DestiMED PLUS

Ecotourism in Mediterranean Destinations: From Monitoring and Planning to Promotion and Policy

Protected Area's Vulnerability to Tourism Pressure map

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Acronyms

EUROSTAT - Statistical office of the European Union

EMODNet - European Marine Observation and Data Network

EEA – European Environment Agency

KBA- Key Biodiversity Areas

MPA- Marine Protected Areas

NUTS (2/3) - Nomenclature of territorial units for statistics (level 2 and 3)

WDPA – World Database on Protected Areas

Executive summary

The scope of the present report is to conceptualise and design a so-called “Mediterranean protected area’s vulnerability to tourism pressure map” that analyses the overlap of tourism pressures and biodiversity protection in place in the Euro-Mediterranean area.

The study shows spatially explicit patterns of tourism pressures at different levels of detail (from NUTS2 to 1 km grid) and provides a first version of a map focussing on the Mediterranean protected area’s vulnerability to tourism pressures. This map highlights the interplay between tourism pressure and biodiversity protection. It shows areas in the Euro-Mediterranean region where mitigation of pressures is of high importance to reduce vulnerabilities, and regions where ecotourism approaches are likely to be successful by maintaining the level of biodiversity protection and limiting the effect of tourism pressure

The assessment of the Mediterranean protected area’s vulnerability to tourism pressure map has identified key regions that show high to very high vulnerability with specific characteristics that need to be tackled in upcoming policy initiatives and management decisions. The most vulnerable regions are coastal regions in the Western Mediterranean with a high coverage of protected area (>30% of its territory), and characterised by high to very high demand (e.g. number of nights spent) and very high tourism offer (high number of bed places and establishments), leading to potential high pressure on sensitive ecosystems. These regions require regional planning regulations that prevent tourism related constructions to occupy protected areas as well as smart destination management to channel and limit visitors’ flows. Some of these regions include in addition important cruise destinations or high density of tourism infrastructure (golf courses and marina ports) that require specific management decisions and regulations linked to international maritime traffic and urban and coastal planning instruments, respectively. Other highly vulnerable regions such as the coastal regions in the Adriatic-Ionian ecoregion and the Aegean Sea are less exposed to pressures from tourism infrastructure, but require special attention due to the high tourism demand and offer. Finally, most hinterland regions and destinations show low vulnerabilities due to low exposure to main tourism pressures. Nevertheless, the growing promotion of rural ecotourism must be handled in such a way that tourism offer, demand and activities and related infrastructure do not negatively affect the situation in protected areas.

Finally, the report summarises the limitations and potential of the methodological approach, highlighting the need for better and more - spatially-explicit - data and the need for expanding the assessment to the whole Mediterranean basin given the transboundary character of drivers, pressures and impacts. These improvements would help to better assist policy-making in relation to the management and implementation of tourism activities in Mediterranean protected areas. Furthermore, potential links to the ecological footprint and bio-capacity approach are drawn for future exploration.

1. Introduction

Tourism has always been – from a historical perspective – a societal response to the human need for wellbeing and personal development, through interaction with other people and the environment. Globally, demand for tourism and recreation opportunities has grown steadily over the last decades. Tourism development, beyond its contribution to national economies, is a major driving force that impacts essential environmental assets (air, water, biodiversity, soil,

land), both in tourist destinations (locally) and on a global scale. At the same time, the recent COVID-19 pandemic has shown the vulnerability of tourism regions in social and economic terms. The reduction in environmental pressure due to the sharp decrease in travelling was a clear indication that new models of tourism are needed to balance the economy and the social and environmental well-being.

The surge in specific types of tourism (e.g. cruise tourism) and the increased frequency of holidays have serious environmental impacts at the regional and local level. Major tourist destinations are faced with challenges related to seasonal water supply, pressure on local water sources, waste generation and management, as well as wastewater generation and treatment, which may exceed, in some cases, the carrying capacity of the territories (especially small and medium-sized islands). Also, land take and soil sealing, air and noise pollution from local means of transport, as well as visual pollution by the ever-expanding built-up areas, represent other – quite common – traceable consequences of tourism development

Tourism is of major importance to European economies, but a damaged environment could undermine tourism in the future, because tourism needs a clean and attractive environment. Therefore, it is necessary to monitor and measure the impact of tourism on the environment, and implement tourism-related policies to ensure greater sustainability of the sector

The Mediterranean region is one of the major global biodiversity hotspots and, at the same time, the world's leading tourism destination in terms of international and domestic tourism. The constant increase in tourist arrivals and tourism related infrastructure and activities pose important pressure particularly on the coastal and marine environment, even after the tourism crisis happening as a consequence of the Covid-19 pandemic. This requires concrete and joint actions, particularly in areas with sensitive environments such as protected areas, to address these developments. These actions, in turn, must be based on strong evidence using both environmental and socio-economic data available at different scales.

In this context, the Interreg Med project DestiMED PLUS aims to improve the levels of integration between regional tourism and conservation policies in Mediterranean Protected Areas (PAs) through the creation of ecotourism itineraries which are to be developed using a collaborative approach, both locally and regionally. The ambition of DestiMED PLUS is to help Mediterranean regions to create the knowledge, expertise and enabling conditions for planning, monitoring and measuring ecotourism in parks and beyond.

The present report supports the specific objectives of the project, particularly to improve the integration of regional tourism and conservation policies in Mediterranean Protected Areas, applying integrated planning and governance strategies by analysing the overlap of tourism pressures and biodiversity protection in place. The scope of the study is to conceptualise and design a so-called "Mediterranean protected area's vulnerability to tourism pressure map".

The results of the study will show spatially explicit patterns of tourism pressures at different levels of detail (from NUTS2 to 1 km grid) and will provide a first version of the Mediterranean protected area's vulnerability to tourism pressure map. This map highlights the interplay between tourism pressure and biodiversity protection. It evidences areas in the Euro-Mediterranean region where mitigation of pressures is of high importance to reduce vulnerabilities, and regions where ecotourism approaches are likely to be successful by at least maintaining the level of biodiversity protection and limiting the effect of tourism pressure. The map would be used as a technical data evidence for capitalisation activities and policy work, mainly for the Mediterranean Ecotourism Policy Roadmap.

The report first provides a methodological overview, including a description of the data used and the techniques for the processing of indicators. In a second part it describes and analyses the results of the single and combined tourism pressure at Mediterranean level.

2. Methodology.

2.1. Overall approach

Tourism demand, offer and activities pose pressure on the environment. There is a clear need to measure, analyse and assess these pressures to understand where and when these pressures occur and how they overlap with sensitive ecosystems and protected areas. This integrated knowledge can then be used to come up with management and policy recommendations for policymakers and protected areas managers.

The definition of drivers and pressures for this analysis is based on the standardised DPSIR framework (Drivers, Pressures, State, Impact and Response model of intervention), a causal framework that has been widely used to define and assess the interactions between society and the environment (EEA, 1999). Developed to analyse environmental problems arising from human activities with the objective to assist in achieving sustainable development, DPSIR has proven to be a coherent structure for the integration of information of biophysical and socio-economic interactions across spatio-temporal scales. Most importantly, it provides an organisational diagram, which brings together, summarises, and visualises information in a standardised, logical and hierarchical way. Both policy- and solution-oriented, DPSIR offers a framework for categorising a problem domain along the cause-effect chain, helping to communicate linkages and relationships to stakeholders involved in the assessment work. Finally, the DPSIR structure is also considered to be an ideal means to structure environmental data (EC 1999). The basic notion of the DPSIR framework applied in this study is that an economic activities such as tourism among others act as drivers (or driving forces) and exert pressures on the terrestrial, coastal and marine ecosystem (e.g., through overexploitation of the natural resources, habitat loss and pollution) thereby changing its state and the associated flow of ecosystem services. While social, demographic and economic developments are the underlying cause of change and initiation of the drivers, pressures are the actual stimulus (tourism demand, offer, infrastructures) that, through alterations of the state of the system. It is the pressures that ultimately affect ecosystem and human well-being, as manifested by impacts such as decrease in biodiversity.

