Transport and Accessibility

Spanish scale

ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

Co-Evolve4BG

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

Transport and accessibility

Spanish scale

UNIVERSIDAD DE MURCIA

Union for the Mediterranean
Union pour la Méditerranée
الاتحاد من أجل المتوسط

CPMR
CRPM

OVERVIEW

The present document was produced in the framework of **Co-Evolve4BG** project "*Co-evolution of coastal human activities & Med natural systems for sustainable tourism & Blue Growth in the Mediterranean*" in relation to Threats and Enabling Factors for maritime and coastal tourism development on a national scale" Co-funded by ENI CBC Med Programme (Grant Agreement A_B.4.4_0075).

This document constitutes the **Deliverable 3.1.4.64** (Transport and accessibility – Spanish scale) of the **Activity 3.1.4** (Threats and Enabling Factors at National scale: Overview) under the **Output 3.1** (Integrated analysis of Threats and Enabling Factors for sustainable tourism at MED scale) of the project.

REVIEW

Contributors

Nuria GARCÍA-BUENO, Postdoctoral researcher
University of Murcia, Faculty of Biology, Spain
Pedro MARTINEZ-BAÑOS, Postdoctoral researcher
University of Murcia, Faculty of Biology, Spain

Reviewers

Pilar LAFUENTE MERCADER, MSc
Technical director at Contesma&Comprotec S.L.P, Spain
Roque TRIVES GRAS, MSc
Contesma&Comprotec S.L.P, Spain
Talal DARWISH, Pr.
Center of Remote Sensing, CNRS, Lebanon
Amin SHABAN, Pr.
National Center for Remote Sensing – CNRS, Lebanon

Supervisors

Béchir BEJAOUI, PhD
National Institute of Marine Sciences and Technologies, Tunisia
Arnaldo MARIN, PhD
University of Murcia, Faculty of Biology, Spain

LAYOUT

Khouloud ATHIMEN, Engineer, Technical Coordinator
National Institute of Marine Sciences and Technologies, Tunisia
HouaidaBOUALI, Engineer
National Institute of Marine Sciences and Technologies, Tunisia
Mohamed Ali BRIKI, Engineer
Coastal Protection and Planning Agency, Tunisia
Mouna MRAD, PhD
Water Technology and Research Center, Tunisia

Index

List of figures

List of tables

Abstract

Improved transport is the cause and effect of tourism. Improved facilities have encouraged the expansion of this. Accessibility is the main function of tourism. The main means of tourist transport in the Mediterranean, the evolution of these in the last decades and the impacts generated by the transport of tourists at an environmental level will be explored in the following.

I. Introduction

It can be said that the Mediterranean Sea is one of the places in the world with the highest number of tourists, thanks to its 2.5 million km^2 of basin and its 30,000 km of coastline. Tourist activity has always been a normal and recurrent fact of life in this area and its importance is not recent.

The climatic parameter is essential to define the Mediterranean environment, where the mildness of its temperatures allows the enjoyment of its natural resources for a good part of the year. The diversity of Mediterranean nature justifies the diversity of touristic scenes offered by this sea. The sunny and golden landscapes, the blue of the sky and the sea, are stereotypes that are maintained in Mediterranean tourism. The most frequent tree formations are pine forests, mixed with various plant formations.

The fact that the influx of international and national tourists is greater each year than the previous one is due to one main factor: the means of transport.

II. Mechanical relationship: Tourism and transport

II.1. Tourism and air transport

Transport is both a cause and a consequence of tourism growth. Air transportation has experienced a high growth rate since the 1970s (Fig. 1), with air freight growing at a rate similar to that of passengers (Rodrigue, 2020). To begin with, the improvement of infrastructure has contributed to the development of tourism and the expansion of tourism has contributed to the development of transport infrastructure. Accessibility is the primary function of tourism's transport base. To reach their desired destinations, tourists use different modes of transport, which are often used sequentially. Air transport is the main form of international tourism, often involving long-distance travel. The growth rate of international air travel is associated with the growth rate of international tourism.

Air travel now overwhelmingly dominates transcontinental and intercontinental travel and has become more competitive for shorter trips in many regional markets. The world's busiest air routes are mostly short-haul flights between cities less than 1,000 km apart, and many of these city pairs are in emerging markets. Overall, despite the expansion of long-haul flights and the increasing globalization of the economy, short-haul flights predominate. This is important for the whole world, as around 59% of seats on aircraft are domestic flights, and in large countries this proportion is even higher, e.g. 88% in China.

Figure 1. Global air transport and global air freight, 1950-2019 (Airlines for America in Rodrigue (2020))

II.2. Democratization of tourism and low-cost companies

If we take the competitive and busy international New York-London route as a benchmark, Air fares have fallen considerably, especially since the 1970s (Fig. 2). In a decade, air fares have fallen by two-thirds. The main reasons for this decline are better and more spacious aircraft (especially the scale effect of the B747), general economic improvements (higher revenues) and deregulation of the industry allowing more competition, more services and more scheduling flexibility (since the 1980s). This is how air transport has gone from being a means of transport accessible only to the rich to becoming a cheap means of transport for the masses in general. However, there are indications that air fares are unlikely to continue to fall, despite improvements in aircraft design, fuel efficiency and safety. Fuel prices and airport congestion are the main cost factors putting pressure on air fares.

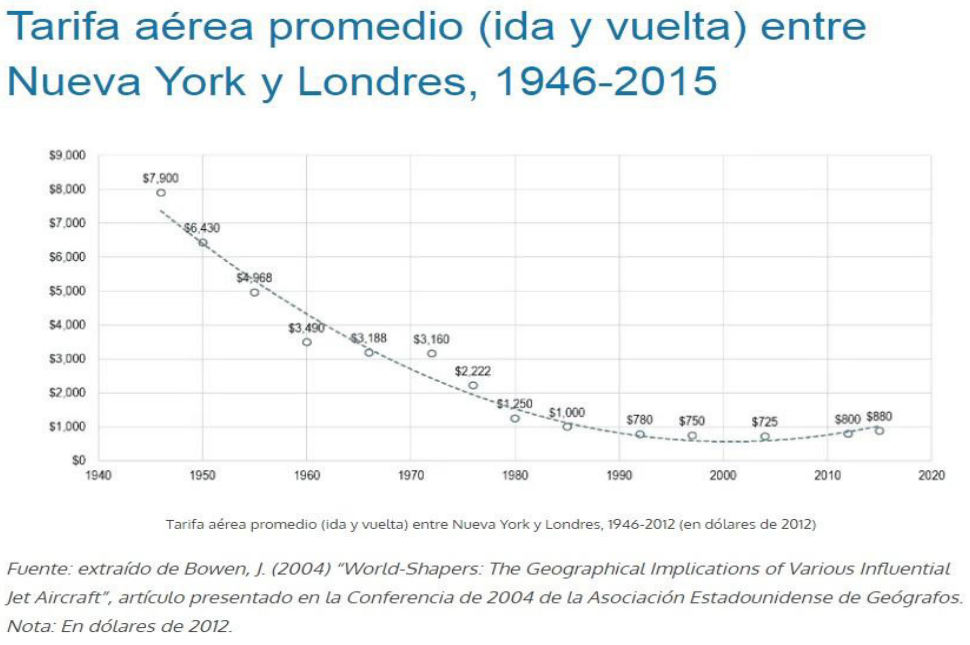

Figure 2. Average airfare (round-trip) between New York and London, 1946-2015 (Bowen, 2004)

