Azores	Madeira	Canary Islands	Others	Budget (in thousands of €)
Blue Growth	Biotechnology	**MACBIOBLUE** *Proyecto demostrativo y de transferencia tecnológica para ayudar a las empresas a desarrollar nuevos productos y procesos en el ámbito de la Biotecnología Azul de la Macaronesia*					1764,35
	I+D+i	**SMART BLUE** *Red de clusters marino-marítimos regionales para la competitividad PYME de la economía azul*					997,08
	Tourism	**MARCET** *Red Macaronésica de Transferencia de Conocimientos y Tecnologías Interregional y Multidisciplinar para proteger, vigilar y monitorizar los cetáceos y el medio marino, y analizar y explotar de forma sostenible la actividad Turística Asociada*					1212,84
		SMARTDEST *Evaluación y propuesta de estrategia y desarrollo de herramientas para la conversión de las islas del espacio de colaboración como Destinos Turísticos Inteligentes*					1891,36
		MACAROFOOD *Valorización de productos marinos de la Macaronesia: turismo, gastronomía y capacitación profesional*					624,80
		NAUTICOM *Red Náutica de Cooperación en la Macaronesia. Fomento de la internacionalización, la competitividad turística y el Crecimiento Azul de la Macroregión MAC*					983,9
		ECOTUR_AZUL *Desarrollo de un modelo común de ecoturismo para valorizar y proteger los recursos patrimoniales de los territorios costeros y marítimos, contribuyendo a la estrategia de "Crecimiento Azul" del área de cooperación macaronésica*					1049,62

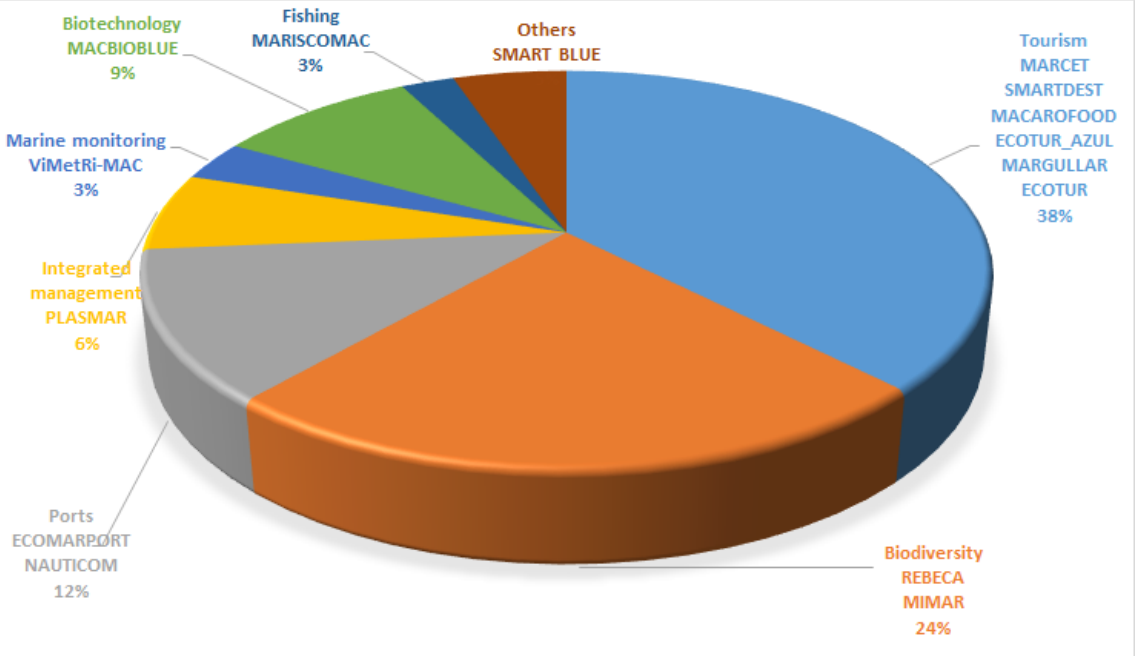
		MARGULLAR *Patrimonio y turismo arqueológico subacuático en la Macaronesia*					1405,74
		ECOTOUR *Valorización de recursos naturales en áreas protegidas costeras como atractivo ecoturístico*					1052,40
	Ports	**ECOMARPORT** *Transferencia tecnológica y eco-innovación para la gestión ambiental y marina en zonas portuarias de la Macaronesia*					1360,71
		MARISCOMAC *Desenvolvimento de bases técnico-científicas, formação e transferência de tecnologia e conhecimento para a exploração, transformação e comercialização de mariscos na Macaronésia*					465,60
Environmental observation		**ViMetRi-MAC** *Sistema de vigilancia meteorológica para el seguimiento de riesgos medioambientales*					621,92
Biodiversity		**REBECA** *Red de excelencia en biotecnología azul (algas) de la región de la Macaronesia*					2352,08
		MIMAR *Seguimiento, control y mitigación de proliferaciones de organismos marinos asociadas a perturbaciones humanas y cambio climático en la Región Macaronésica*					2218,30
Integrated Management		**PLASMAR** *Bases para la Planificación Sostenible de áreas marinas en la Macaronesia*					1216,88

Source: own, based on available data in INTERREG-MAC Program web: https://www.mac-interreg.org

In general, the European projects approved for the marine environment of Macaronesia present a tendency towards certain sectors. For the 2014-2020 period, the number of initiatives framed within the blue growth with tourism as a central reason can stand out.

Indeed, the main investments refer to projects related to the growth or blue economy and focus on achieving the objectives related to the priority axes of the calls, which logically are closely related to the goals of the Marine Space Planning[14] (Figure 47).

Figure 47. Budget percentage of all INTERREG-MAC 2014-2020 projects for the main issues in the marine environment. Source: own elaboration.



It should be noted that in the second period analysed (in force during the elaboration of the present document[15]), the initiatives approved in the first call were considered, leaving out of the analysis the projects that could be approved in the following calls, so that the data cannot be interpreted as definitive for the entire INTERREG-MAC period 2014-2020[16]. However, the increase in initiatives whose objectives are related to fishing and tourism stands out.

In any case, the responses analysed seem to be in line with the aspects analysed in other parts of the present diagnosis. Even so, it is necessary to take into account that a specific and in-depth analysis of marine management in Macaronesia is necessary, taking into account, in addition to the scale of the bioregion, the management carried out by the different autonomous governments of the archipelagos as well as the one made by the national governments of the countries to which they belong. This should be analysed in detail in specific reports on the governance of the region for the MSP.

[14] More information about concepts, terminology and MSP principles available in: http://msp.ioc-unesco.org/msp-good-practices/concepts-and-terminology/

[15] INTERREG-MAC 2014-2020 diagnosis published in June 2018

[16] Note: as of June 2019, the second call for projects INTERREG-MAC 2014-2020 has been published with the new associated project list. For the preparation of these statistics, this update has not been included. Nevertheless, the aforementioned thematic trend remains. For more information: https://www.mac-interreg.org/noticias/detallenoticia.jsp?id=da3dbeb4-4bc6-4701-baba-050687393b57