The approach applied in this study uses geospatial data and spatial analysis techniques that allow quantifying and mapping the pressures arising from tourism, overlaying them with the current network of protected areas (and KBAs) and assess different degrees of vulnerabilities. The basic idea of this approach is to analyse and assess, in a spatially explicit way, where high intensities and densities of tourism activities overlap with protected areas, i.e. where sensitive terrestrial, coastal and marine environments are exposed to high degrees of threats.

Figure 1 shows a schematic overview of the methodological approach. The individual tourism pressure indicators will be combined to come up with a combined tourism pressure map. This will be overlaid with a spatial layer of protected areas and KBAs to identify the vulnerabilities of protected areas to tourism pressures at basin and regional level. The spatially explicit approach allows analysing and assessing vulnerabilities at different scales in the Euro-Mediterranean region.

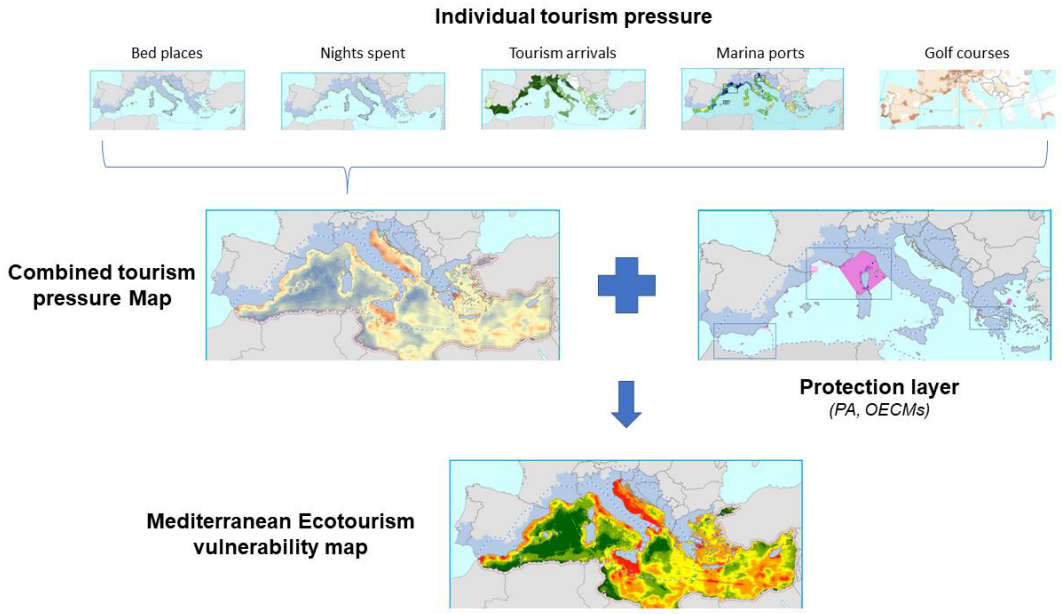

Figure 1: Methodological approach for the design of a Mediterranean protected area's vulnerability to tourism pressure map

2.2. Selection and definition of tourism drivers and indicators

The drivers and pressures considered as the most relevant ones for tourism activity in the Mediterranean were identified based on previous work (Abdul Malak et al. 2015, Guilietti et al. 2018). Additional indicators were identified based on new data sources after a review of scientific literature on the topic and data on frequently used data portals (e.g., EUROSTAT, EMODnet, EEA, etc.).

The most important criteria for including the indicators in the analysis was the availability and quality of data. After the identification of the indicators, a comprehensive data review was accomplished to ensure the data availability, data quality and fitness for the purpose of proposed data sources. The required datasets needed to match the following criteria:

- Data coverage (at least full coverage of one of the regional seas);
- Date (i.e., data should be as updated as possible);
- Being spatial-explicit (i.e., data linked to a data point, grid cell or small administrative unit, not country statistics).

Based on these criteria, eight indicators were finally agreed upon for their analysis, grouped into three driver categories.

Table 1: List of tourism related drivers and indicators identified for the analysis.[1]

[1] A full description of each indicator is included in the indicator fishes in Annex 6.2.

Driver	Indicator
Tourism offer	Number of bed places (per km^2 in coastal/non-coastal areas)
	Number of tourism accommodation establishments (per km^2 in coastal/non-coastal areas)[2]
Tourism demand	Number of nights spent at tourist accommodation establishments (per km^2 in coastal/non-coastal areas)
	Number of cruise passengers per port
	Number of arrivals (per NUTS2)
Infrastructure linked to tourism activities	Marina port capacity (per NUTS3 and km of coast)
	Density of pleasure craft (per 1km pixel)
	Density of golf courses (per NUTS3)

2.3. Data review and collection

The selected main drivers and tourism indicators were used to structure the data collection. Data for each indicator was collected, storing a wide range of attributes for each single dataset, including format (raster, vector, table data), resolution, temporal and spatial coverage, data source, state of availability, gaps and limitations (see Annex 6.1).

In addition to the tourism indicators, data related to areas of ecological interest, i.e. protected areas, both terrestrial and marine, and Key Biodiversity Areas (KBAs), were obtained for the vulnerability analysis.

2.3.1. General approach used for mapping and data integration

In terms of data coverage, the first step was to clearly define the area of interest for the analysis. Being DestiMED PLUS an Interreg MED Project it was agreed to focus on the MED Cooperation Area for the analysis of tourism indicators and produce the vulnerability map. Coastal/non-coastal areas delimitation follows the EUROSTAT definition: a coastal area consists of those municipalities that border the sea or that have 50% of their surface within 10km from the sea.

The map template was produced to cover the study area and the whole Mediterranean region in an A4 sheet. The templates use a scale of 1:14,500,000 and the ETRS 1989 LAEA projection as the standard reference, providing a shape that maximises the size of the study areas on the maps. As base information, the template uses the GISCO statistical unit at 1:10,000,000, being the most suitable to the scale of the map, and the Mediterranean ecoregions defined by Spalding et al., 2007. In addition, the Interreg Med Cooperation Area regions were highlighted using the GISCO NUTS distribution.

The template also includes the standard mapping elements (i.e., legend, north arrow, scale bar) as well as the reference to the source data and a description of the illustrated indicator.

[2] Tourism accommodation represent hotels and similar accommodation, holiday and other short-stay accommodation, camping grounds, recreational vehicle parks and trailer parks (based on Eurostat definitions). A significant part of the holiday rentals in NACE 55.2 (holiday accommodation) is currently not represented in the official statistics and does not consider tourism apartments (e.g. Airbnb, etc.).

Indicators based on statistics at NUTS 2 and 3 level were integrated into the GISCO layer. For the calculation of geometries (areas, coastline length, etc.) the layer with the highest available resolution (1:1,000,000) was used to obtain the best spatial accuracy. No data areas were identified with the value 999,999,999 to distinguish them from 0 in those cases where this was the real value of the data. EUROSTAT identifies them with the symbol ';' which cannot be used on numeric fields in the GIS layers.

Spatially explicit indicators produced as raster datasets were processed at 1 km resolution and snapped to a reference grid at 1km x 1km resolution. This grid is an extension of the reference grid developed for the whole of Europe by the EEA. The grid is used to record land and sea attributes for each grid cell (human activities, pressures, observations, etc.), as well as information relating to the species and habitats found at that location. The data for each cell can then be aggregated, for reporting purposes and pressure analysis generated for any larger spatial unit. In this way, spatially explicit analyses can be generated and the input data that underlie these analyses can be traced back. This was done with the aim of producing spatially compatible data with other datasets, such as those generated by Abdul Malak et al. (2015) for the Mediterranean Sea and which can ensure spatial continuity to the assessment in the future.

The coordinate system for all data is ETRS 1989 LAEA (EPSG:3035), following the EEA standards. It also fits the technical requirements, as a coordinate system projected in metres instead of degrees is needed to calculate some of the indicators.

A full list of the final maps developed during the assessment and their description is available in appendix 6.3.

2.3.2. Data review

The data review is based on a comprehensive evaluation process that considers the thematic content of the data, their limitations and their relevance. Technical reports and reporting data from national and regional policies and regulations were considered. The data content and its relevance were checked for different aspects: thematic relevance (drivers and pressures covered), format (raster, vector, tabular, etc.), resolution and scale (administrative units, grid, point data etc.), reference data used to produce the dataset, etc. The methodology used to produce the data as well as the uncertainty was considered. Other criteria that were also considered included whether the data belong to a reliable source, whether they have had a validation process or have been used in other relevant studies. Links to policies or reporting obligations were also considered.