Air travel has become the most popular mode of transport: in 2016, 57% of global overnight travelers arrived at their destination by air, up from 44% in 1995 (Rodrigue, 2020). The remainder traveled by land (43%) or by land (40%) or water (4%). Air travel is also the dominant mode of transport to EU destinations, with 55% of international travelers using this mode of transport in 2016, compared to 45% by land or water. By country group, EU destinations in Northern Europe accounted for the largest volume of air travel (75% of arrivals), followed by the South and Mediterranean (67%), Western Europe (44%) and Central and Eastern Europe (28%).

The growth in air travel has led to an increase in demand for international tourism, including the growing tendency of Europeans to take many short holiday trips abroad during the year. Deregulation of the European airline industry and the growth of low-cost carriers (LCCs) also contributed to this rapid growth.

II.3. Island transport in the Mediterranean

Connectivity is a crucial issue for tourism development, especially in Mediterranean island destinations, whose accessibility from the mainland is entirely dependent on sea and air passenger transport services. Surprisingly, the regional structure of modern tourism is characterized by a high degree of concentration at different regional levels: Europe has been and remains the undisputed leader, now accounting for 60% of international tourism and more than half of world revenues (UNWTO, 2020).

In this context, the Mediterranean countries of Europe play an important role; although France is excluded from the statistics (because many tourists visit the non-Mediterranean regions of that country), they still attract a third of arrivals and arrivals in Europe (UNWTO, 2020).

Regional concentration is also reflected at a lower level. Italy and Spain constitute the core of Mediterranean tourism, with their combined share exceeding 70% of arrivals and trips to the region, leaving Greece, Portugal, Croatia and Turkey to play a peripheral role (UNWTO, 2020).

Similar regional inequalities are observed in both core and peripheral countries; in Spain, for example, most tourists visit the Balearic Islands, the Canary Islands, and some coastal regions of Spain. Despite the evolving patterns of tourism in each case, the concepts of core and peripheral regions can be reasonably applied to the contemporary Mediterranean environment. As expected, these concepts are related to the diversity of connectivity conditions in both continental and island destinations.

In the latter context, the larger islands have a sufficient (air) gateway infrastructure, corresponding to their size and/or tourist popularity, and represent dense markets with regular maritime connections throughout the year. Crete in Greece and the Balearic Islands in Spain are good examples. In contrast, small markets include many remote islands with poor transport infrastructure and accessibility conditions that are only seasonally suitable, mainly during the summer peak. This regional distinction is firmly rooted and requires planning within a mature tourism market and transport technology that is at least close to its limits for tourism activities. Therefore, the study of possible changes in the future regional configuration of the Mediterranean should focus primarily on issues related to the industrial aspect of transport geography.

Cheap airlines take the region into account. The Mediterranean region, such as the Balearic Islands, where resort tourism is common. In this regime, the number of tourists arriving to the Balearic Islands increases year after year, rising in two years by 8.6% (2004/2005) and 12.3% (2005/2006), which represents just over 30% of the tourists arriving to the islands, above the 21.9% that they represent in the national declarations. This increase in the number of low-cost airline users enriches the tourist destination.

III. Tourist Mobility: Public transport, intelligent system and sustainability

Sustainable mobility measures are generally well developed, at least in theory, in normal urban environments, *i.e.*, in cities where mobility mostly follows a recurrent pattern related to reasons such as work and studies. However, mobility is clearly different in environments where tourism is the dominant component. The motivations for tourism are different, the value of time is different, travel patterns over time are different. Therefore, measures to promote sustainable mobility must be different. The popularity of some destinations, coupled with the development of mass tourism in recent decades, has made environments such as coastal areas particularly vulnerable.

The physical configuration of the tourist environment is one of the distinguishing features from ordinary cities. In many cases, the attractiveness of a given town lies precisely in its complex topology, with narrow, winding streets whose layout is centuries old. Streets with no place to park cars and buildings with no garages. Even in many places, heritage has meant that the presence of garages on buildings has been eliminated forever. This is contrary to the highly motorized urban culture characteristic of developed societies, where every household has at least one car.

Seasonality is another characteristic of mobility in tourist destinations. Particularly in Spain, where the sun and beach tourism model are used, 50% of visits are concentrated between mid-June and mid-September, *i.e.*, less than 20% of the time. This results in an oversized infrastructure, as it is designed to accommodate demand during peak periods. But even this size does not usually provide an adequate level of service to the peak centers, which are disproportionately large even though these infrastructures are virtually empty on most days.

A similar problem exists for transport services, for which it is difficult to adapt to the pattern of the peaks and troughs in demand. In many cases, journeys must be made by private car and sometimes by taxi. This causes enormous congestion problems, both in terms of the number of cars on the road and the number of parked cars. One of the most shocking sights in some tourist areas of the Mediterranean are the huge car parks “on the beach”, which create a devastating visual effect, far from the typical advertising image of tropical beaches surrounded by exotic palm trees.

Some of the measures implemented by tourist destinations to improve mobility coincide with the traditional measures of the European Union’s Sustainable Urban Mobility Plans, but many others are such large variations that they are hardly recognizable. Here are some reflections and examples of how mobility measures can improve the quality of the tourism product on offer (Álvaro and De la Fuente, 2012):

1. Traffic management and regulation measures. This set of measures aims to reduce the volume and speed of vehicle traffic to achieve a better, more comfortable and safer use of public spaces. These measures are particularly necessary in tourist

centers, as the negative impacts (noise, congestion, *etc*.) caused by private vehicles are unacceptable in places visited for pure pleasure and the measures must go further, requiring partial or total closure of traffic.

2. Measures for personal vehicle management and parking restrictions. One of the main leisure activities related to tourism is walking, which combines the need to travel and leisure. Therefore, it is interesting to improve the quality of walking routes and the experience of visitors by freeing up the space used by parked cars on the road.

3. Actions to promote public transport. To achieve better mobility, it is not enough to apply restrictive measures on the use of private motor vehicles, but these measures must be combined as alternatives. Measures to promote public transport, such as buses in the summer season, or less traditional means of transport, such as tourist trains, both electric and biomass fuel, are more sustainable alternatives to private transport.

4. Promote walking and cycling. There is a general trend to replace private car-based mobility with a new, more diversified mobility in which pedestrians and cyclists play a new role. This is particularly important in tourist destinations, as it is while walking, when people are in a more direct and intimate relationship with the environment, that tourists tend to look for what they notice when they stop in a particular place. Activities that may be sufficient in traditional cities should be emphasized in tourist destinations.