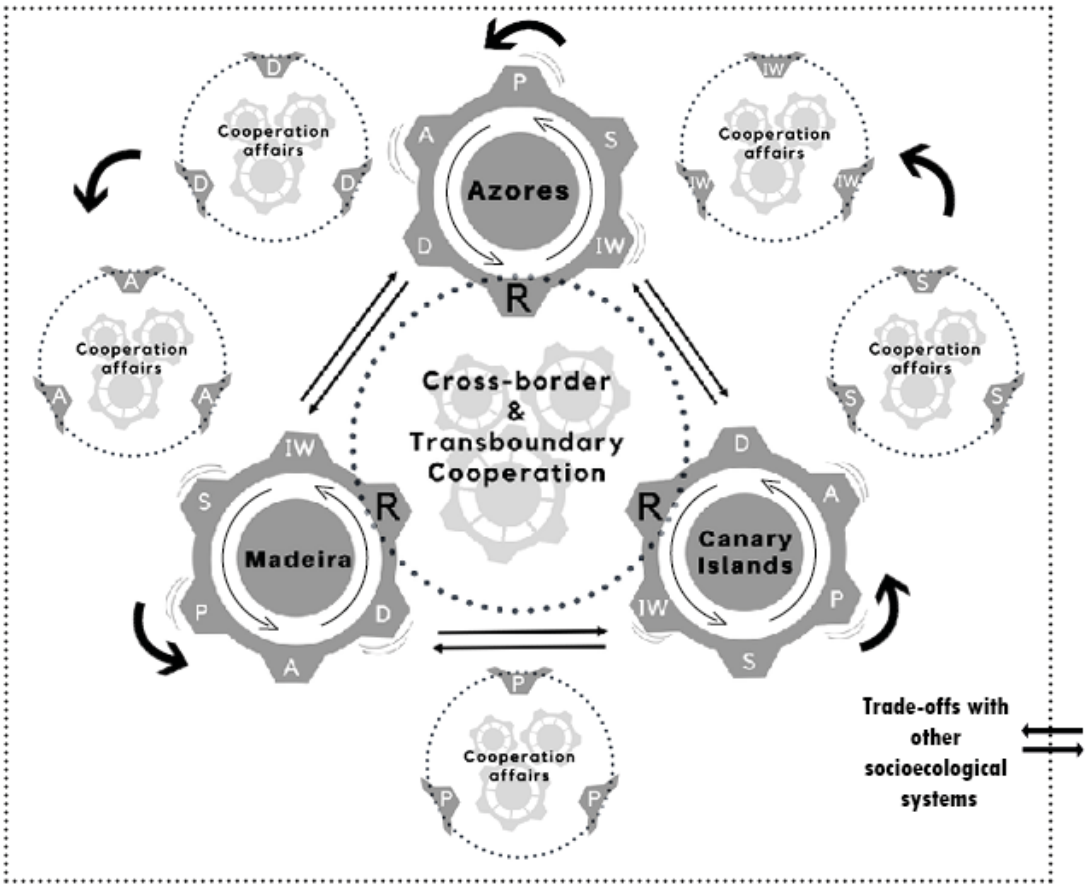
6. CONCLUSIONS

The objective of the present document is to improve the understanding among the archipelagos of Macaronesia and its various actors involved in maritime affairs and, especially, those that facilitate cooperation and cross-border collaboration in the marine planning process.

In this sense, this diagnosis has attempted to provide a cross-sectional and comprehensive vision following a conceptual framework that decomposes marine issues into different elements (Drivers, Activities, Pressures, Changes of State, Impact on Human Well-being and Responses), remarking the existing relationships between them. In this sense, the model used has allowed the identification of issues of interest for cross-border cooperation between the different archipelagos of Macaronesia. However, it also allows to point out some ideas about the approach and direction that could have future actions of the region.

Therefore, the following figure shows how facing the main Driving Forces (D), Activities (A), Pressures (P), Changes of State (S) or Impacts for Human Well-being (IW) that occur in the three archipelagos considered, is possible to identify issues for cooperation in marine spatial planning (R) (Figure 48).

Figure 48. Conceptual framework for cross-border cooperation in Macaronesia



Source: own

Following the conceptual framework considered, the main options identified for cross-border cooperation in MSP will be presented here-under. These appear turning the three wheels of Figure 47 (representing each of them one archipelago) to the different positions D, A, P, S, I (W). Nonetheless, the analysis will begin by considering the existing relationships between archipelagos and between Macaronesia and other external socio-ecological systems (trade-offs).

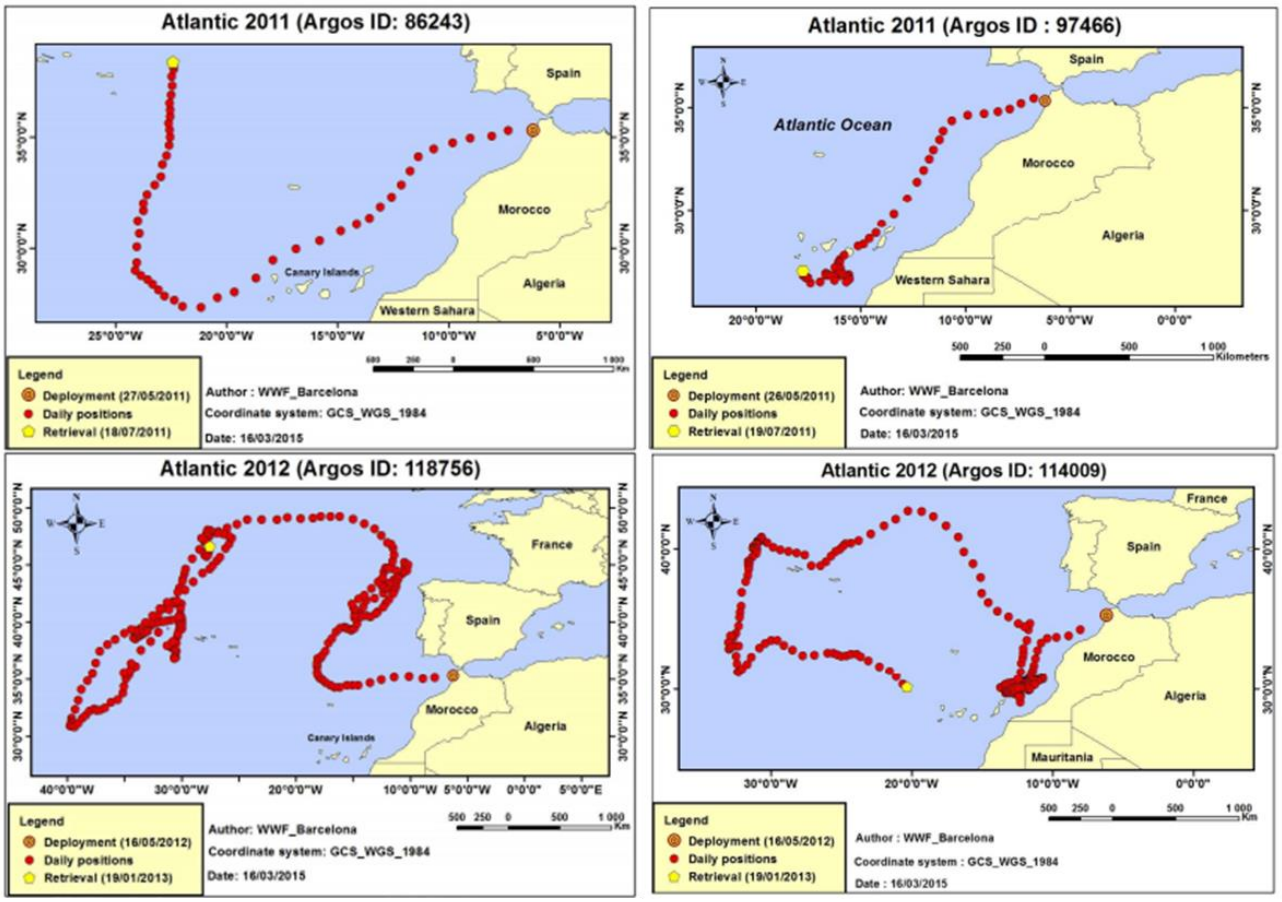
6.1. COMPLEX COOPERATION ISSUES (TRANSBOUNDARY TRADE-OFFS)

Due to the special continuity and connectivity conditions that the marine environment presents, it is necessary to consider the spatial decoupling that often occurs between ecosystem services or between these and pressures exerted on them. In a similar way, it is possible that the same ecosystem service produces a benefit for human welfare in spatially very distant places.

Thus, an alteration in the conditions of the environment that generates services (for example, breeding places) will affect, through a cascade effect, the whole area beyond the place where the alteration occurs. In this sense, a certain activity that exerts a pressure on one of the three archipelagos can induce or contribute to a change of state in another leading to a decrease in an ecosystem service that will have an impact on the human well-being of the neighbour islands. Moreover, these type of relations can also occur with activities and pressures exerted outside the scope of Macaronesia being able to influence an ecosystem service loss in the region. These interactions reflect the relationship of dependence of one service with each other between the same group of islands or between archipelagos within the same socio-ecological system, or even between different bioregions or socio-ecosystems. When the relationship is positive, it is a synergetic relationship (the advantage of one improves the use of the other). When the relationship is negative between ecosystem services (one service undermine another) it is called a "trade-off". In this manner, there may be relations among ecosystem services so that the improvement of one implies the deterioration of the other in the same archipelago.

There are investigations (Chaabani, 2015; Powers and Fromentin, 2005) that point to the migration of tunas between archipelagos of Macaronesia, and between these and waters beyond national jurisdiction (ABNJ). Despite this, there are also tuna migrations that come from other bioregions such as the Mediterranean (Figure 49). This implies the existence of relationships between different socio-ecological systems widening the scope of management to limits that surpass those of the bioregion of Macaronesia. For instance, an increase in fishing pressure on tuna in the Mediterranean may cause a decline in the provisioning service of this tuna species in Macaronesia. A similar situation associated with overfishing in the Gulf of Guinea had already caused a crisis in the sector. This same relationship can be found between the different archipelagos of Macaronesia, and in both cases, the different elements of DAPS (IW) R (see concept map, Figure 6) will have to be addressed if the aim is to have a complete view of the issue to be managed. These relationships can also occur between activities or impacts and not only between pressures.