Available data on tourism offer, demand and activities are quite limited in the Mediterranean region being mainly the databases available in EUROSTAT, in addition to some EMODnet and EEA indicators. These data did not allow an analysis of the entire Mediterranean region since its coverage was limited to the Interreg Med Cooperation area.

Identified sources contain mainly data aggregated by NUTS2 or NUTS3 regions, requiring later a disaggregation process to obtain spatial-explicit tourism indicators.

2.3.3. Data collection

The data finally collected for the analysis include:

- Official datasets and statistics from EUROSTAT:
  - GISCO statistical unit dataset containing NUTS regions and territorial land boundaries.
  - GISCO transport network dataset containing port location.
  - Number of establishments, bedrooms and bed-places by NUTS 2 regions (Eurostat code: tour_cap_nuts2c)
  - Nights spent at tourist accommodation establishments by NUTS 2 regions (Eurostat code: tour_occ_nin2c)
  - Arrivals at tourist accommodation establishments by NUTS 2 regions (Eurostat code: tour_occ_arn2)
  - Passengers embarked and disembarked in all ports by direction - annual data (Eurostat code: mar_pa_aa)

- European Commission datasets:
  - Density of maritime traffic of pleasure craft, produced by EMODnet.
  - Indicator on density of golf courses by NUTS3 areas, produced by EEA.

- Global datasets
  - Distribution of protected areas from the World Database on Protected Areas (WDPA), produced by UNEP-WCMC and IUCN.
  - Key Biodiversity Areas (KBAs), provided by the KBA Partnership[3]
  - Marine Ecoregions of the World (MEOW), provided by WWF.

- Mixed sources:
  - Location of marinas and number of moorings, based on georeferencing and data from Plan Bleu, 2014; Spanish Federation of Associations of Recreational Marinas, 2014; EEA, 2014; Portbooker.com, 2022. Produced by ETC-UMA.

2.4. Indicator calculation

This section provides an overview of the processing steps performed to calculate the single tourism pressure indicator (see Figure 1) clarifying how the single indicators were prepared for the further processing steps. The section is divided into different types of indicators from a processing point of view. The pressure indicators relate to them in the following way (see Table 2)

[3] BirdLife International (2022). *The World Database of Key Biodiversity Areas*. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. Available at www.keybiodiversityareas.org. [Accessed (23/05/2022].

Table 2. List of tourism related pressures, indicators and indicator types

Tourism offer	Number of bed places (per km^2 in coastal/non-coastal areas)	Disaggregated indicators
	Number of tourism accommodation establishments (per km^2 in coastal/non-coastal areas)	Disaggregated indicators
Tourism demand	Number of nights spent at tourist accommodation establishments (per km^2 in coastal/non-coastal areas)	Disaggregated indicators
	Number of cruise passengers per port	Ready-to-use indicators
	Number of arrivals (per NUTS2)	Ready-to-use indicators
Infra-structures	Marina port capacity (per NUTS3 and km of coast)	Aggregated indicators
	Density of pleasure craft (per 1km pixel)	Ready-to-use indicators
	Density of golf courses (per NUTS3)	Ready-to-use indicators
PA coverage	Protected area layer	Protected area layer

2.4.1. Ready to use indicators

Ready-to-use indicators are based on existing datasets that describe the tourism pressure themselves. In these cases, the only processing required has been the harmonization of the spatial data to adjust it to the study area coverage and ensure the scale and projection match the one used in the assessment. Therefore, it has not been necessary to modify the original data, but to integrate and represent them in the mapping template.

These ready to use indicators are:

- Number of cruise passengers per port
- Number of arrivals (per NUTS2)
- Density of pleasure craft (per 1km pixel)
- Density of golf courses (per NUTS3)

2.4.2. Disaggregated statistical indicators

Tourism offer and demand indicators were disaggregated to km^2 grid cells. These indicators include density of tourism capacity and nights spent:

- Number of bed places (per km^2 in coastal/non-coastal areas)
- Number of tourism establishments (per km^2 in coastal/non-coastal areas)
- Number of nights spent at tourist accommodation establishments (per km^2 in coastal/non-coastal areas)

These indicators are based on EUROSTAT tourism statistic on bed places, nights spent at tourist accommodation establishments and urban areas distribution from the Copernicus Coastal Zones and Corine Land Cover.

Tourism statistics differentiate between coastal and non-coastal areas within a NUTS2 region, based on the EUROSTAT definition. The land cover data was previously aggregated at 1 km^2 in order to calculate the percentage of urban areas in each cell with respect to the total of the

NUTS2 region. Copernicus Coastal Zones was used for counting urban coverage in the coastal area, while Corine Land Cover was used in the non-coastal area.

The total number of beds, establishments and nights spent in coastal areas of a NUTS2 region were disaggregated to the most urban intensity at 1 km^2 defined by the land cover data assuming that most bed places and establishments are located in areas with high urban density. Results are showing low to high intensive tourism capacity and demand per km^2 pixel.

2.4.3. Aggregated indicator

The indicator on marinas and recreational shipping represents the number of moorings in marina ports per kilometre of coastline for each NUTS3 region. The total number of moorings was obtained from data compiled by ETC-UMA on the location and capacity of the marinas, assigning each port its corresponding NUTS3 code and counting the total number of moorings. This value was divided by the length of the NUTS3 coastline in km. Results show low to high intensive capacity for this activity by region.

As ancillary data, this indicator is accompanied by an area of influence of each marina based on an exponential decay according to its capacity (number of moorings), with a maximum extension of 20 km. This layer allows detecting the distribution of marina ports and its potential area of pressure on marine and coastal ecosystems, being greater in those places where the activity is more concentrated.

2.4.4. Protected area layer

All protected areas designations included in the World Database on Protected Areas (WDPA) overlapping with the Interreg Med Cooperation Area regions, excluding Other effective area-based conservation measures (OECMs), were extracted to show the distribution of land and coastal protected areas. To extract marine protected areas (MPAs), the WDPA was filtered by country of the Interreg Med region and, finally, a manual selection was made to discard the MPAs out of coverage in the cases of north Portugal and France.

Key Biodiversity Areas, provided by the KBA partnership, were included as ancillary data on relevant ecological areas using the same approach.

All geometries were preserved unaltered to show full coverage of the protected areas and KBAs both inside and outside the Interreg MED region.

2.5. Combined pressure and vulnerability analysis

Based on the described single pressure indicators and the protected area data, the combined pressure and vulnerability analysis was performed which is described in the following sub-sections.

2.5.1. Cumulative tourism pressure indicator

Single indicators were combined in a cumulative tourism pressure indicator to represent the added effect from different sources. It has only been possible to produce this indicator at the NUTS3 level due to limitations in the scale of the data. This, however, offers an indicator that is easy to interpret and communicate.

Indicators on golf courses, marina port capacity, tourists arrivals and tourism density, measured as number of beds, establishments and nights by km^2, were reclassified in five categories from very low to very high based on the statistical distribution of values (natural breaks). These

categories were represented by numbers from 1 to 5, being 1 the minimum pressure value (very low) and 5 the maximum (very high).

Prior to this operation, tourism density data at 1 km^2 were aggregated to NUTS3 by counting and summing the pixel values within each region. Data on tourists arrivals, available in NUTS2, were disaggregated to NUTS3 using the percentage of urban coverage in each region.

After the reclassification of values of each individual indicator, the combined value of them was calculated for each NUTS3 region by means of a weighted sum. Since no specific weights were defined for the individual indicator, the same weight was used for all of them. Therefore, the result is equal to the mean of the values. Result shows the cumulative pressure by NUTS3 areas classified in five categories: very low (0 to 1.0), low (1.1 to 2.0), moderate (2.1 to 3.0), high (3.1 to 4.0) and very high (4.1 to 5.0).

Indicator on number of cruise passengers per port was included as an ancillary layer to highlight those NUTS3 region where the activity takes place, being an indicator of the type of tourism in the area.