5. New propulsion systems. Cars are the most used means of transport for travel in tourist environments, especially private cars, although more and more cars are being hired. Emission reductions will change the operation of these vehicles. The biggest reductions are in electric propulsion. Hybrid cars represent another type of technology that is very common today.

III.1. Transport and Sustainability in Spain in the last decade

Transport plays a major role in economic development; it was one of the first common policies of the European Union and its growth has followed the growth of the European economy over the last 30 years. The challenges of transport sustainability led the European Union to make a firm commitment to sustainable mobility, which was set out in the European Commission's 2001 White Paper and reaffirmed as one of the main axes of transport policy in the 2011 White Paper "Roadmap to a united Europe. Transport space: a competitive and sustainable transport policy". But the analysis of modal split in 2018 shows that the most used mode of transport by people moving between cities was the personal car, both passenger car and motorbike.

These challenges include, first and foremost, energy consumption and emissions from the use of fossil fuels, as well as many other negative impacts that make up the so-called external costs of transport, which include the costs of accidents, noise, air pollution, climate, nature and landscape change, additional costs in urban areas,

upstream and downstream processes (vehicle construction, infrastructure, extraction of raw materials, etc.) and congestion. In addition, the network of roads and their infrastructures occupy and fragment the area and irreversibly alter the landscape.

Promoting the shift to more environmentally friendly modes of transport is especially important in cities and metropolitan areas, where the use of personal vehicles and their emissions of tropospheric ozone precursors and particulate matter affect urban air quality, noise, and congestion (Arce-Ruiz and López-Lambas, 2020).

The analysis of the results and the problems identified in this chapter led to the following recommendations:

1. Trip reduction and, above all, a shift to more sustainable and efficient modes of transport should be encouraged. Genuine cooperation between modes of transport is needed. This complex reality can only be managed in such a way that all benefit from a joint strategy in which public transport is the backbone of the overall urban transport system.

2. Economic growth needs to be decoupled from growth in transport and energy consumption; reducing the energy intensity of GDP will be the key to the necessary transition towards greater sustainability. Acting on demand, yes, but also on transport.

According to the Transport and Logistics Observatory (OTLE, 2020) of the Ministry of Transport, Mobility and Urban Planning (MITMA), national passenger traffic increased by 3.1% year-on-year in 2018, reaching 441,084 million passenger-kilometers in the last year for which data is available. In international transport, passenger mobility also increased by 4.6% (in this case, the data is from 2016).

The data show that in 2018 compared to the previous year in all modes and segments across the country, except for air transport, where there was a slight decrease (-0.2%). In terms of international mobility, all modes and segments also reflected an increase in activity, apart from rail and road passenger transport.

Data for 2021 is not yet available, and there is even less information on the impact of the SARSCoV-2 pandemic in 2020 which is expected to have a major impact from early March. Air and passenger transport will be the most affected.

Private vehicles, both cars and motorbikes, were the most common means of transport used to move people between cities. According to the Directorate General for Road Transport of the Ministry of Transport, Mobility and Urban Planning, this mode accounted for 78.6% of national mobility, expressed in car-kilometers. If bus journeys are added, road transport accounts for 85.9% of the country's total passenger traffic. Air transport was the second most used mode of interurban transport, albeit by a wide margin, with a share of 7.4%, followed by rail transport with a share of 6.4%. Finally, maritime transport by inland waterways accounted for barely 0.3% of national mobility. In 2018, there was an increase of 2.5% and 3.6% for inland road passenger and freight transport, respectively (DGC).

Analysing the intra-modal mobility of passengers by mode of collective transport (Fig. 6), it can be seen that the most used mode of transport was air transport, with a modal share of 34.7%, slightly higher than that of buses, which recorded a share of 34.1%. Rail transport fell to 30.0% and maritime transport accounted for the remaining share of national passenger traffic, 1.2%.

In terms of international passenger traffic, it is worth noting that air transport (49.3%) overtook road transport (48.44%) for the first time in 2016. Figure 8 also shows that both rail and maritime transport have a small share, although the latter excludes cruise passengers.

Transport has significantly improved people's quality of life and freedom, and the car is especially attractive for its utility, autonomy, flexibility, comfort, speed, perceived safety and privacy, as Steg and Gifford (2008) in particular pointed out. At the other end of the scale, the weight of the transport sector in energy consumption, as well as in greenhouse gas emissions, is a major challenge for both energy sustainability and mitigation of change. The transport sector is a major contributor to final energy consumption, and its share has been increasing in recent years: from 24.2% of final consumption in 1971, until nowadays it accounts for more than 33%of total energy consumption in the 25 European Member States and 42% in Spain.

Noise is another problem partly caused by transport. The number of people exposed to annoying noise levels is significant. According to the European Environment Agency, across Spain, 10,519,600 people are exposed to average night-time noise levels of more than 55 dB (Lden ≥ 55 dB), exceeding WHO recommendations. Of these, 10,039,700 are in urban areas and 479,900 outside cities

III.2. Some Mediterranean experiences in the improvement of transport in places with a large number of tourist attractions

Cinque Terre (Italy), a coastal area in the eastern part of the Liguria region. The tourist destination consists of a strip of land formed by steep hills surrounded by deep valleys and five urban centres spread over the area: Monterosso al Mare, Vernazza, Corniglia and Riomaggiore. Tourism, which once contributed to the revitalization of the territory after the gradual abandonment of traditional agricultural activities, puts great pressure on the environment and changed the character of the villages and rural areas, introducing large apartment buildings housing thousands of visitors, most of them arriving in private cars, resulting in a significant deterioration of the environmental quality that once characterised the territory. Measures have been proposed to mitigate this deterioration, such as restrictions on private car traffic in urban centres, plans to build alert parking lots and campaigns to promote walking and recreational tourism. These environmental measures put an end to the typical beach offer and increased the offer of "green tourism", hiking or cultural activities, extending the tourist season from April to October. The number of visitors increased from 175,000 in 2004 to 191,000 in 2006.

An example of a measure to control and restrict private car parking is Quiberon, a municipality in Brittany (France) located on the peninsula of the same name. Its use as a tourist destination dates back to the 19th century, but it was from the 1970s onwards that the town began to suffer from problems of tourist overexploitation, which manifested itself in significant traffic congestion and serious parking problems. In the 1990s, studies on the quality of tourism began to be carried out and the results showed that traffic and parking problems were the main causes of visitor dissatisfaction. To change this situation and improve the quality of Quiberon as a destination, a tourism mobility management master plan was drawn up, which resulted in the following measures):

- The construction of a five-hectare area car park on the outskirts of the town, with a capacity of 1,200 cars and 18 buses. At the same time, regulated parking was introduced in urban areas to prevent the arrival of private vehicles.
- Introduction of a shuttle service to transport visitors from the car park to the city centre with a high-quality service and waiting times of no more than 10 minutes. This service will be provided by three low-floor city buses. In addition, cycle and motorbike lanes have been constructed on the main municipal road and public transport has been converted to a single ticket.
- Creation of an information service to encourage visitors to leave their personal vehicles outside the peninsula.