Figure 49. Example of tunas that passed through Macaronesian archipelagos

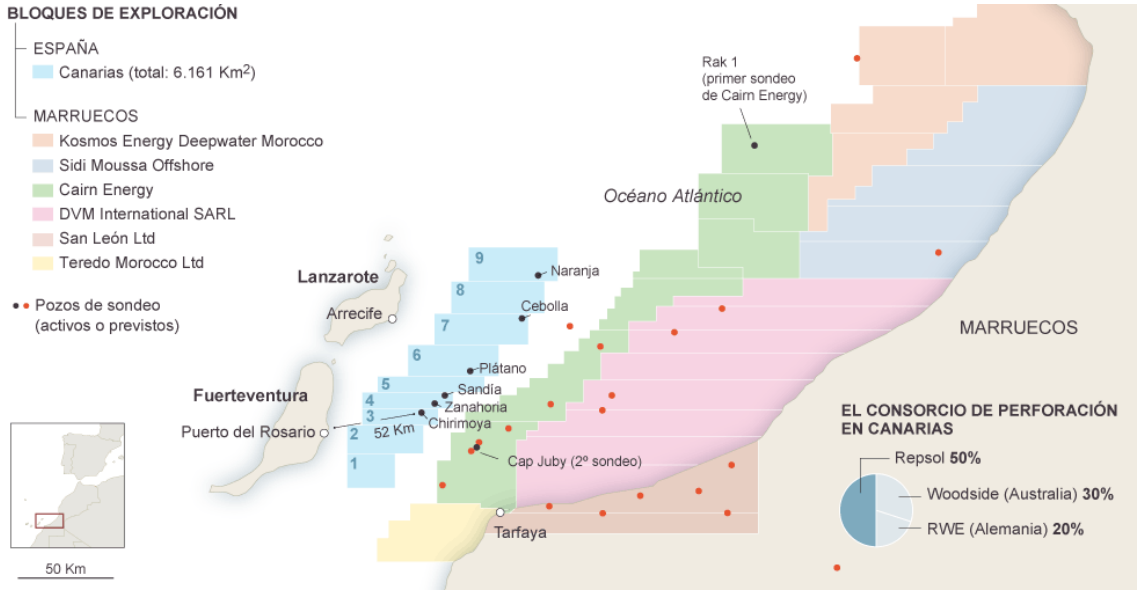


Source: Chaabani, 2015

Another example of interest for cross-border cooperation in Macaronesia is related to the activity of oil extraction in waters off the Canary Islands. In this case, a bag of crude oil exists under the oceanic platform that crosses the hypothetical limits between the Canaries and Moroccan waters (Figure 50).

On the Spanish side, the activity has been limited to oil prospecting, but in the case of Morocco the "Pozo Cabo Juby" is active and located only 45 kilometres from the Canary Island of Lanzarote. It might be a shared oil bag. In this case, the extraction of oil from the Moroccan side will reduce the reservoir and affect the possible future use (potential provisioning service) of the neighbouring country. In the same way, any accident on one side would presumably affect the other. In this case, in addition to considering a cross-border relationship between the archipelagos of the European Macaronesia, there are interactions with third countries.

Figure 50. Oil prospecting and extraction activity between the Canary Islands and Morocco



Source: El País, 2014

6.2. MAIN COOPERATION ISSUES IDENTIFIED

In the first place, and as a basis for any collaboration in Macaronesia, it is necessary to understand and promote the existing common cultural base. The conditions of insularity, isolation and a high sense of belonging are shared in all three archipelagos. In this sense, the recognition of these similarities and the creation of a greater sense of belonging linked to the whole sea basin should be seen as an opportunity. Cooperation could be possible, for example, in the creation of educational materials, the inclusion of the region in school curricula, cultural and informative campaigns, or even in a joint proposal to Spain, Portugal and the EU to provide advantageous conditions for visits by residents to other archipelagos of the region. This contribution to education can, in turn, promote the future development of participatory processes, fundamental in various phases of the MSP. In this regard, a rapprochement between the societies of all three archipelagos in terms of their cultural, social, economic and ecological interrelation is essential also for the proposal of joint participatory processes on issues of cross-border cooperation. Furthermore, cooperation among users of the same sector (for example, fishing) of the three archipelagos should be based on an understanding of the socio-ecological transboundary processes. This is essential for any cooperation participatory process undertaken by the agents involved.

Another issue of great interest is related to the generation of responsible science for Macaronesia. Actions that prioritize the allocation of existing funds to the evaluation of the "trade-offs" occurring at their different scales should be encouraged as well as proposing the coordinated gathering of information on key aspects, perhaps by creating a scientific coordination body for the region. Research must also be linked to management needs linked to insularity, such as those related to sustainable solutions in the field of energy, water purification, etc.

On the other hand, the Macaronesian region can and must coordinate to make joint proposals aimed at guiding specific European Union policies for the sea basin. Key issues such as the blue growth policy should be complemented in the region with analysis of the carrying capacity of territories (such as islands) with limited resources. The promotion of tourism and population growth should avoid falling into unplanned growth that addresses short-term vested interests and compromises the islands' capacity for their future development while making them increasingly dependent on external inputs that are not able to control. These and other issues must be debated, coordinated and agreed upon in terms of influencing the regional policies of the European Union for Macaronesia.

More concretely, there are important opportunities in various issues. In relation to aquaculture, there is a wide experience in the Canary archipelago that could be beneficial for the other island systems. Madeira has an incipient development of this activity, whereas the Azores have not yet begun to develop it. Collaboration in this matter could be beneficial for the whole. On the one hand because it generates benefits and well-being and on the other because if developed correctly it can be an alternative to overfishing of some species or fishing grounds. This same possibility can occur with the processing industry, in this case, based on the good practices developed in the Azores for the conservation of tuna with certified sustainable fishing.

There are important opportunities in relation to the development of tourism in Macaronesia. On the one hand, the Canary Islands and Madeira have a developed and mature sector and on the other, the Azores is currently on a developing stage with new airlines connecting the islands with the mainland that may lead to the growth of the sector. Opportunities related to the exchange of experiences and lessons learned are obvious, but also collaboration to create a common touristic image of Macaronesia. Strengthening the region as a destination for cruises that travel to the three archipelagos, or the promotion of tourist packages that allow the possibility of visiting several islands of the different archipelagos are more future opportunities that could be considered. As there are studies that point to the movement of cetaceans throughout the different archipelagos (Wenzel et al., 2009) [17], other possibility could be the collaboration in the tourist exploitation of whale watching.

In relation to fishing, cooperation and collaboration are essential. On the one hand, the Spanish and Portuguese States have powers up to the Territorial Sea and the Exclusive Economic Zone (to which is added the extended continental shelf), but fishing activities can be developed beyond any administrative limit (under national or international activity regulations).

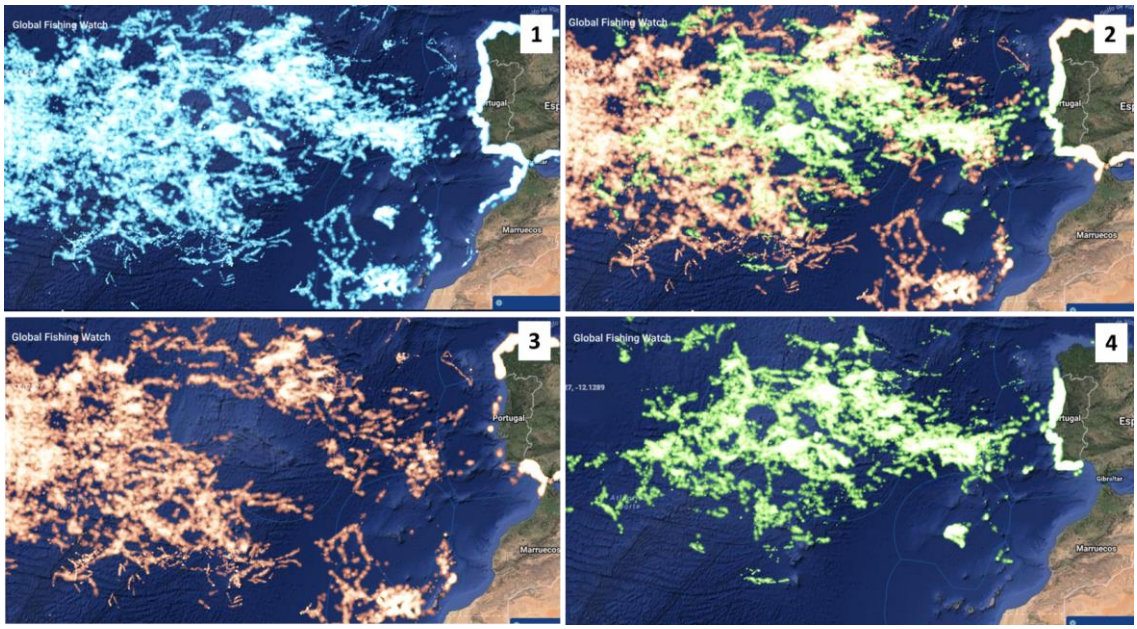
In this sense, cooperation can be directed to cooperate in cross-border spaces, but also to collaborate (agree, negotiate, participate, coordinate, etc.) in monitoring, regulation, empowerment, etc. of maritime fishing activities (Figure 51). This regulation-cooperation can refer to what the activity of each country can and cannot do in the neighbouring region and in the environment of its jurisdictional waters, but also to the sum (collaboration) of the efforts of regulation and management of fishing stocks or shared migratory species of the region.