Density of pleasure craft (per 1km pixel) was not considered in the analysis due to it exclusively maritime coverage and being the pressure already included in the capacity of the marinas.

2.5.2. Land and sea vulnerability analysis

Land vulnerability was based using the cumulative tourism pressure indicator and the surface percentage of protected area inside each NUTS3. This percentage was classified into five numerical classes, from 1 to 5 (very low to very high), based on the following thresholds: 1) lower than 10%; 2) from 10 to 17%; 3) from 17 to 30%; 4) from 30 to 50%; and 5) higher than 50%. The vulnerability was calculated by the mean value of cumulative and protected areas percentage classes, assuming that those areas with greater pressure and protected areas are more vulnerable. The resulting layer represents the ecological vulnerability in terrestrial areas in five categories from very low to very high.

Vulnerability in marine areas was based on the density of pleasure craft indicator only. Mean traffic intensity, expressed as total hours of vessels presence per month, were calculated inside each MPA and KBA polygon and reclassified in five categories according to the statistical distribution of values (natural breaks). The resulting layer represents the ecological vulnerability in marine areas in five categories from very low to very high.

3. Results

3.1. Individual tourism pressure maps

Based on the methodology presented above the individual tourism pressure maps[4] were processed and delivered, providing an overview of the distribution of individual tourism pressure in the Euro-Mediterranean basin.

The results are presented by category (tourism offer, demand, activities).

3.1.1. Tourism offer

As expected, the tourism offer, both in terms of establishments and bed places is highly concentrated in coastal regions of the Euro-Mediterranean region. There are just a few exceptions with high numbers in Sevilla (ES) and Florence (IT). The disaggregated data (see data for tourism establishments in Figure 2 and Figure 3) shows that major hotspots of tourism offer are in the NUTS3 regions of Algarve (PT), Cádiz, Málaga, Alicante, Valencia, Tarragona, Barcelona and Girona, Balearic Islands (ES), Lazio, Emilia-Romagna and Veneto (IT), as well as Istria (HR), Malta, as well as in Central Macedonia and most of the Aegean Islands of Greece.

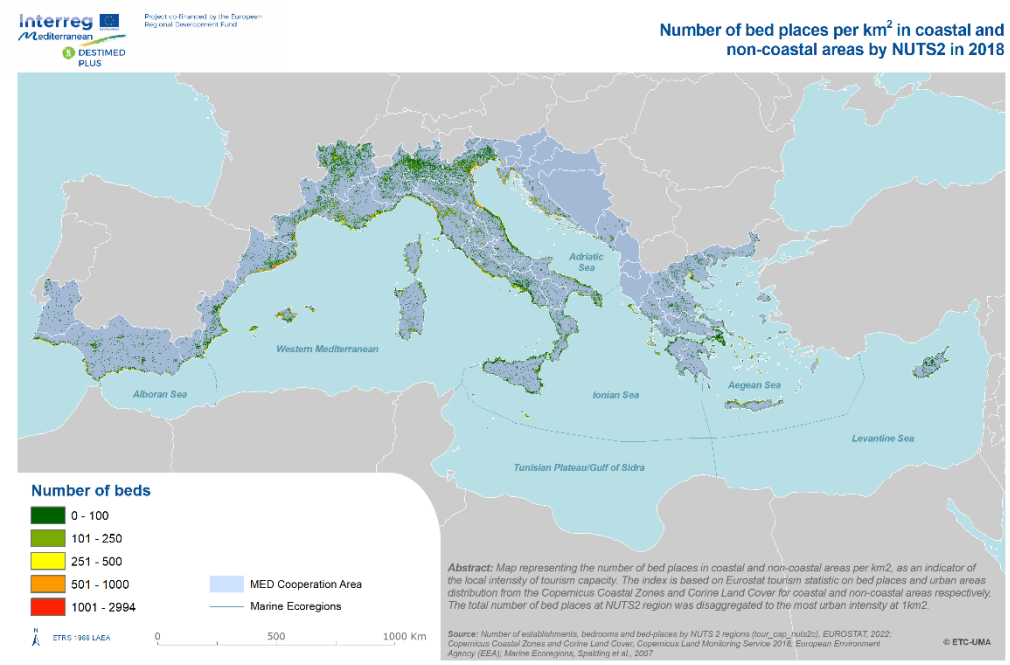

Figure 2: Number of bed places per km² in coastal and non-coastal areas by NUTS2.

There is a high concentration of bed places with a relatively low number of establishments in some countries (e.g. Portugal, Spain, France) and vice versa, i.e. low bed places density with high number of establishments in others. (e.g. Italy, Croatia, Greece, Cyprus). For the top six regions with the highest number of bed places (Alpes Maritime, Bouches-du-Rhone, Herault, Barcelona, Mallorca, Venezia), only Venezia has also a high number of establishments, while the others are classified as very low to medium. The high share of beds per establishments in this group of regions indicates a concentration of big hotel and apartment complexes with its related use of resources and generation of residues. On the other hand, the regions with the highest number of establishments (Venezia and the coastal regions of Croatia) also show a high

[4] All maps are included in Annex 6.3

number of beds. This may indicate a higher number of smaller hotels and other touristic establishments that may in turn lead to higher demands of land for constructed areas.

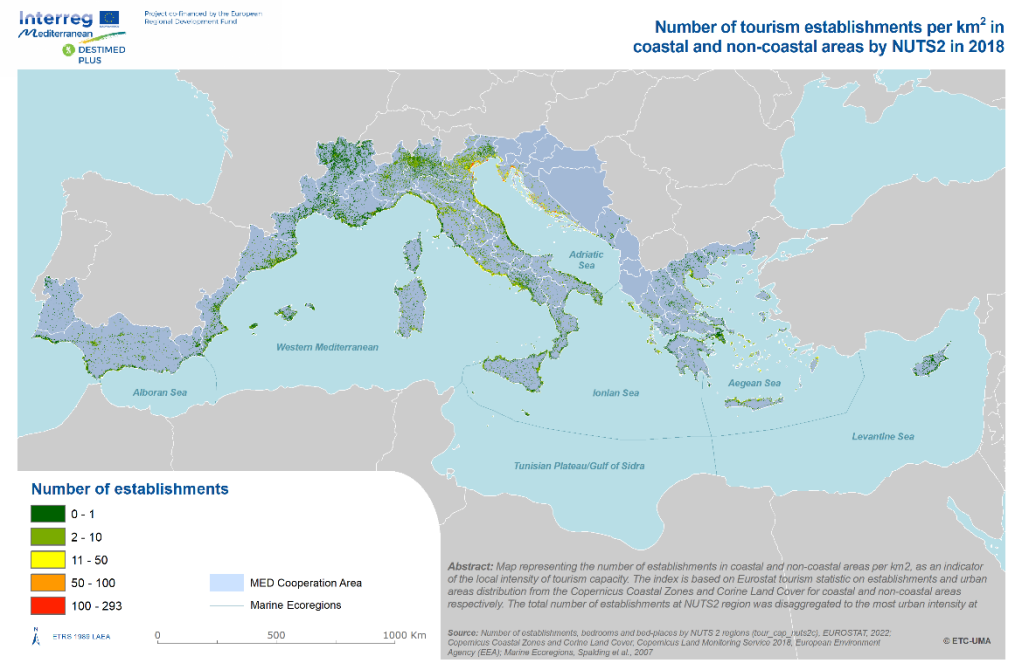

Figure 3: Number of tourism establishments per km² in coastal and non-coastal areas by NUTS2.

3.1.2. Tourism demand

In line with the previous section, the indicator on the number of nights spent is one the most indicative variable to understand the real demand for resources for tourism purposes (see Figure 4). In this case the urban or city-dominated destinations such as the Barcelona area, Palma de Mallorca, Venice, Rome, Heraklion (Crete), the Rijeka and Split area (Croatia) could be highlighted as hotspot areas of tourism demand. The pattern again reveals the heavy concentration on the coastal strips of all Mediterranean regions, to such a degree that e.g. in Andalusia, the area classified as high or very high tourism demand in terms of nights spent account for 46% of all nights spent in Andalusia, but only covers 5% of its urbanised territory. Furthermore, a more specific demand indicator at cruise ports, the number of cruise passengers reveals the high pressure on urban environments in major cruise ports in Mallorca, Barcelona, Marseille, Genova, Civitavecchia and Genova, to name just the major cruise ports. While the number of ports in the Western Mediterranean and Alboran Sea is relatively limited with a high concentration in major ports, Adriatic, Ionian and Aegean Sea are characterised by a high number of small ports.