On the Mediterranean coast there are dozens of examples of the promotion of alternative public transport. Notably, the city of Peñíscola (Spain) offers tourist excursions that include “tourist trains” passing through the main attractions: The Sierras de Cerromar, Las Atalayas or the medieval castle. Similarly, Palma de Mallorca (also Spain), which offers a route from Playa de Palma through the resorts to Cala Estancia. Thus, the itineraries present clear links to essential tourist destinations with features unimaginable within regular urban transport, such as fares (which are often relatively high), timetables (which can vary according to the season) and even dates of service (which can be affected by factors such as “bad weather”, which is a common cause of disruption). This type of travel product is often advertised on the basis that the service offers “one of the best memories of your holiday”.

-

IV. Cruise tourism in the Mediterranean

First, we refer to UNWTO (United Nations World Tourism Organization) definition: sea travel by domestic and foreign passengers on large pleasure craft, known as cruise ships, on regular and defined routes, stopping at various ports of call in the cities visited and consuming services on board the ship and the products, services and tourist attractions offered at each destination.

Demand for Mediterranean cruises has been growing since the early 2000s and was very high until the economic crisis of 2008 (VicoMaimó, 2015). From that year until 2013, the industry stagnated as a result. From that year onwards the demand for cruises started to increase gradually until 2019, when due to COVID-19 trips were suspended until today, when the future of the industry is unclear due to the health crisis.

According to CLIA (Cruise Lines International Association), the following trends are highlighted:

- Cruises continue to become more expensive. Cruisers intend to continue their journey on a cruise and are very satisfied with their previous experience on board. In addition, 62% of cruise passengers would cruise again and 69% value cruises more than shore excursions.
- The trend is less about the size of the ship and more about offering unique design and amenities.
- New destinations tourists are going to. The cruise industry has seen an increase in the number of travelers seeking global experiences. As a result, cruising has made the world more accessible than ever before. CLIA members offer nearly 1,000 ports of call around the world, including many UNESCO World Heritage Sites.
- The cruise industry is responding to consumer demands with the implementation of key innovations, such as Wi-Fi throughout the ship, telephone connectivity, services adapted to each generation of passengers and themed or gastronomic cruises.

Mediterranean cruises are the most convenient for Spaniards, as the departure ports are on the Mediterranean coast and the ports of Barcelona, Valencia and Mallorca make it possible to save on transfers to other ports, *i.e.*, to contract other cruises departing from foreign ports. This type of trip allows a very reasonable cost depending on seasonality. The all-inclusive option gives the traveler the peace of mind that the "extras" are in their pocket and will not deplete their budget.

On a cruise, the cost of getting from one city to another and the comfort of the same accommodation or cabin for the entire trip is an option that customers will consider, and one of the main reasons favoring cruise transport is wanting to see different destinations in a short time. On most itineraries, you will travel at night, which allows

you to optimize the duration of your trip and arrive at ports during the day so that passengers can go to the different cities they want to visit. This fact contributes to the tranquility and relaxation of cruise customers. The time spent on transfers, luggage transport, means of transport, *etc*., can be used for relaxation or for sightseeing. It can be used for relaxation or for various activities.

The Caribbean and the Mediterranean dominate the list of the largest cruise ports (Cruise Market Watch; Fig. 3). The Mediterranean is the world's second-largest cruise shipping market, representing over 16% of the annual cruise capacity. It can be broken down into distinctive multi-port regions, the Western Med, the Eastern Med, and the Adriatic. The Western Med represents the main market, but congestion is inciting the consideration of new itineraries in the Eastern med and the Black Sea (Port Economics, Management and Policy, 2020). The main list of cruise ports located in the Mediterranean are:

Alicante (España)

Barcelona (España)

Cagliari (Italia)

Civitavecchia, Roma (Italia)

Corfú (Grecia)

Dubrovnik (Croacia)

El Pireo (Grecia)

Estambul (Turquía)

Génova (Italia)

Kotor (Montenegro)

Kusadasi (Turquía)

La Goulette (Túnez)

Messina (Italia)

Mykonos (Grecia)

Nápoles (Italia)

Palma de Mallorca (España)

Rodas (Grecia)

Santorini (Grecia)

Savona (Italia)

Split (Croacia)

Toulon (Francia)

Villefranche(Francia)

La Spezia (Italia)

La Valetta (Malta)

Livorno (Italia)

Málaga (España)

Marsella (Francia)

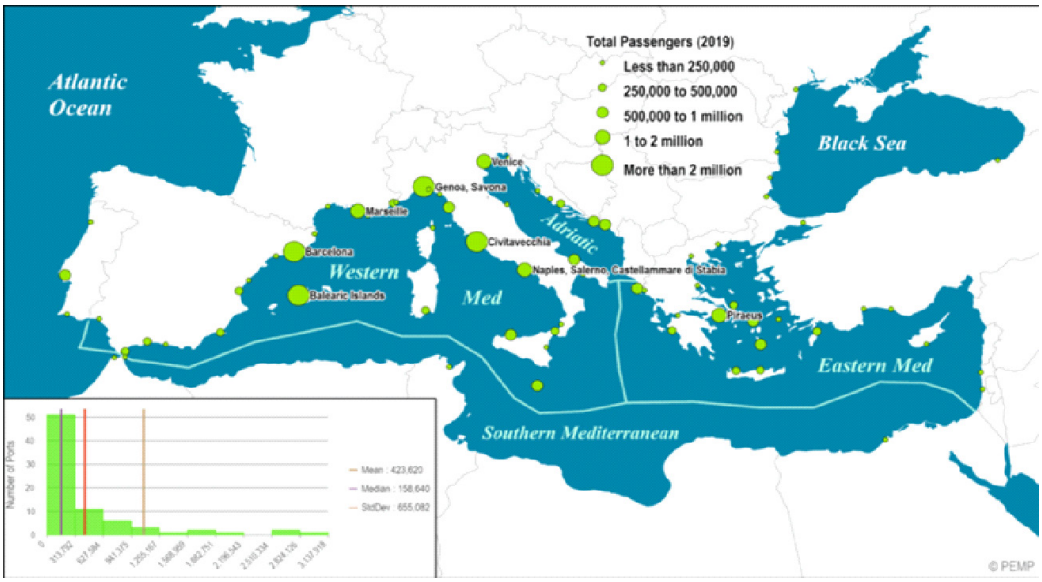

Figure 3. Cruise Passengers Visits, Mediterranean, 2019 (Med Cruise (2020). Cruise Activities in Med Cruise Ports: Statistics 2019. Tenerife: Med Cruise. Cruise Market Watch)

V. Sailing in the Mediterranean

V.1. Dedicated shipping infrastructure

The Dictionary of the Royal Spanish Academy defines port as "a natural or built place on the coast or on the banks of a river, sheltered from the wind and provided for the loading and unloading of ships and goods, embarkation and disembarkation of passengers from a ship, *etc*.