Another important issue for fisheries is the importance of improving the information available. For example, data of "landed fishing" normally used in the three archipelagos, is not the same as the biomass data extracted in the marine area of Macaronesia, its immediate

[17] Current Knowledge on the Distribution and Relative Abundance of Humpback Whales (*Megaptera novaeangliae*) off the Cape Verde Islands, Eastern North Atlantic. Frederick W. Wenzel, Judith Allen, Simon Berrow, Cornelis J. Hazevoet, Beatrice Jann, Rosemary E. Seton, Lisa Steiner, Peter Stevick, Pedro López Suárez, and Padraig Whooley. *Aquatic Mammals* 2009, *35*(4), 502-510, DOI 10.1578/AM.35.4.2009.502

environment and that can be landed in other ports. In this sense, it is logical to ask how much of the fish extracted in waters outside Portuguese and Spanish national jurisdictions affect the Macaronesian ecosystems.

Figure 51. Fishing vessels fishing in the jurisdictional waters of the European Macaronesia and its surrounding area between the months of January and May of 2018



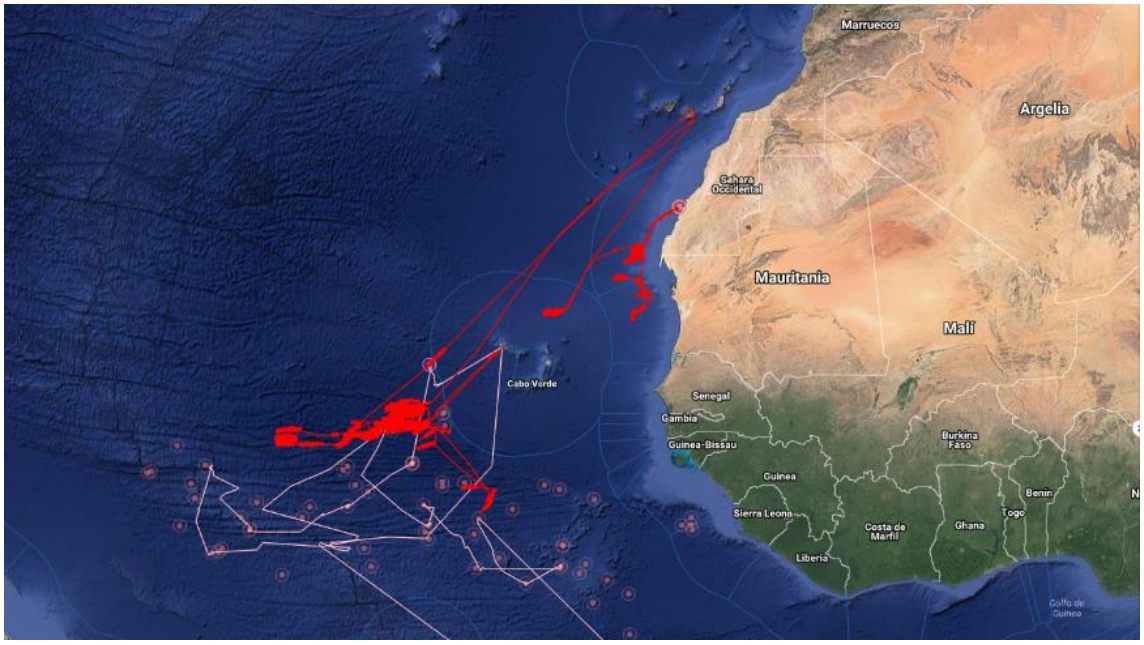
(1); of the total number of vessels, fishing vessels of Spanish flag (in red) and Portuguese (in green) have been highlighted (2); exclusively, fishing vessels of Spanish flag (3); exclusively, Portuguese flag vessels (4)Source: Global Fishing Watch

To the above, two issues of great interest must be added. Firstly, the illegal, unregulated and unreported fishing (IUU) and secondly, the practices of possible illegal transhipment involving fishing vessels with ports in the Canary Islands, but carrying out their fishing and transhipment activities in distant waters, mainly in Africa and Cape Verde. This implies a transfer of pressure by activities originating in Macaronesia and regulated by Spanish legislation to other socio-ecosystems (see Figure 52).

Regarding the transhipment activity in the marine area of Macaronesia, although no cases have been detected directly through the Global Fishing Watch system, as noted in Galland, et al. (2018) it is necessary to consider that many fishing vessels may be too small to transmit AIS[18] or may have intentionally disabled their devices, resulting in cases in which only the transhipment vessel is visible in AIS (INTERPOL, 2014). In the case of the islands of Macaronesia where the majority of the fleet are small boats, the presence of these transhipment vessels is of particular concern and must be specially monitored.

[18] Automatic Identification System (en español, Sistema de Identificación Automática) para buques

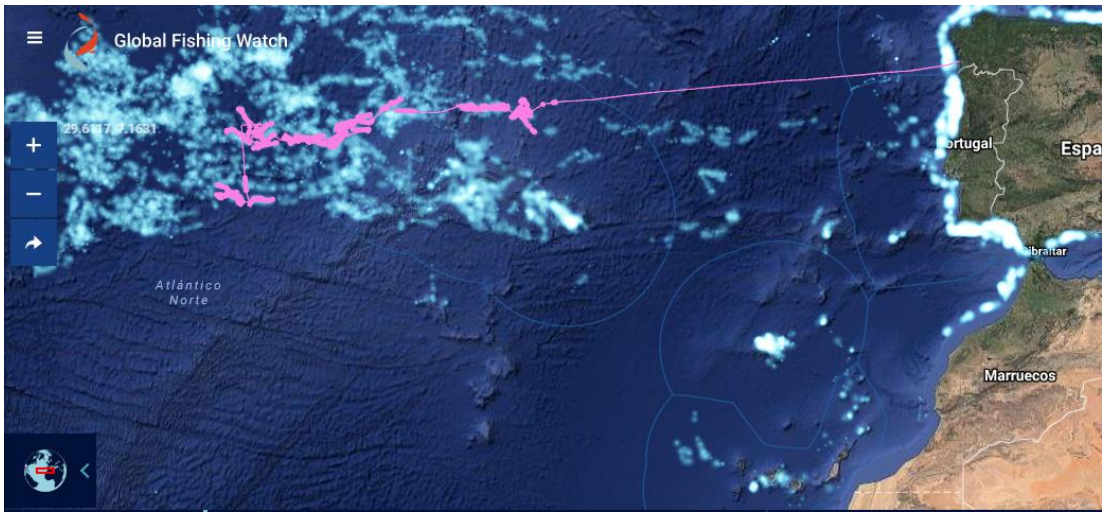
Figure 52. Example of cases of "transhipment" of fishing boats originating in the Canary Islands



Source: Global Fishing Watch, 2018

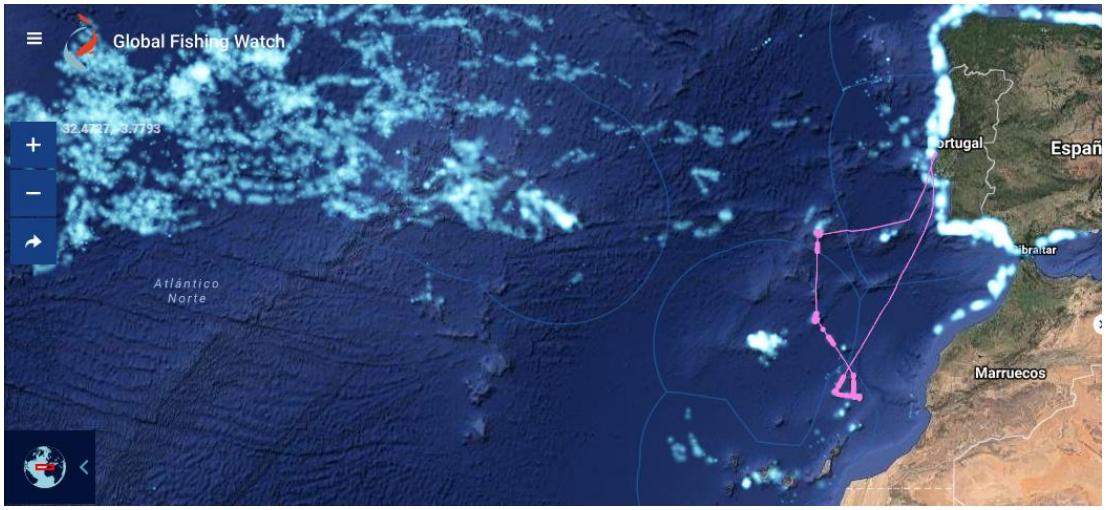
On the other hand, there are also detected cases where other external fleets extract fishing resources in the Macaronesia that are then landed in continental ports, making the evaluation of the ecosystem service status very difficult (Figures 53 and 54).