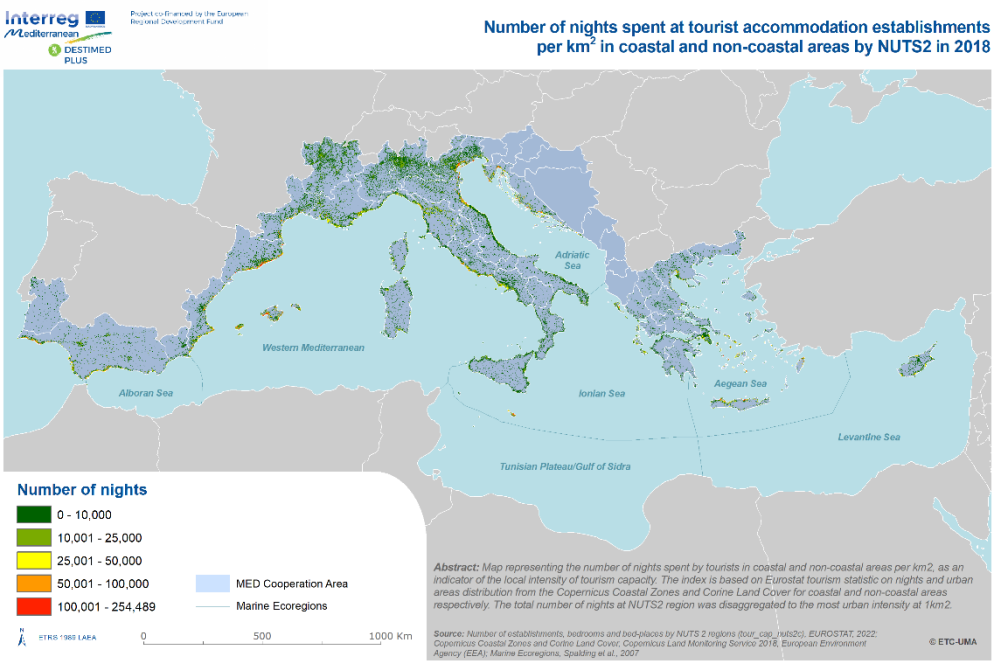

Figure 4: Number of nights spent per km² in coastal and non-coastal areas by NUTS2.

3.1.3. Infrastructure for tourism activities

The indicators for tourism activities represent very specific tourism-related pressures with localised impacts on resources such as water abstraction (golf courses), coastal dynamics (marina ports) and sea bed habitats and species (pleasure crafts). Golf related tourism (see Figure 5) is a very important sub-sector in terms of spatial extent in the coastal regions of Portugal, Spain, Malta and France, particularly the Algarve, Cádiz and Marbella, Alicante, Girona, Bouche du Rhone and Var, all of which show very high to high levels of nights spent and tourism offer (see above). Other regions (Italy, Western-Balkan countries, Greece and Cyprus) show moderate to very low coverage, with some exceptions (e.g. Rimini, Gorizia, Trieste, Kerkyra).

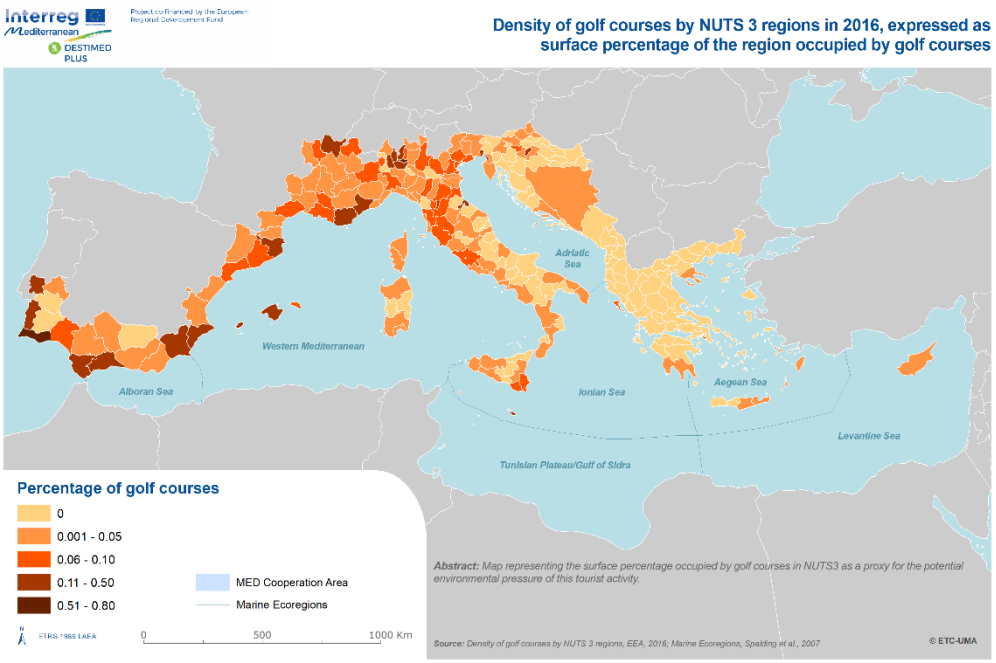

Figure 5. Map on density of golf courses by NUTS3.

Marina ports capacity (= number of moorings per coastline of NUTS3, see Figure 6) highlights the high density in the north-western Mediterranean (from Barcelona till Nice) and in the northern Adriatic. Marina ports developments have major impacts on the coastal ecosystems and coastal dynamics as well as generate major impact on the surrounding waters by leisure boat tourism, including anchoring. These direct pressures are well illustrated by the density of pleasure craft indicator that shows very high densities in coastal regions at the border between Italy and France as well as between the islands Corsica and Sardinia. The Croatian coast as well as the Greek Aegean Islands and the Balearic Islands are other areas of high densities.

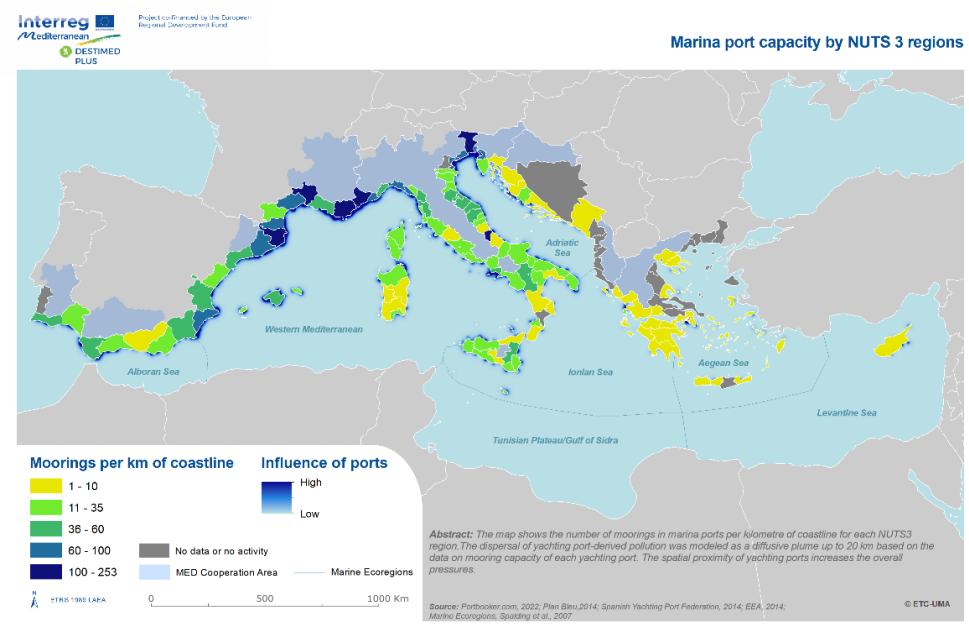

Figure 6: Marina port capacity per NUTS3 coastline

3.2. Combined tourism pressure map

Following the methodology described earlier, the different indicators of tourism pressures were combined to come up with a cumulative tourism pressure map and assess its distribution and characteristics.