- Ports carry out activities of public interest that serve international trade and benefit the economy of nations, their development contributes to the economic growth of large coastal areas, and with all this they fulfill a social function by creating employment and wealth in their areas of influence. Ports therefore fulfill a public function which must be managed by the State to which they belong.
- Four types of facilities can be distinguished in a port: external or protection works, internal quays, access infrastructures and additional structures or facilities.
- External works are necessary to provide a sheltered water surface where ships can stay. Their importance depends on the type of port and can practically be non-existent in ports with relevant natural conditions (*e.g*., Lisbon) or important in cases where ports have reached open water (*e.g*., Barcelona).
- It is the infrastructures which delimit the outer perimeter of the port that defines its appearance on the ground. In general, there are two types of breakwaters at the Cape: breakwaters and vertical weirs. Breakwaters consist of large natural or artificial stones placed on the slopes surrounding the core; they act by absorption, so that the waves crash against the breakwater, whose stones and the spaces between them absorb the energy released, this is why these dykes are also called breakwaters. Vertical weirs, on the other hand, work by reflection, so that the waves do not crash against the weir but are reflected by it; for this, the vertical surface of the weir must be cemented deep enough to prevent the waves from breaking.
- The quay infrastructure allows vessels to approach and berth in such a way that loading and unloading operations can take place. Basically, there are four types of quays: piers, jetties, jetties, and docks. Piers are vertical surfaces attached to a horizontal esplanade for port operations; the vertical surface must be deep enough for vessels to berth and in this position to load and unload. There are several types of structures: piles or packed piles, sheet piles, gravity piles (with boxes or blocks on top of each other), special blocks, *etc*. Breakwaters are not attached to an active horizontal esplanade. Piers are structures, usually lighter than the previous ones, which allow ships to dock, even if they only have elements for the transport of products (pipelines for bulk liquid products, conveyor belts for bulk solid products, loading and unloading walkways). Lofts are isolated quay

structures, ideally connected to each other and to the shore by means of gangways. If analyzed from an operational point of view, two main types of docks can be distinguished: docks for special traffic (normally designed for large shipments, where the loading and unloading speed is determined by the production process that requires it, and which in many cases are used by a single receiver or loader of goods, *e.g.*, port docks for the loading of crude oil, cement, grain, *etc*.) and docks for ordinary commercial traffic (normally public and common) for various users.

- The access infrastructure consists of navigation channels from the seashore, appropriately deepened to allow access for ships and navigational equipment (lighthouses, beacons, shields, *etc*.). On the land side, these infrastructures consist of roads and railways linking the port to its catchment area. Additional works and facilities include warehouses, silos, depots, sheds, service buildings, cranes and other handling equipment, dry docks, *etc*. All these elements make up what is commonly referred to as the gangway superstructure. The sea area of a port, delimited by protective measures or, in the case of a natural harbor, by the configuration of the coastline itself, and divided into three main areas: the foreshore, the channel or entrance/exit and the berths. A harbor is that part of a port that is essentially open water. Its function is to provide space for ships to move and berth while awaiting arrival.
- A navigation channel is the part of the port through which ships pass to reach a berth, and which must be deep enough to guarantee ship traffic. Piers are made up of different types of moorings and the water space they delimit. The current trend is for yards and shipyards to specialize in a particular type of traffic (containers, liquid bulk cargo, solid bulk cargo, *etc*.) so that the superstructure and its equipment can better withstand traffic. It should be borne in mind that most infrastructures and superstructures have very high construction costs and long lifetimes. It is therefore relatively common for the public sector to provide the main infrastructure, although private capital often contributes to the superstructure of several terminals.

V.2. Dry ports

This is an intermodal freight terminal located in an economic zone, connecting rail transport with the port of origin or destination. Hence its name, as it handles goods inland. One of the most important in Spain is located inCoslada, Madrid (Stock logistic, 2019) (Fig. 4). Located close to the Barajas air cargo hub and many industrial areas in the region, it boasts, according to the latest published statistics (2017), of having moved 67,889 UTIS (Intermodal Transport Units).

Figure 4. Map of dry ports*in Spain* (Stock logistic, 2019)

VI. Environmental Impacts

VI.1. Impacts, vulnerability, and adaptation to climate change in the tourism sector

According to Tourism movement at borders (Frontur, 2021) data, more than 51 million foreign tourists visited Spain by air, with road transport being the second most used means of transport to visit our country. If we turn to the 2012 study of tourist trips in Spain (Familiatura), the car turned out to be the main means of domestic transport for Spanish residents, with 84% of the total. Traveling by bus (5.6%), by plane (5%) and by train (4.5%) was much less important (Fig. 5). Land and air infrastructures are therefore essential to the management of tourist flows to our country, and it is therefore necessary to study the impact and vulnerability of climate change on both of these infrastructures and their operating systems. Climate change may affect both the physical environment of these infrastructures and, indirectly, tourist demand for the different means of transport, causing a redistribution of tourist flows.

Regarding transport demand and passenger mobility as a consequence of climate change, studies show that, although difficult to predict, tourist flows may be distributed in areas with favorable climatic conditions (higher latitudes), although this criterion is not common in the design of infrastructures such as airports.

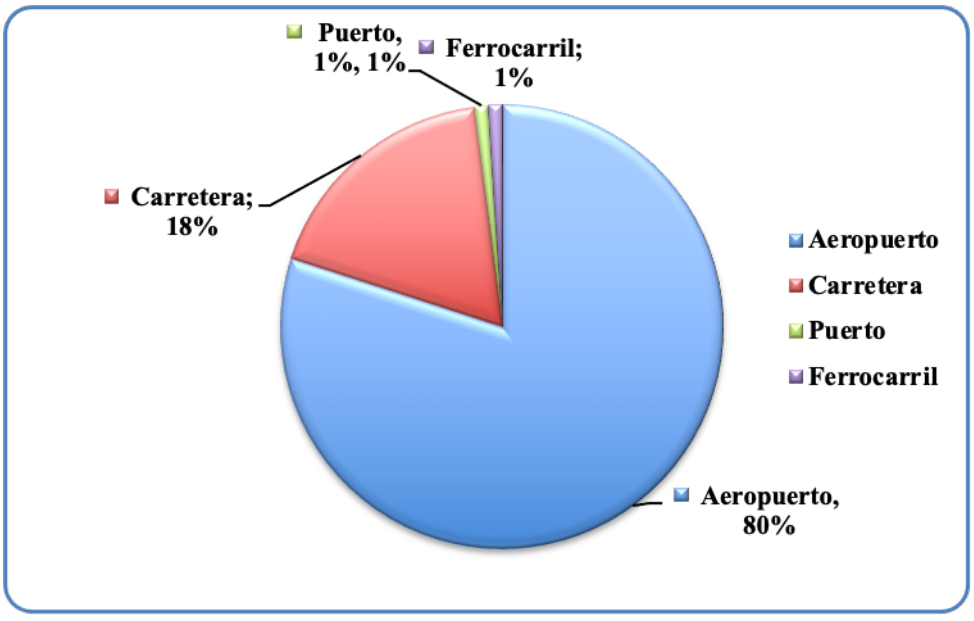

Figure 5. Tourist arrivals by access route
(Tourism movement at borders (Frontur, 2021))

According to the World Tourism Organization (2021), the tourism system is composed of four elements: geographical space, demand, supply, and factors. All these elements are closely interrelated and provide an integrated service to tourists at their destinations, so the impacts and vulnerability of the sector to climate change need to be studied from different approaches.