Figure 53. Example of a Spanish flag vessel that operates in the Azores and disembarks in Galicia



Source: Global Fishing Watch, 2018

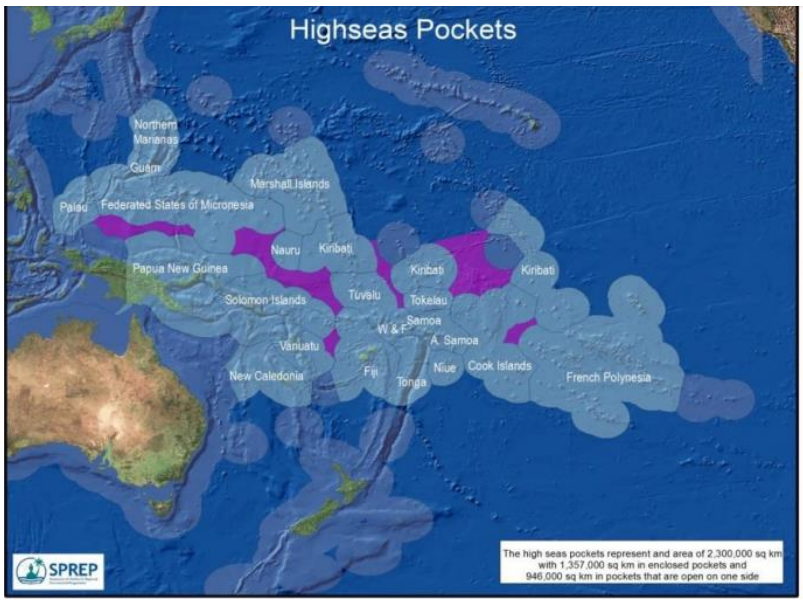
Figure 54. Portuguese flag vessel that works in the Canary Islands and disembarks in Lisbon



Source: Global Fishing Watch, 2018

Finally, it is important to reach agreements in areas of the high seas that are encapsulated by the EEZs of the different archipelagos of Macaronesia. When these areas are fully encapsulated they are internationally known as "high seas pockets" or "high seas areas enclosed". There are already references to fishing agreements for migratory species such as tuna at the Noumea Convention in 1985 and the Nauru Arrangement in Oceania (Figure 55).

Figure 55. Regional Seas Program that covers areas beyond national jurisdictions



Source: UN, 2017.Available in: http://www.un.org/Depts/los/biodiversityworkinggroup/Regional_seas_programmes_ABNJ.pdf

Finally, it is very important to collaborate in the regulation of maritime traffic in Macaronesia (fishing, passengers, freight, etc.) by establishing routes and obligatory steps to the different fishing grounds and ports. The example of the Canary Islands with the declaration of the PSSA by the IMO can serve as inspiration in this regard.

Regarding emerging activities, renewable energies have a great development potential in the islands as proved by the different pilot projects undertaken in each archipelago with the use of different energy sources. Given the insular condition, remoteness and isolation of Macaronesia, collaboration in this sense becomes fundamental as well as in other activities such as biotechnology or mining, especially in border areas.

All the above must be taken as an example of the potential to cooperate in possible planning initiatives of the marine space of Macaronesia. These initiatives come from a previous analysis that has tried to highlight the relationships between the different maritime issues and their consequences on human well-being.

Therefore, the main conclusion is that processes of Marine Spatial Planning in the region of the European Macaronesia should be developed from a holistic approach, overcoming partial visions and prioritizing the understanding of common interrelationships and processes. For this, cross-border cooperation, overcoming administrative barriers and taking advantage of common opportunities, problems and physical and cultural conditions, are essential.

7. REFERENCES

Abecasis, R.C., Afonso, P., Colaço, A., Longnecker, N., Clifton, J., Schmidt, L., Santos, R.S., 2015. Marine Conservation in the Azores: Evaluating Marine Protected Area Development in a Remote Island Context . Front. Mar. Sci. .

Afonso, P., Porteiro, F.M., Fontes, J., Tempera, F., Morato, T., Cardigos, F., Santos, R.S., 2013. New and rare coastal fishes in the azores islands: Occasional events or tropicalization process? J. Fish Biol. 83, 272–294. https://doi.org/10.1111/jfb.12162

Agardy, T., Davis, J., Sherwood, K., Vestergaard, O., 2011. Taking Steps toward Marine and Coastal Management. UNEP.

Autoridad Portuaria de Las Palmas, 2017. Memoria Anual 2016.

Autoridad Portuaria de Santa Cruz de Tenerife, 2017. Memoria de Actividades 2016.

Brito, A., Falcón, J.M., Herrera., R., 2005. Sobre la tropicalización reciente de la ictiofauna litoral de las islas Canarias y su relación con cambios ambientales y actividades antrópicas. VIERAEA 33, 515–525.

Brito, A., López, C., Ocaña, O., Herrera, R., Moro, L., Monterroso, O., Rodríguez, A., Clemente, S., Sánchez, J., 2017. Colonización y expansión en Canarias de dos corales potencialmente invasores introducidos por las plataformas petrolíferas. VIERAEA 45, 65–72.

Bruno, M., 2008. Suratlántico y Macaronesia, in: Mares de España: The Seas of Spain. Secretaría General del Mar. Ministerio de Medio Ambiente, y Medio Rural y Marino.

Buhl-Mortensen, L., Galparsoro, I., Vega Fernández, T., Johnson, K., D'Anna, G., Badalamenti, F., Garofalo, G., Carlström, J., Piwowarczyk, J., Rabaut, M., Vanaverbeke, J., Schipper, C., van Dalfsen, J., Vassilopoulou, V., Issaris, Y., van Hoof, L., Pecceu, E., Hostens, K., Pace, M.L., Knittweis, L., Stelzenmüller, V., Todorova, V., Doncheva, V., 2017. Maritime ecosystem-based management in practice: Lessons learned from the application of a generic spatial planning framework in Europe. Mar. Policy 75, 174–186. https://doi.org/10.1016/j.marpol.2016.01.024

Castro, J., Divovich, E., Delgado de Molina, A., Barrera-Luján, A., 2015. Over-looked and under-reported: A catch reconstruction of marine fisheries in the Canary Islands, Spain, 1950–2010, Working papers by Fisheries Centre, University of British Columbia.

Chaabani, S., 2015. Estudio sobre el comportamiento migratorio y de reproducción del atún rojo del Atlántico oriental y del Mediterráneo (Thunnus thynnus) en el Mediterráneo occidental y central y en el Atlántico oriental. Tesis Master of science en gestión pesquera sostenible.

Clemente, S.; Lorenzo-Morales, J.; Mendoza, J.C.; López, C.; Sangil, C.; Alves, F.; Kaufmann, M.; Hernández, J.C., 2014. Sea urchin Diadema africanum mass mortality in the subtropical Eastern Atlantic: role of waterborne bacteria in a warming ocean. Mar. Ecol. Prog. 506, 1–14.

Comisión de Pesca de la Unión Europea, 2002. Informe de la visita de una delegación a la Región Autónoma de las Azores del 17 al 19 de julio de 2002.

De Girolamo, M., Torboli, V., Pallavicini, A., Isidro, E., 2017. Genetic diversity and structure of Megabalanus azoricus in the Azores: Implications for aquaculture management. J. Sea Res. 129, 53–60. https://doi.org/10.1016/j.seares.2017.09.004

EASME, 2017a. Annex 12 to the final report. The Blue Economy in the Macaronesia Sea Basin, in: European Commission (Ed.), Realising the Potential of the Outermost Regions for Sustainable Blue Growth. Publications Office of the European Union, Brussels, p. 77. https://doi.org/10.2826/44237

EASME, 2017b. Annex 7 to the final report. The blue economy in the Azores, in: Realising the Potential of the Outermost Regions for Sustainable Blue Growth. European Commission, Brussels, p. 80. https://doi.org/10.2826/765231

EASME, 2017c. Annex 8 to the final report. The blue economy in Madeira, in: Realising the Potential of the Outermost Regions for Sustainable Blue Growth. European Commission, Brussels, p. 83. https://doi.org/10.2826/2810

EASME, 2017d. Annex 9 to the final report. The blue economy in the Canary Islands, in: Realising the Potential of the Outermost Regions for Sustainable Blue Growth. p. 129. https://doi.org/10.2826 / 64901

EEA, 2015a. State of Europe's seas, EEA Report No 2/2015. European Environment Agency, Copenhagen, Denmark.

EEA, 2015b. Marine protected areas in Europe's seas. An overview and perspectives for the future, EEA Report No 3/2015,. European Environment Agency, Copenhagen, Denmark.

EEA, 1998. European Environment Agency. Annual Report 1997. Copenhagen.

Elliott, M., 2014. Integrated marine science and management: Wading through the morass. Mar. Pollut. Bull. 86, 1–4. https://doi.org/10.1016/j.marpolbul.2014.07.026

Elliott, M., Burdon, D., Atkins, J.P., Borja, A., Cormier, R., de Jonge, V.N., Turner, R.K., 2017. "And DPSIR begat DAPSI(W)R(M)!" - A unifying framework for marine environmental management. Mar. Pollut. Bull. 118, 27–40. https://doi.org/10.1016/j.marpolbul.2017.03.049

Espino, F., González, J.A., Boyra, A., Fernández, C., Tuya, F., Brito., A., 2014. Diversity and biogeograpy of fishes in the Arinaga-Gando area, East coast of Gran Canaria (Canary Islands). Rev. la Acad. Canar. Ciencias 25, 9–25.