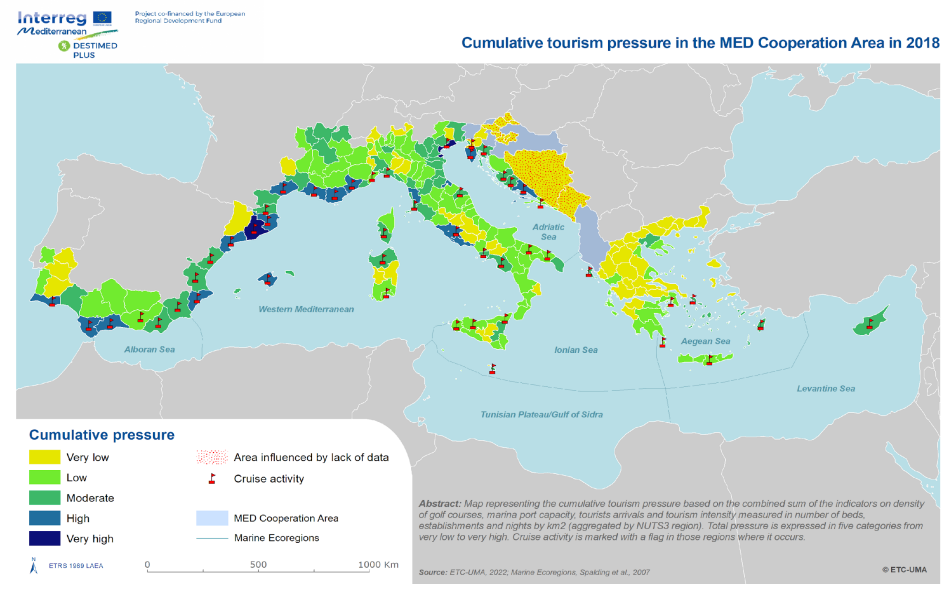

Figure 7: Cumulative tourism pressure map

The map (see Figure 7) confirms previous results (e.g. Plan Bleu 2016, Guiletti et al. 2018) in highlighting the main tourism destinations and the concentration of highly pressured regions in the Western Mediterranean as well as in the Northern Adriatic. Overall all regions with high and very high pressures are located in coastal areas. Just a few regions with moderate pressures are interior regions such as French regions in the Rhone-Alpes linked to urban and Alpine tourism (e.g. Lyon, Grenoble, Savoie), or Italian regions in Lombardy (Milan), Veneto (Verona) and Tuscany (Florence). In the Western Mediterranean, including Alboran Sea and the Portuguese coast, the Algarve, Cádiz and Málaga, Valencia, Mallorca as well as the Catalan coast (Girona, Barcelona, Tarragona) and finally the whole French coast from Herault over Bouche du Rhône till Alpes Maritime and the Italian regions of Pisa, Rome and Latina stand out due to high to very high levels of tourism pressure. In the northern Adriatic Rimini, Venice, Pula and Split are the most pressured regions. On the other side, the main islands in the Western Mediterranean, Corsica and Sardinia, and the regions around the southern Adriatic, the Ionian and the Aegean Sea show only very low to moderate combined pressures.

This geographical distribution does not provide an indication about which single pressures characterise the differences between the regions. Table 3 provides an overview of the main characteristics of the most affected regions. This overview shows that very high and high combined pressures are always linked to high or very high demands and offers, while there are differences in secondary indicators such as tourism infrastructure or the presence of cruise ports. For instance, this top 10 list includes regions with a big or very attractive urban centre such as Barcelona, Venezia or Bouches-du-Rhone as well as regions with more dispersed demand and offer, but with important tourism infrastructure (e.g. marina ports and golf courses) that adds additional pressure to the territory, such as in Girona, Alicante, Var and Cádiz.

Table 3: NUTS3 regions with highest combined tourism pressures

NUTS 3 region	**Main characteristics**
Barcelona (ES)	• High to very high demand • Very high bed offer, low establishments • Important cruise destination (Barcelona)
Mallorca (ES)	• High to very high demand • Very high bed offer, low establishments • Important cruise destination (Palma de Mallorca) and tourism infrastructure (marina ports)
Venezia (IT)	• High to very high demand • Very high bed offer, low establishments • Important cruise destination
Bouches-du-Rhone (FR)	• High to very high demand • Very high bed offer, low establishments • Important cruise destination (Marseille)
Alpes-Maritimes	• High demand • Very high bed offer, low establishments • Very high density of tourism infrastructure (marina, golf)
Roma (IT)	• High to very high demand • Very high bed offer, low establishments • Important cruise destination (Civitavecchia)
Girona (ES)	• High demand

	• Very high bed offer, low establishments • Very high density of tourism infrastructure (marina, golf)
Alicante/Alacant (ES)	• High demand • High bed offer, low establishments • Very high density of tourism infrastructure (marina, golf)
Var (FR)	• High to very high demand • Very high bed offer, low establishments
Cádiz (ES)	• High demand • Moderate bed offer, low establishments • High density of golf infrastructure

Rural NUTS3 regions primarily in Slovenia and Croatia as well as in Greece are among the areas with lowest combined pressures. While most of the single pressure indicators are at a very low or low level, some regions of them count with moderate to high pressure from golf courses such as in Posavska (SI) and Grad Zagreb (HR). As can be seen when compared to the urban-rural classification of NUTS 3 regions (Eurostat 2018, see Figure 8), the regions with very low pressures correspond to a large degree to *Predominantly rural regions*. The correlation between degree of combined pressure and rural-urban typology can be exemplified in the island of Sardinia where the regions with very low combined pressures coincide with the predominantly rural areas while the low and moderately pressured regions in the northern and southern part correspond to the intermediate regions.

On the other hand, several regions in Sicily, Apulia, Piedmont, Andalusia, the Athens metropolitan area among others are defined as predominantly urban (incl. Athens, Turin, Palermo, Seville), but are among the regions with low and even very low tourism pressures due to relatively low tourism demand and offer and limited density of tourism infrastructure. There are exceptions such as Zagreb, Prato, Monza, Varese and Como where the pressure related to golf courses is high or very high, but the rest of indicators are relatively low leading to an overall low or very low combined pressure.

Furthermore, in the predominantly rural regions, 10 regions represent moderate combined pressures, including coastal regions in Croatia (e.g. Istarska Županija), Italy (e.g. Alessandria, Grosseto, Rovigo), Greece (e.g. Kerkyra) and France (e.g. Aude, Ain). Even though they are characterised as rural, they have a moderate to high tourism offer and demand, but mostly lack tourism infrastructure.