VI.2. Carbon footprint of transport in the field of Mediterranean tourism

Obviously, the tourism sector as it stood pre-pandemic was highly unsustainable. Transport, including international travels, was the biggest emitting sector across the European Union, ranging between 15 to 40% of the countries' carbon emissions, with total transport emissions accounting for about 30% of all EU emissions. Maritime transportation represents nearly 4% of this Figure. At a global scale, carbon emissions from tourism are estimated roughly at 8% of total carbon emissions, mainly due to air transport, growing year after year (Eco-union, 2021; Fig. 6).

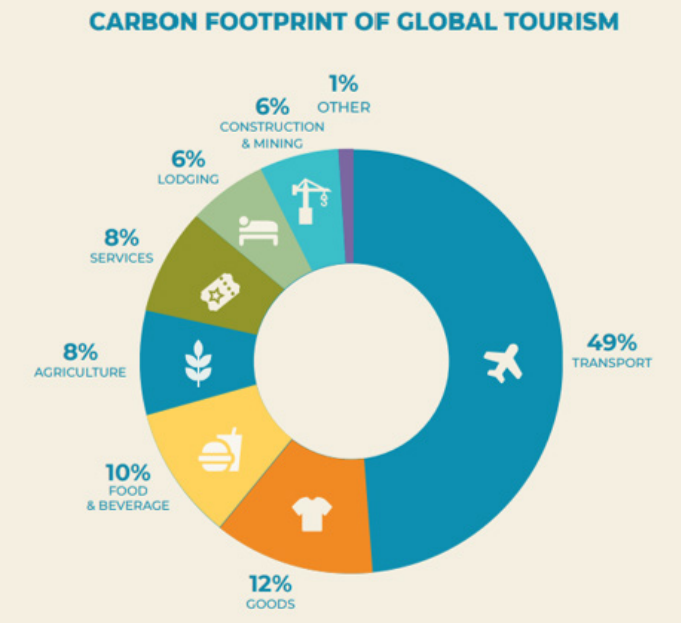

Figure 6. Carbon footprint of global tourism (Fosse. Eco-union (2021))

VI.3. Marine litter in the Mediterranean

The Mediterranean is an ecosystem that is in a critical state, however, due to the bactericidal action of some single-celled algae - exclusively due to some single-celled algae (found in the open sea); certain critter bacteria (living on the seabed); and higher algae nesting on the shores, a balance is created in the marine ecosystem of the Mediterranean.

These waters are literally breathing hard. In fact, the “eutrophication process”, characterized by the lack of oxygen and the avalanche of organic matter generated by the annual release of more than 60,000 tons of chemicals from producers, is causing the oxygen needed to decompose the original plant life in this waste to diminish at an alarming rate. The Mediterranean’s capacity for self-purification and regeneration is therefore insufficient; moreover, the balancing mechanism itself is changing. The sea, which represents 50% of the world’s maritime surface, receives 35% of the world’s oil transport and 800,000 tons of oil products are discharged into its waters.

As for marine pollution caused by cruise ship tourism, a recent report published by the European Organization for Transport and Environment warns that these ships emit large quantities of Sulphur oxides, five times more polluting than EU cars on the mainland, when they call at the port (Transport andEnvironment, 2021).

In 2005, in the seas surrounding Europe (the Baltic Sea, the North Sea, the North-Eastern part of the Atlantic, the Mediterranean and the Black Sea), Sulphur dioxide (SO_2) emissions from international shipping were estimated at 1.7 million tons a year, nitrogen dioxide (NOx) emissions at 2.8 million tons, and particulate matter (PM 2.5) at 195,000 tons (Transport and Environment, 2021). Emissions will be further reduced in the remaining EU seas with the implementation in 2020 of the global Sulphur caps which limits Sulphur to 0.5% in shipping fuel (Transport and Environment, 2021).

VII. Selection of Parameters in CoEvolve4BG

VII.1. GIS database

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

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

The NUTS classification subdivides the economic territory of the EU Member States into territorial units (regions; Fig. 7). The classification is made up of three hierarchical levels: each Member State and the UK are divided into NUTS 1 regions, which in turn are subdivided into NUTS 2 regions and then further divided into NUTS 3 regions. Each of these regions is allocated a specific code and name.

Since several different regions within Europe have the same name, a distinction has been made by adding to each of these the abbreviation for the country concerned.

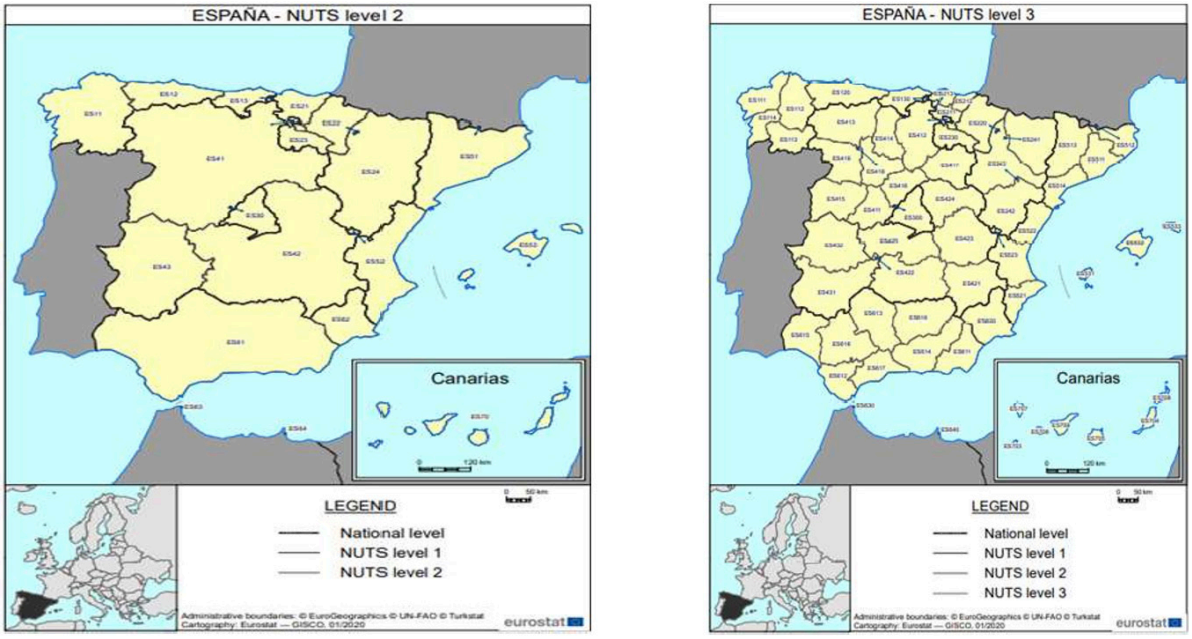

Figure 7. Spain (España): NUTS level 2 and 3 (EUROSTAT (2021))

VII.2. Data Records

The developed Spanish Mediterranean coastal database described in this report is available through the figshare (Figshare, 2020) repository of results. We have included a csv file with all the information at Nuts 3 level into the repository. The database will be updated and expanded as soon as new and improved data become available.