European Commission, 2017. Territorial Cooperation Operative Program (Interreg V-A) España-Portugal (Madeira-Açores-Canarias [MAC]) 2014-2020.

European Environmental Agency, 2018. European Bathing Water Quality in 2017., in: EEA Report. Nº2/2018.

European Union, 2014. Directive 2014/89/EU of the European Parliment and of the Council of 23 July 2014 establishing a framework for maritime spatial planning. Off. J. Eur. Union 135–145.

Falcón, J.M., 2015. Ictiofauna de las Islas Canarias. Análisis biogeográfico. Universidad de La Laguna.

Falcón, J.M., Herrera, R., Ayza, O., Brito, A., 2015. New species of tropical litoral fish found in Canarian waters. Oil platforms as a central introduction vector. Rev. la Acad. Canar. Ciencias 27, 67–82.

Galland, G.R., Nickson, A.E.M., Hopkins, R., Miller, S.K., 2018. On the importance of clarity in scientific advice for fisheries management. Mar. Policy 87, 250–254. https://doi.org/10.1016/j.marpol.2017.10.029

García-Onetti, J., García-Sanabria, J., 2007. La gestión integrada de zonas costeras en territorios insulares. Universidad de Cádiz.

García-onetti, J., Scherer, M.E.G., Barragán, J.M., 2018. Integrated and ecosystemic approaches for bridging the gap between environmental management and port management. J. Environ. Manage. 206, 615–624. https://doi.org/10.1016/j.jenvman.2017.11.004

Gil Fernández, C., Paulo, D., Serrão, E.A., Engelen, A.H., 2016. Limited differences in fish and benthic communities and possible cascading effects inside and outside a protected marine area in Sagres (SW Portugal). Mar. Environ. Res. 114, 12–23.

https://doi.org/10.1016/j.marenvres.2015.12.003

Gobierno de Canarias, 2012. Informe sobre la Evolución del Sector de los Cultivos Marinos de peces en Canarias, in: Plan Estratégico de La Acuicultura En Canarias PEACAN (2014-2020).

Hernández, C.L., Perales, C., Pascual, P., Martín, P., Jiménez, S., García-Santamaría, M.T., López-Abellán, L., Sarralde, R., Gonzalez-Irusta, J.M., Delgado de Molina, A., Arrese, B., Druet, M., Acosta, J., Lens, S., Bellas, J., de Armas, D., 2012. Estrategia Marina Demarcación Marina Canaria. Evaluación Inicial. Parte I: Marco general, evaluación inicial y buen estado ambiental. Instituto Español de Oceanografía. Ministerio de Agricultura, Alimentación y Medio Ambiente.

Hernández, J.C., Clemente, S., Sangil, C., Brito, A., 2008. The key role of the sea urchin Diadema aff. antillarum in controlling macroalgae assemblages throughout the Canary Islands (eastern subtropical Atlantic): An spatio-temporal approach. Mar. Environ. Res. 66, 259–270. https://doi.org/10.1016/j.marenvres.2008.03.002

Hernández Luis, J.A., González Morales, A., Hernández Torres, S., Ojeda, A.A.R., 2017. The impact of mass tourism in the Canary Islands in the context of world biosphere reserves. Cuad. Tur. 685–688. https://doi.org/10.6018/turismo.40.309751

Hernández Pérez, J.C., 2006. Estrategia reproductiva de la población canaria del erizo Diadema aff. Antillarum Philippi, 1845: maduración gonadal, asentamiento larvario y reclutamiento.

Herrero, C., Soler, A., Villar, A., 2013. Desarrollo humano en España: 1980-2011. Ivie, Valencia.

INE, 2018a. Viajeros por comunidades autónomas 2017. Instituto Nacional de Estadística de España.

INE, 2018b. Hóspedes nos estabelecimentos hoteleiros por Localização geográfica 2017.

INE, 2017a. Resident population by place of residence.

INE, 2017b. Población por comunidades autónomas y sexo.

INE, 2017c. Viajeros y pernoctaciones por comunidades autónomas y provincias.

INE, 2016a. Porto declarante e tipo de fluxo das embarcações Portugal.

INE, 2016b. Estatísticas da Pesca 2016. Instituto Nacional de Estatística Portugal. https://doi.org/0377-225-X

INTERPOL, 2014. Study on Fisheries Crime in the West African Coastal Region. 1–64.

Interreg, 2017. Programa operativo de cooperación territorial (INterreg V-A) España- Portugal (Madeira-Açores-Canarias [MAC]) 2014-2020.

Kelble, C.R., Loomis, D.K., Lovelace, S., Nuttle, W.K., Ortner, P.B., Fletcher, P., Cook, G.S., Lorenz, J.J., Boyer, J.N., 2013. The EBM-DPSER Conceptual Model: Integrating Ecosystem Services into the DPSIR Framework. PLoS One 8. https://doi.org/10.1371/journal.pone.0070766

Lloret, A., del Barrio, I., Moreno, I.M., 2012. Estrategia Marina Demarcación Marina Canaria. Evaluación Inicial. Parte II: Análisis de presiones e impactos. CEDEX. Ministerio de Agricultura, Alimentación y Medio Ambiente.

Lukic, I., Schultz-Zehden, A., Fernandez, J., Pascual, M., Nigohosyan, D., Maarten de Vet, J., 2018. Maritime Spatial Planning (MSP) for Blue Growth. Final Technical Study. European Commission, Brussels. https://doi.org/10.2826/04538

MAPAMA, 2017a. Producción acuícola de Lenguado Senegalés (Solea senegalensis) Canarias 2010-2016. Ministerio de Agricultura y Pesca Alimentación y Medio Ambiente.

MAPAMA, 2017b. Producción acuícola de Lubina o Róbalo (Dicentrarchus labrax) Canarias

2010-2016.

MAPAMA, 2017c. Producción acuícola de Dorada (Sparus aurata) Canarias 2010-2016.

Martín-García, L., Brito-Izquierdo, T., Brito-Hernández, A., Barquín-Diez, J., 2015. Changes in benthic communities due to submarine volcanic eruption: black coral (Antipathella wollastoni) death in the Marine Reserve of El Hierro (Canary Islands). Rev. Acad. Canar. Cienc XXVII, 345–353.

Martín-Sosa, P., Revenga, S., 2008. Seguimiento científico de las reservas marinas canarias. Rev. del Inst. Español Oceanogr. 10, 41–50.

Miguel, M., Nogueira, T., Martins, F., 2017. Energy storage for renewable energy integration: The case of Madeira Island, Portugal. Energy Procedia 136, 251–257. https://doi.org/10.1016/j.egypro.2017.10.277

Murawski, S.A., 2007. Ten myths concerning ecosystem approaches to marine resource management. Mar. Policy 31, 681–690. https://doi.org/10.1016/j.marpol.2007.03.011

National Tourism Authority of Portugal, P., 2013. Marinas e portos [WWW Document]. URL https://www.visitportugal.com/pt-pt/print/search?context=395 (accessed 11.11.19).

Nelson, G.C., Bennett, E., Berhe, A.A., Cassman, K., DeFries, R., Dietz, T., Dobermann, A., Dobson, A., Janetos, A., Levy, M., Marco, D., Nakicenovic, N., O'Neill, B., Norgaard, R., Petschel-Held, G., Ojima, D., Pingali, P., Watson, R., Zurek, M., 2006. Anthropogenic drivers of ecosystem change: an overview. Ecol. Soc. 11.

Ojamaa, P., 2015. Fisheries in Azores. European Parliament Committee on Fisheries. https://doi.org/10.1017/CBO9781107415324.004

Pajuelo, J.G., Gonzalez, J.A., Triay-Portella, R., Martin, J.A., Ruiz-Diaz, R., Lorenzo, J.M., Luque, A., 2016. Introduction of non-native marine fish species to the Canary Islands waters through oil platforms as vectors. J. Mar. Syst. 163, 23–30. https://doi.org/10.1016/j.jmarsys.2016.06.008

Pearson, T.H., Black, K.D., 2001. The environmental impacts of marine fish cage culture, in: Black, K.D. (Ed.), Environmental Impacts of Aquaculture. Sheffield Academic Press, pp. 1–27.

Portos dos Açores, 2016. Relatório de Gestão e Contas do exercício 2016.

Powers, J.E., Fromentin, J.-M., 2005. Atlantic bluefin tuna: population dynamics, ecology, fisheries and management. FISH Fish. 6, 281–306.

RegioPlus Consulting, 2014. Diagnóstico Territorial y Análisis DAFO del espacio de cooperación MAC Documento de trabajo para la elaboración del: Programa de Cooperación Madeira-Açores-Canarias.