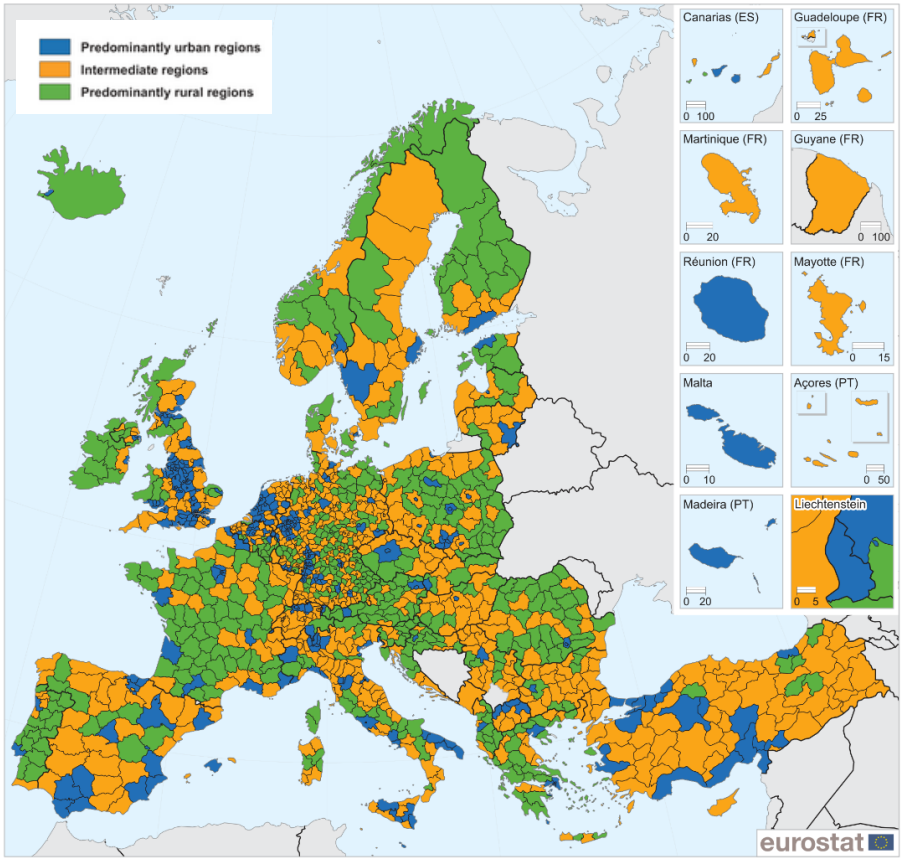

Figure 8: Eurostat's Urban-Rural Typology

As can be seen below (section 3.3), the rural character is linked to a high share of protected areas in these regions in addition to lower tourism offer and lack of tourism-specific infrastructure, even in coastal regions.

3.3. Protected Area's Vulnerability to tourism pressure map

The final Mediterranean protected area's vulnerability to tourism pressure map combines the cumulative tourism pressures and the protected area layer (see section 2.6) to assess the vulnerability of regions linked to tourism. This analysis and the assessment is divided into the terrestrial and the marine part. The cumulative pressure map described above combines all pressure indicators available for the terrestrial part. The spatial analysis with protected area data was done at the level of the provinces, i.e. analysing the share of NUTS3 territory under legal protection and the level of tourism pressure, with the aim of extracting the level of vulnerability of protected areas to tourism pressures.

For the marine environment, tourism pressure is described only with the presence of pleasure boats that is combined with the marine protected areas (MPA), extracting the degree of pressure per MPA.

3.3.1. Terrestrial protected area's vulnerability to tourism pressure map

Figure 3 presents the terrestrial protected area's vulnerability to tourism pressure map, showing the degree of vulnerability from very low to very high. The map partially mirrors the cumulative tourism pressure map with a clear concentration of high vulnerabilities in coastal regions in the Western Mediterranean, but it also reveals that some regions that appeared with

low or very low cumulative tourism pressure are actually highly or very highly vulnerable due to the large overlap with protected areas.

This is the case for several regions in Greece (Arta-Prevez, Ionian Sea, and the islands of Andros, Thira, etc.) in the Aegean Sea, as well as the Belluno in the north and Salerno and Imperia in the south of Italy, all coastal regions in Croatia, in the alpine regions in France (Alpes de Hautes Provence, Isere and Hautes Alpes) as well as Corsica and Cyprus. The high degree of vulnerability is clearly linked with the large share of legal protection in these areas, both on the coast and in mountainous regions.

The areas with moderate vulnerability encompasses regions that have

- very high share of protected areas (>50%), but with very low combined pressures, such as Obalno-kraška (SI), Lozère (FR) or Pella (EL)
- high share of protected areas (30% - 50%) with low to very low combined pressures such as Lasithi (EL), Ardéche (FR) or Grosseto (IT)
- moderate share of protected areas (17% - 30%) with low combined pressures such as Chieti (IT), Granada (ES) or Alentejo Litoral (PT)

The regions with low or very low vulnerability are characterised by low cumulative pressure levels and moderate share of protected areas. These are mostly located in predominantly rural regions in Greece, Portugal and Italy, and in many cases are not connected to the Mediterranean Sea.

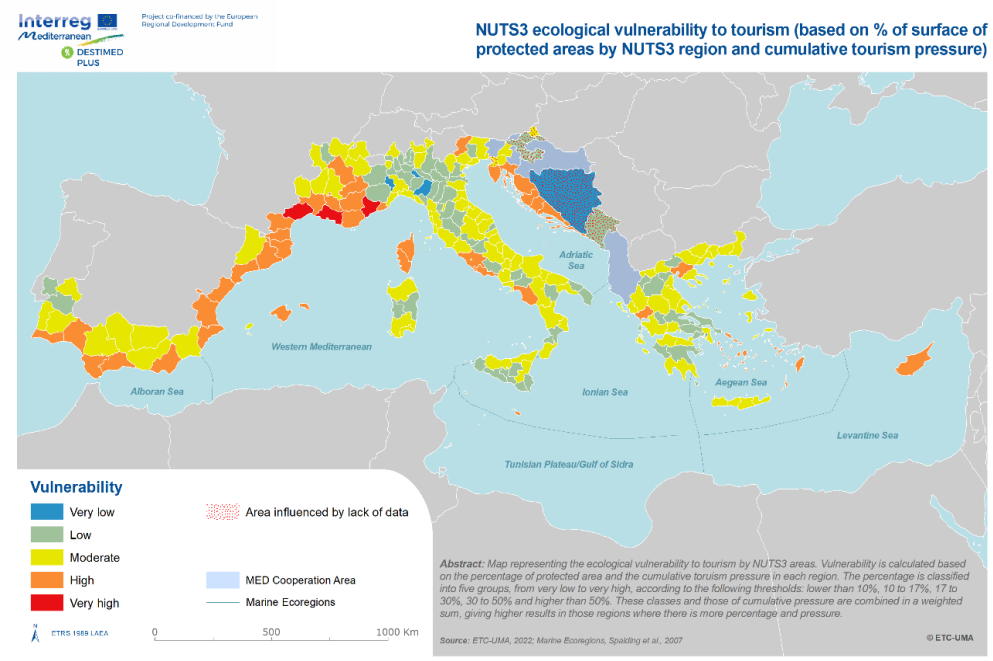

Figure 9 Terrestrial vulnerability map

The top 10 regions at NUTS3 level with the highest vulnerability are listed in Table 4. The list includes a characterisation of the tourism typology summarised from section 3.2 and of the PA distribution. Given that the vulnerability score is taken at the NUTS3 level, the PA characteristics indicate nicely if the vulnerabilities are linked to direct or indirect exposure to external threats and pressures. If the PA coverage overlaps with main tourist centres (i.e. coastal urbanisations, tourism infrastructure) the exposure of these sensitive areas might become a vulnerability due to the direct threats. While for other regions where the PAs are not

directly overlapping with main touristic areas, such as in Alpes-Maritime, the exposure might be indirect due to pressures on natural resources (e.g. water extraction, waste and waste water disposal) and effects of secondary infrastructure (i.e. road and railway infrastructure connecting the destination).

Table 4 NUTS 3 regions with highest vulnerability

NUTS3	Tourism typology	PA characteristics
1. Alpes-Maritimes (FR)	High intensity destination with infrastructure	Very high PA coverage, concentrated in the mountainous hinterland
2. Bouches-du-Rhone (FR)	High intensity destination, incl. Cruise port	Very high PA coverage, overlapping main touristic centres
3. Hérault (FR)	High intensity destination	Very high PA coverage, both in coastal and hinterland areas
4. Girona (ES)	High intensity destination with infrastructure	High PA coverage, both in coastal and hinterland areas
5. Zadarska županija (HR)	Low density destination	Very high PA coverage, overlapping main touristic centres
6. Primorsko-goranska županija (HR)	Low density destination	Very high PA coverage, overlapping main touristic centres
7. Var (FR)	High intensity destination	High PA coverage, concentrated in the mountainous hinterland
8. Roma (IT)	Mature urban destination, incl. Cruise port	High PA coverage, overlapping main touristic centres
9. Cádiz (ES)	Moderate density destination with infrastructure	High PA coverage, both in coastal and hinterland areas
10. Algarve (PT)	High intensity destination with infrastructure	High PA coverage, concentrated in the mountainous hinterland

Beyond this list of the 10 most vulnerable regions at NUTS3 level, high and very high vulnerability is present almost entirely in coastal NUTS3 regions except for the French alpine regions of Alpes de Hautes Provence, Isere and Hautes Alpes as well as Belluno in Italy. The highest concentration of highly vulnerable regions is in the Western Mediterranean, including Alboran Sea and the Portuguese coast. All regions from Algarve to Genova are in this group with the exception of Granada and Murcia. The islands of Mallorca and Corsica as well as the Italian regions of Roma, Latina and Salerno complete this picture. In the Adriatic Sea it is the complete Croatian coast from Pula to Dubrovnik that presents high vulnerability. In the Ionian Sea it is the island of Malta as well as the Greek region of Arta/Preveza. In the Aegean Sea, the Greek regions of Thessaloniki and the island regions of Andros, Thira, Kea, Milos, Mykonos, Naxos, Paros, Syros, Tinos and Kalymnos, Karpathos, Kasos, Kos, Rodos are highly vulnerable. Finally, Cyprus is as well included in the highly vulnerable regions.