The database presented here has been created using several publicly available datasets, which are thoroughly documented and described in reports or scientific articles (Table 1). Thus, these datasets have undergone rigorous quality controls and/or validation. In addition, for those parameters where consistent information for the studied area were not available, new datasets were generated.

VII.3. Transport and accessibility parameters

A panel of external experts and the working group at the Mediterranean level of the Co-Evolve4BG project has selected the following parameters of Transport and accessibility which will be analyzed on National and Mediterranean scale (Table 1). The supplementary material includes an excel table with the values of the parameters selected at the level of Spain.

Table 1. Transport and accessibility parameters

Parameters	Parameter's description and objective	Units	Source
Cargo Port			
Number of Cargo Ports by NUT	Indicate the number of Cargo in the NUT	Number	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/bibliotecav2/dosier%20puertos%20web-esp.pdf
Port Name	Name of the port	Name of the Port	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf
Port Location	Indicate the port location	Lon, Lat (in Degree)	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf
Status of the Port	Give an appreciation of the status of the port; the possible values are Good/Medium/Bad	Possible values: Good/Medium/Bad	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf
Min water depth inside the navigability area	Give the minimum water depth in the navigability area	m	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf

Max water depth inside the navigability area	Give the maximum water depth in the navigability area	m	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf
Problems of the Port	Give observations of the problems of the port: Possible values, sedimentation, pollution…..	Possible values: Pollution/ Sedimentation/…	Rom 5.1-13, Ministerio de Fomento. http://www.puertos.es/es-es/BibliotecaV2/ROM%205.1-13.pdf
Capacity of the Port: Number of the BERTHS (Quais)	The capacity of the ports is measured by the number of BERTHS (Quais in French)	Number	www.fondear.com www.canalmar.com www.viamichelin.com
Number of BERTHING boats/ ships in 2014	Indicate the number of the berthing boats in 2014 (as an example)	Number	www.fondear.com www.canalmar.com www.viamichelin.com
Number of BERTHING boats/ ships in 2019	Indicate the number of the berthing boats in 2019 (as an example)	Number	www.fondear.com www.canalmar.com www.viamichelin.com

Rate of BERTHING in the port	Rate of the BERTHING boats/ ships using 2 different statistics of 2 dates (as an example 2014 and 2019)	Formula: **[(Berthing2019- Birthing2014) * Berthing 2014^{-1}]*100%**	www.fondear.com www.canalmar.com www.viamichelin.com
Are the activities in the Port linked to tourism?	The answer could be yes or no in order to understand if the port activities are linked to TOURISM	Yes/No	Own data
Marina			
Number of Marinas by NUT	Indicate the number of Marinas in the NUT	Number	http://www.portbooker.com/es/puertos
Port Name	Name of the port	Name of the Port	http://www.portbooker.com/es/puertos
Port Location	Indicate the port location	Lon, Lat (in Degree)	http://www.portbooker.com/es/puertos
Status of the Port	Give an appreciation of the status of the port; the possible values are Good/Medium/ Bad	Possible values: Good/Medium/ Bad	Own data

Min water depth inside the navigability area	Give the minimum water depth in the navigability area	m	http://www.portbooker.com/es/puertos
Max water depth inside the navigability area	Give the maximum water depth in the navigability area	m	http://www.portbooker.com/es/puertos
Problems of t he Port	Give observations of the problems of the port: Possible values, sedimentation, pollution……	Possible values: Pollution / Sedimentation……	Rom 5.1-13, Ministerio de Fomento. http://www.puertos.es/es-es/BibliotecaV2/ROM%205.1-13.pdf
Capacity of the Port: Number of the BERTHS	The capacity of the ports is measured by the number of BERTHS	Number	www.fondear.com www.canalmar.com www.viamichelin.com
Number of BERTHING boats/ ships in 2009	Indicate the number of the berthing boats in 2009 (as an example)	Number	www.fondear.com www.canalmar.com www.viamichelin.com

Number of BERTHING boats/ ships in 2019	Indicate the number of the BERTHING boats in 2019 (as an example)	Number	www.fondear.com www.canalmar.com www.viamichelin.com
Rate of BERTHING in the port	Rate of the BERTHING boats/ ships using 2 different statistics of 2 dates (as an example 2009 and 2019)	Formula: **[(Berthing2019-Berthing2009)/ Berthing2009]*100Unit: %**	www.fondear.com www.canalmar.com www.viamichelin.com
Are the activities in the Port linked to tourism?	The answer could be yes or no in order to understand if the port activities are linked to TOURISM	Yes/No	Own data
Fishing Port			
Number of Fishing Ports by NUT	Indicate the number of Fishing Ports in the NUT	Number	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf
Port Name	Name of the port	Name of the Port	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf

Port Location	Indicate the port location	Lon, Lat (in Degree)	Memorias de las AutoridadesPortuarias y AnuarioEstadístico de PuertosdelEstado. http://www.puertos.es/es-es/estadisticas/Paginas/Memorias.aspx DOSIER PUERTOS DEL ESTADO http://www.puertos.es/es-es/BibliotecaV2/Dosier%20Puertos%20WEB-ESP.pdf
Status of the Port	Give an appreciation of the status of the port; the possible values are Good/Medium/Bad	Possible values: Good/Medium/Bad	Rom 5.1-13, Ministerio de Fomento. http://www.puertos.es/es-es/BibliotecaV2/ROM%205.1-13.pdf
Min water depth inside the navigability area	Give the minimum water depth in the navigability area	m	www.fondear.com www.canalmar.com www.viamichelin.com
Max water depth inside the navigability area	Give the maximum water depth in the navigability area	m	www.fondear.com www.canalmar.com www.viamichelin.com
Problems of the Port	… Give observations of the problems of the port: Possible values, sedimentation, pollution	Possible values: Pollution / Sedimentation	Rom 5.1-13, Ministerio de Fomento. http://www.puertos.es/es-es/BibliotecaV2/ROM%205.1-13.pdf
Capacity of the Port: Number of the BERTHS	The capacity of the ports is measured by the number of BERTHS	Number	www.fondear.com www.canalmar.com www.viamichelin.com