Rustici, M., Ceccherelli, G., Piazzi, L., 2017. Predator exploitation and sea urchin bistability: Consequence on benthic alternative states. Ecol. Modell. 344, 1–5. https://doi.org/10.1016/j.ecolmodel.2016.10.021

Sangil, C., Martín-García, L., Clemente, S., 2013a. Assessing the impact of fishing in shallow rocky reefs: A multivariate approach to ecosystem management. Mar. Pollut. Bull. 76, 203–213. https://doi.org/10.1016/j.marpolbul.2013.08.041

Sangil, C., Martín-García, L., Hernández, J.C., Concepción, L., Fernández, R., Clemente, S., 2013b. Impacts of fishing and environmental factors driving changes on littoral fish assemblages in a subtropical oceanic island. Estuar. Coast. Shelf Sci. 128, 22–32. https://doi.org/10.1016/j.ecss.2013.04.023

Sangil, C., Sansón, M., Clemente, S., Afonso-Carrillo, J., Hernández, J.C., 2014. Contrasting the species abundance, species density and diversity of seaweed assemblages in alternative

states: Urchin density as a driver of biotic homogenization. J. Sea Res. 85, 92–103. https://doi.org/10.1016/j.seares.2013.10.009

Sarà, G., Scilipoti, D., Milazzo, M., Modica, A., 2006. Use of stable isotopes to investigate dispersal of waste from fish farms as a function of hydrodynamics. Mar. Ecol. Prog. Ser. 313, 261–270.

Silva, R., Ferreira-Lopes, A., 2014. A Regional Human Development Index for Portugal. Soc. Indic. Res. 118, 1055.

SRA, 2014. Estratégia Marinha para a subdivisão da Madeira. Diretiva Quadro Estratégia Marinha. Secretaria Regional do Ambiente e dos Recursos Naturais. Secretaria Regional do Ambiente e dos Recursos Naturais.

SRA (Secretaria Regional do Ambiente e dos Recursos Naturais), 2014. Estratégia Marinha para a subdivisão da Madeira. diretiva Quadro Estratégia Marinha.

SRMCT, 2014. Estratégia Marinha para a subdivisão dos Açores. Diretiva Quadro Estratégia Marinha. Secretaria Regional dos Recursos Naturais.

Suárez de Vivero, J.L., 2018. Macaronesia MarSP Atlas (Draft). European Parliament.

Toledo Guedes, K., Sánchez-Jerez, P., González-Lorenzo, G., Brito Hernández, A., 2009. Detecting the degree of establishment of a non-indigenous species in coastal ecosystems: Sea bass Dicentrarchus labrax escapes from sea cages in Canary Islands (Northeastern Central Atlantic). Hydrobiologia 623, 203–212. https://doi.org/10.1007/s10750-008-9658-8

Tuya, F., Boyra, A., Hauron, R.J., 2004. Blanquizales en Canarias.

UNCLOS, 1982. United Nations Convention on the Law of the Sea.

Vélez Belchí, P., González Carballo, M., Pérez Hernández, M.D., Hernández Guerra, A., 2015. Open ocean temperature and salinity trends in the Canary Current Large Marine Ecosystem, in: Valdés, L., Déniz-González, I. (Eds.), Oceanographic and Biological Features in the Canary Current Large Marine Ecosystem. IOC-UNESCO, Paris.

Wenzel, F.W., Allen, J., Berrow, S., Hazevoet, C.J., Jann, B., Seton, R.E., Steiner, L., Stevick, P., Suárez, P.L., Whooley, P., 2009. Current knowledge on the distribution and relative abundance of humpback whales (Megaptera novaeangliae) off the Cape Verde Islands, Eastern North Atlantic. Aquat. Mamm. 35, 502–510. https://doi.org/10.1578/AM.35.4.2009.502

ANNEX I. Key concepts

In this section, a series of key concepts are defined for the construction of a conceptual base and the subsequent development of the diagnosis. Without intending to constitute an exhaustive glossary, it seeks to unify the basic terminology for marine spatial planning

- **Marine (or maritime) spatial planning (MSP):** a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process. As part of this political process, the delimitation of boundaries is fundamental. In most cases, they are defined by political and jurisdictional boundaries, which normally do not correspond to the limits of maritime activities or ecosystems (IOC-UNESCO, 2018).
- **Ocean zoning:** It is an important management action to promote the implementation of comprehensive marine spatial management plans. Generally, through a map or zoning maps and regulations for some or all areas of a marine region. The zoning of the oceans is an effective MSP tool (IOC-UNESCO, 2018). It contributes to minimize the conflicts caused by the overlapping of incompatible activities or uses. Ocean zoning addresses the interaction between them through a holistic vision that guarantees the provision of ecosystem services. This converts it into an operational EBM tool for MSP (Agardy, 2010).
- **Coastal waters:** means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters (Directive 2000/60/EC).
- **Marine waters:** according to the Marine Strategy Framework Directive 2008/56/EC definition, **(a)** waters, the seabed and subsoil on the seaward side of the baseline from which the extent of territorial waters is measured extending to the outmost reach of the area where a Member State has and/or exercises jurisdictional rights, in accordance with the Unclos, with the exception of waters adjacent to the countries and territories mentioned in Annex II to the Treaty and the French Overseas Departments and Collectivities; and, **(b)** coastal waters as defined by Directive 2000/60/EC, their seabed and their subsoil, in so far as particular aspects of the environmental status of the marine environment are not already addressed through that Directive or other Community legislation.
- **Marine region:** regions and their subregions that have been designated for the purpose of facilitating implementation of the Marine Strategy Framework Directive 2008/56/EC and are determined taking into account hydrological, oceanographic and biogeographic features (Directive 2008/56/EC).
- **Outermost regions:** regions among which Azores, Madeira and the Canary Islands are considered. The outermost regions have to cope with a number of specific constraints such as remoteness, insularity, small size, difficult topography and climate, and economic dependence on only a few products. The combination of these factors over time severely hinders the regions' socio-economic development (European Commission glossary).

- **River basin district**: means the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified (…) as the main unit for management of river basins (Water Policy Framework Directive 2000/60/EC).
- **Ecosystem services:** nature components directly enjoyed, consumed or used to produce human well-being (Boyd and Banzhaf, 2007). They are the contribution that ecosystems make to human well-being, highlighting the ecological results that the characteristics or processes of the ecosystem in particular generate, and that can ultimately benefit people. The classification of ecosystem services aims to classify and identify the purposes or uses that people have for different types of ecosystem services and associate them with the particular ecosystem attributes or behaviors that support them (Haines-Young, R. and MB Potschin, 2018).
- **Ecosystem Based Management (EBM):** the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity (HELCOM/OSPAR, 2003). The objective of EBM in the marine environment is to maintain marine ecosystems in a healthy, productive and resilient condition so that they can sustain ocean human uses and provide the goods and services that human beings want and need (McLeod et al., 2005). While there are ecosystem approaches to marine management that are not necessarily site-based, in most cases marine ecosystems are fixed in space. Therefore, the spatial component is intrinsically critical in the concept of ecosystem-based management, which justifies the notion of EB-MSM.
- **Good environmental status (Marine Strategy Framework Directive 2008/56/EC):** means the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations, i.e.:
    - (a) the structure, functions and processes of the constituent marine ecosystems, together with the associated physiographic, geographic, geological and climatic factors, allow those ecosystems to function fully and to maintain their resilience to human-induced environmental change. Marine species and habitats are protected, human-induced decline of biodiversity is prevented and diverse biological components function in balance;
    - (b) hydro-morphological, physical and chemical properties of the ecosystems, including those properties which result from human activities in the area concerned, support the ecosystems as described above. Anthropogenic inputs of substances and energy, including noise, into the marine environment do not cause pollution effects.
- **Dynamic ocean management (DOM):** because the human-ocean system is dynamic, DOM is a management system that changes in space and time that responds to the shifting nature of the ocean and its users based on the integration of current biological, oceanographic, social, and/ or economic data. DOM can be particularly useful for

managing species or oceanographic areas (feeding or breeding areas) that migrate or move in time; DOM can reduce conflicts by limiting restrictions to a sequence of small spatial areas rather than a large fixed-scale area (IOC-UNESCO, 2018).

- **Blue Growth:** according to the European Commission, "blue growth" is a long-term strategy to support "sustainable growth" in the marine and maritime sectors as a whole. It is the maritime contribution to achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth. The strategy consists of three components: (1) develop sectors that have a high potential for sustainable jobs and growth; (2) essential components to provide knowledge, legal certainty and security in the blue economy; and (3) sea basin strategies to ensure tailor-made measures and to foster cooperation among countries (IOC-UNESCO, 2018).
- **Blue Economy:** no specific definition of the term, the "Blue Economy" exists. For some, it means the "use of the sea and its resources for sustainable economic development"; for others, it includes "any economic activity in the maritime sector, whether sustainable or not". In the context of MSP, the goals and objectives of the plan should identify the desired outcomes—and the relative balance of economic development and marine conservation (IOC-UNESCO, 2018).
- **Planning:** a management activity that through analysis generates information for decision-making. It is the process of deciding who gets what, when, and where, how, at what costs, and who pays the costs? Planning should be organized to generate information at various points in time. A continuous activity of planning should exist to generate information for management that responds to changing conditions, i.e., adaptive management (IOC-UNESCO, 2018).
- **Socioecological system:** bio-geophysical units to which one or more social systems, delimited by different actors and institutions, are associated. The bio-geophysical units are conformed by ecosystems and social systems that are composed at the same time by ecosystem services users and formal and non-formal institutions. These, regulate the relations within the social system and the social system with the natural system (Martín-López et al., 2012).

ANNEX II. Reference platforms and information sources

- **MSP-Platform:** The European MSP platform is an information and communication gateway designed to offer support to all EU Member States in their efforts to implement maritime spatial planning (MSP) in the coming years. With the adoption of the EU Maritime Spatial Planning Directive (2014/89 / EU), all EU coastal Member States must prepare cross-sectoral maritime spatial plans for 2021. Funded by the Directorate General for Maritime Affairs and Fisheries of the EU (DG MARE), the European MSP Platform acts as the central exchange forum for all the knowledge generated in previous and current MSP processes and projects. This will allow officials, planners and other interested parties in MSP to build on what is already available, avoid duplication of efforts, assist in capacity building and encourage the development of new practices.
- **European Strategy for Blue Growth:** from Europe, MSP is promoted as a tool to improve the governance of maritime activities in European waters. It is, thus, a tool for Blue Growth, which is a fundamental pillar of the integrated maritime policy of the EU aiming to achieve the objectives of the European 2020 Strategy for smart, sustainable and inclusive growth of all maritime sectors as a whole. In this sense, for the present diagnosis the different official reports of the EU on blue growth have been consulted, especially the reports related to the outermost regions where the Macaronesia is framed, to obtain significant data of the different sectors of activity, its level of development and future trends.
- **IOC-UNESCO:** MSP is presented as a planning tool that can efficiently offer an ecosystem based management of marine and coastal resources (Crowder and Norse, 2008). This notion is supported by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). Through its current MSP initiative, the IOC seeks to support the operability of ecosystem-based management by specifically promoting MSP through the provision of documentation on global initiatives, training opportunities and guides and implementation guides on its website (IOC, 2015).
- **Common International Classification of Ecosystem Services (CICES):** it is a classification for Integrated Environmental and Economic Accounting proposed by the Program on Natural Systems and Vulnerability of the European Environment Agency (EEA). CICES follows the tradition of the Millennium Ecosystem Assessment (MA, 2005) and initiatives such as The Economics of Ecosystems and Biodiversity (TEEB) and the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES).
- **Marine Strategies**: these are the planning tool for the marine environment created by the Directive 2008/56/EC, of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). Their main objective is to achieve the good environmental status of our seas for 2020. For its development, the European Commission approved the Decision of the Commission 2010/477/EU on the criteria and standards applicable to the good environmental status of marine waters, where the associated criteria and indicators are defined to assess the good environmental status, and its relationship with qualitative descriptors, on which to base the application of marine strategies.

- **Millennium Ecosystem Assessment:** initiated in 2001, its objective was to assess the consequences of ecosystem changes to human well-being and the scientific basis for actions needed to improve conservation and sustainable use of these ecosystems and their contribution to human well-being. The Millennium Assessment has involved the work of more than 1,360 experts around the world. Their findings, contained in five technical volumes and six synthesis reports, provides a scientific evaluation on the condition and trends in the world's ecosystems and services they provide (such as drinking water, food, forest products, floods, control and natural resources) and the options to restore, conserve or improve the sustainable use of ecosystems. The approach of the Millennium Ecosystem Assessment has been carried out for large environmental units on a global scale, but it has also been developed at national, regional and ecosystem scale. The different reports obtained from this evaluation can be consulted in https://www.millenniumassessment.org/en/index.html

ANNEX III. Main impacts obtained through the relationships between principal types of ecosystem services from which the activity sectors of Macaronesia depend and the pressures that these exert on the system.

		Submarine dredging and sand depositions in harbors and beaches	Installation of submarine cables and pipelines	Increase of artificial reefs and sinking of boats	Increase in port infrastructures	Non-selective fishing gear	Increase in sport fishing	Increase in maritime transport	Increase in marine litter	Liquid discharges to the sea	Introduction of exotic species
Provisioning services	Biomass	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities Communities mortality	Changes of distribution, diversity and/or characteristics of the populations Initial displacement of communities	Communities mortality Displacement of communities	Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities	Communities mortality Changes of distribution, diversity and/or characteristics of the populations Bioaccumulation and biomagnification	Communities mortality Changes of distribution, diversity and/or characteristics of the populations Bioaccumulation and biomagnification	Communities mortality Changes of distribution, diversity and/or characteristics of the populations
	Products of the non-aqueous natural abiotic ecosystem	Elimination and / or displacement of abiotic materials	Elimination and / or displacement of abiotic materials	Limitation of available space	Elimination and / or displacement of abiotic materials	Limitation of available space	Limitation of available space	Limitation of available space	Hydrogeomorphological characteristics alteration	Hydrogeomorphological characteristics alteration	Hydrogeomorphological characteristics alteration
	Water as an energy source	Hydrological characteristics alteration Acoustic pollution and vibrations	Acoustic pollution and vibrations	Limitation of available space Alteration of hydrodynamic and hydrological characteristics	Alteration of hydrodynamic and hydrological characteristics			Limitation of available space Alteration of hydrodynamic and hydrological characteristics Acoustic pollution and vibrations	Alteration of hydrodynamic and hydrological characteristics	Eutrophication	Alteration of hydrodynamic and hydrological characteristics
	Genetic material of biota	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Communities mortality	Communities mortality	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations	Displacement of communities Communities mortality Changes of distribution, diversity and/or characteristics of the populations
Regulation and maintenance services	Transformation of biochemical or physical inputs to ecosystems	Habitat destruction Substratum alteration Hydrogeomorphological characteristics alteration Biogeochemical cycles alteration Pollution (release and dilution of toxic substances from the substrate)	Habitat destruction Substratum alteration Hydrogeomorphological characteristics alteration Biogeochemical cycles alteration Pollution (release and dilution of toxic substances	Habitat alteration Substratum alteration Hydrogeomorphological characteristics alteration Biogeochemical cycles alteration Pollution (release and dilution of toxic substances	Habitat destruction Substratum alteration Hydrogeomorphological characteristics alteration Biogeochemical cycles alteration Pollution (release and dilution of toxic substances			Acoustic pollution and vibrations Hydrogeomorphological characteristics alteration	Substratum alteration Hydrogeomorphological characteristics alteration Biogeochemical cycles alteration	Hydrogeomorphological characteristics alteration Biogeochemical cycles alteration Pollution (release and dilution of toxic substances from the substrate)	Habitat alteration

			from the substrate)	from the substrate)	from the substrate)						
Cultural services	Direct interactions, in situ and outdoors with living and physical systems that depend on the presence in the environmental environment	Loss of landscape quality Water quality alteration Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options Limitation of available space	Loss of landscape quality Water quality alteration Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options Limitation of available space	Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options Limitation of available space	Loss of landscape quality Water quality alteration Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options Limitation of available space	Limitation of available space	Limitation of available space	Loss of landscape quality Water quality alteration Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options Limitation of available space	Loss of landscape quality Water quality alteration Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options	Loss of landscape quality Water quality alteration Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options	Alteration of interactions with biota (displacement and/or attraction of communities of scientific or cultural interest) Modification of recreation and knowledge options
	Indirect, remote, often inferior interactions with living and physical systems that do not require presence in the environmental environment	Alteration of demand and social appreciation of the environment Alteration of appreciation of derivate products (price, etc.)	Alteration of demand and social appreciation of the environment Alteration of appreciation of derivate products (price, etc.)	Alteration of available information and knowledge about environment	Alteration of demand and social appreciation of the environment	Alteration of appreciation of derivate products (price, etc.) Alteration of available information and knowledge about environment	Alteration of appreciation of derivate products (price, etc.) Alteration of available information and knowledge about environment	Alteration of demand and social appreciation of the environment Alteration of appreciation of derivate products (price, etc.)	Alteration of demand and social appreciation of the environment Alteration of appreciation of derivate products (price, etc.)	Alteration of demand and social appreciation of the environment Alteration of appreciation of derivate products (price, etc.)	Alteration of demand and social appreciation of the environment Alteration of appreciation of derivate products (price, etc.) Alteration of available information and knowledge about environment
	Other abiotic characteristics of nature that have a cultural significance	Conflicts over spatial and other interactions with other activities	Conflicts over spatial and other interactions with other activities	Conflicts over spatial and other interactions with other activities	Conflicts over spatial and other interactions with other activities	Conflicts over spatial and other interactions with other activities	Conflicts over spatial and other interactions with other activities	Conflicts over spatial and other interactions with other activities	Alteration of flow of benefits of certain activities dependent on the system	Alteration of flow of benefits of certain activities dependent on the system	Alteration of flow of benefits of certain activities dependent on the system