Number of BERTHING boats/ ships in 2009	Indicate the number of the berthing boats in 2009 (as an example)	Number	www.fondear.com www.canalmar.com www.viamichelin.com
Number of BERTHING boats/ ships in 2019	Indicate the number of the BERTHING boats in 2019 (as an example)	Number	www.fondear.com www.canalmar.com www.viamichelin.com
Rate of BERTHING in the port	Rate of the BERTHING boats/ ships using 2 different statistics of 2 dates (as an example 2009 and 2019)	Formula: **[(Berthing2019-Berthing2009) /Berthing2009]*100Unit: %**	www.fondear.com www.canalmar.com www.viamichelin.com
Are The activities in the Port linked to tourism?	The answer could be yes or no in order to understand if the port activities are linked to TOURISM	Yes/No	Own data

Airport			
Number of Airports by Nut	Indicate the number of Airports in the NUT	Number	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home
Name of the Airport	Indicate the name of the Airport	Name	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home
Airport Location	Indicate the location of the Airport by Longitude and Latitude	Lon., Lat. (in Degree)	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home
Airport type	Indicate the type of the Airport	Passenger/Sales/Sales & Passenger/Military/Primary commercial port/General Aviation port	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home
Accessibility of airport by public transport	Indicate if the airport is accessible by public transport, the possible answer could be Yes or No	Yes/No	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home
Number of passengers during 2009	Indicate the number of passengers during 2009 (as an example), just calculate the rate after. We must have statistics in 2 different dates	Number	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home

Number of passengers during 2019	Indicate the number of passengers during 2019 (as an example), it is just to calculate the rate after. We must have statistics in 2 different dates	Number	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home
the passenger count rate in the airport	Once we have the 2 statistics in 2 different dates, we can then calculate the passenger count rate in the airport.	Formula: **[(Passengers2019-Passengers2009) /Passengers2009]*100Unit: %**	Aena https://wwwssl.aena.es/csee/Satellite?pagename=Estadisticas/Home

VIII. Conclusions

Air transport is the main form of international tourism, often involving long-distance travel. The growth of air travel has led to an increase in demand for international tourism.

Sustainable mobility measures are generally well developed, at least in theory, in normal urban environments, *i.e.*, in cities where mobility mostly follows a recurrent pattern related to reasons such as work and studies. The popularity of some destinations, coupled with the development of mass tourism in recent decades, has made environments such as coastal areas particularly vulnerable.

Mediterranean cruises are the most convenient for Spaniards, since the departure ports are on the Mediterranean coast and the ports of Barcelona, Valencia and Mallorca make it possible to save on transfers to other ports, *i.e.*, to contract other cruises departing from foreign ports. In terms of trends: Cruises are still on the rise. The trend is less to the size of the vessel than to the offer of a unique design and equipment. The cruise sector has seen an increase in the number of travelers looking for global experiences.

One of the biggest impacts of tourism transport is greenhouse gasses. Mitigating this is one of the biggest challenges, both for sustainable energy and climate change. The Mediterranean is an ecosystem that is tending towards eutrophication, characterized by a shortage of oxygen and an avalanche of organic matter, produced by dumping.An additional problem of imbalance in Mediterranean ecosystems is the uncontrolled development of seasonal tourism on the coast in recent years.

As for marine pollution caused by cruise ship tourism, a recent report published by the European Organization for Transport and Environment warns that these ships emit large quantities of Sulphur oxides, five times more polluting than EU cars on the mainland, when they stop over.

IX. References

Arce-Ruiz R., López-Lambas M., 2020. Transporte ysostenibilidad en España en la últimadécada. In book: INFORME SOBRE SOSTENIBILIDAD EN ESPAÑA 2020 Cómoacelerar la transiciónecológica con lo aprendido en las últimasdécadas. Publisher:FundaciónAlternativas.

Álvaro O.M., De la Fuente P.H., 2012. Movilidadsostenible en entornosturísticos. Singularidades y medidas. In: X Congreso de Ingenieríadel Transporte (CIT 2012), 20/06/2012 - 22/06/2012, Granada, España. ISBN 978-84-338-5402-5, 167.

Bowen B.D., 2004. The Airline Quality Rating 2004. Omaha, Nebraska. Available at: http://works.bepress.com/brent_bowen/60/[accessed 26/07/2021].

CLIA (Cruise Lines International Association).Available at: https://cruising.org/es-es[accessed 26/07/2021].

Eco-union, 2021. Available at:https://www.ecounion.eu/en/about/ [accessed 26/07/2021].

EUROSTAT. Available at: https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-gq-20-92[accessed 19/04/2021].

Frontur, 2021. Tourism movement at borders.Available at: https://www.dataestur.es/en/global/tourism-movement-at-borders-frontur/ [accessed 26/07/2021].

Fosse, J., 2021. The future of Mediterranean tourism in a (post) covid world. Eco-union.

Ministry of Ecological Transition and Demographic Challenge (MITECO). Available at: https://www.miteco.gob.es/es/ [accessed 26/07/2021].

Ministry of Transport, Mobility and Urban Planning (MITMA). Available at: https://www.mitma.gob.es/ [accessed 26/07/2021].

OTLE, 2020. Portal delObservatoriodel Transporte y la Logística en España. Available at:https://observatoriotransporte.mitma.es/ [accessed 26/07/2021].

Port Economics, Management and Policy, 2020. Available at: https://porteconomicsmanagement.org/ [accessed 26/07/2021].

Rodrigue J.P., 2020. The Geography of Transport Systems. New York: Routledge, 456. ISBN 978-0-367-36463-2

Steg L., Gifford R., 2008. Sustainable transport and quality of life. In: Building blocks for sustainable transport policy: Obstacles, trends, solutions. Publisher: Bingley, UK: Emerald Editors: Perrels A., Himanen V., Lee-Gosselin M.

Stock Logistic, 2019. Available at:https://www.stocklogistic.com/puertos-secos/ [accessed 26/07/2021].

Transport & Environment, 2021. Available at: https://www.transportenvironment.org/what-we-do/shipping-and-environment [accessed 26/07/2021].

UNWTO, 2021. World Tourism Organization. International Tourism Highlights, 2020 Edition, UNWTO, Madrid.

Figshare, A repository for all open access resources. Available at: https://www.figshare.com/[accessed 26/07/2021].

Vico Maimó J.L., 2015. Turismo de cruceros en el Mediterráneo. Memoria delTreball de Fi de Grau. Facultad de turismo.

DISCLAIMER

The present document has been produced with the financial assistance of the European Union under the ENI CBC Med Programme. The contents of this document are the sole responsibility of *the University of Murcia (UMU)* and can under no circumstances be regarded as reflecting the position of the European Union of the programme of structures management.

PARTNERS

ASSOCIATES PARTNERS

Bs partage 95 05 05 15
Design and Editing