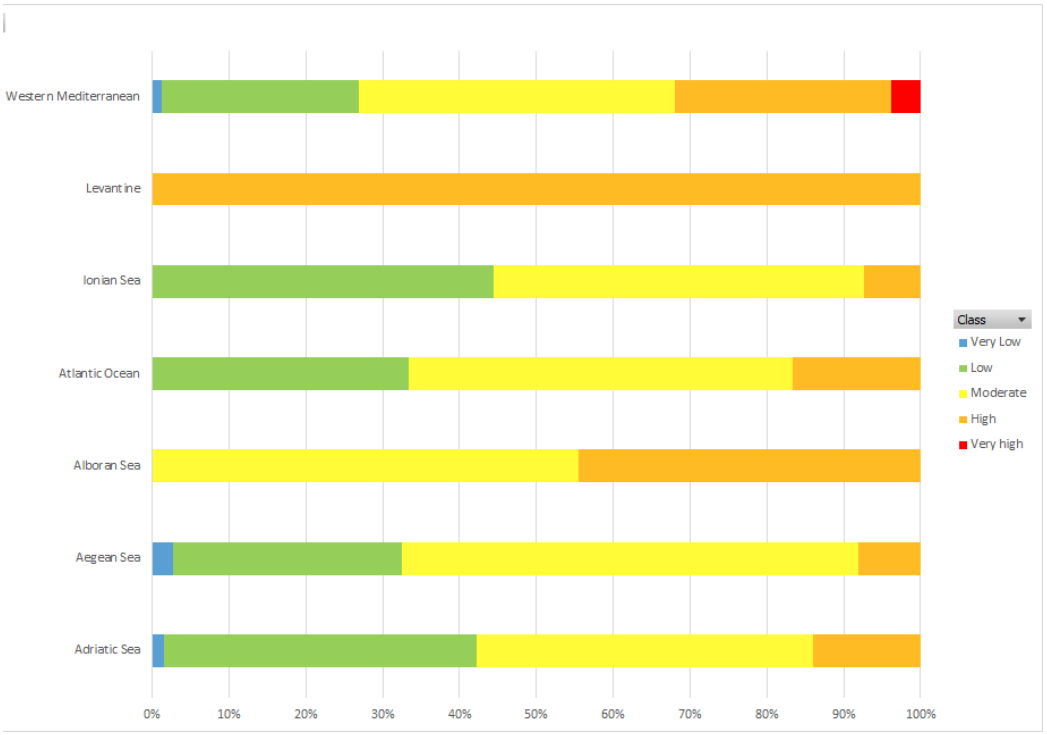

Figure 10: Distribution of different levels of vulnerability per marine ecoregions

An overview at the level of marine ecoregions (Figure 10) and countries (Figure 11) provides additional insights of the distribution of vulnerable regions across the Mediterranean Sea. Apart from Levantine Sea which only includes Cyprus, Alboran Sea is the marine ecoregion with highest share of regions with high or very high vulnerability, followed by the Western Mediterranean that includes the three regions with very high vulnerability. On the other side, the Ionian Sea is the marine ecoregion with the highest share of very low and low vulnerability, closely followed by the Adriatic Sea.

Looking at the more detailed distribution per country in the marine ecoregions, different patterns can be extracted. Especially, in the highly vulnerable Western Mediterranean, it becomes clear that Spanish regions are in the worst situation, particularly since all Spanish regions belonging to this ecoregion are coastal regions. The situation is more balanced in Italy for instance.

It also becomes clear that countries show different patterns depending on the marine ecoregion the regions belong to. In the specific case of Italy, the regions belonging to the Western Mediterranean and the Adriatic Sea show similar vulnerabilities while the ones bordering the Ionian Sea show higher shares of regions with low vulnerability. In the case of Greece, the situation is better (higher share of regions with low vulnerability) in the Aegean than in the Ionian Sea.

This complete overview, including the situation in the Alboran Sea, confirms the gradient of decreasing vulnerability from the western towards the eastern Mediterranean.

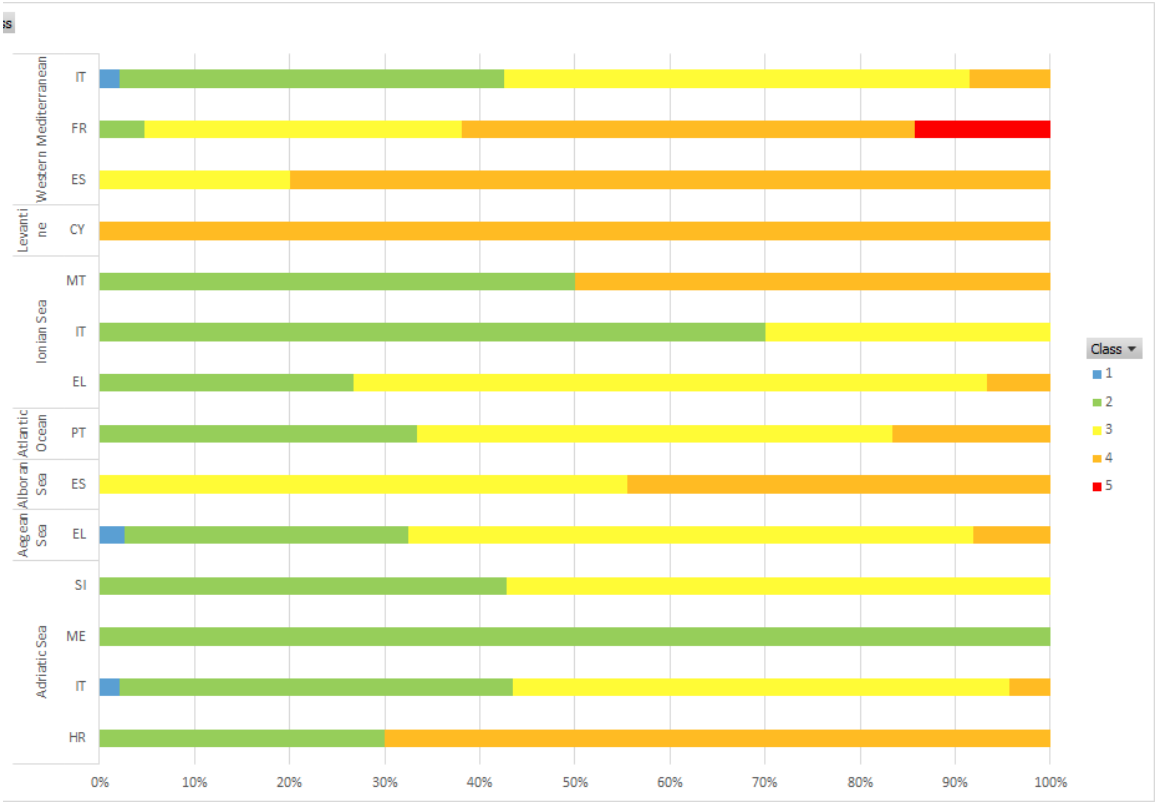

Figure 11: Distribution of different levels of vulnerability per marine ecoregions and countries

Another differentiation can be clearly made between coastal and non-coastal regions in the Mediterranean and its marine ecoregions. Throughout, all marine ecoregions coastal regions show higher vulnerability than the non-coastal regions. An interesting case is the Alboran Sea where the difference between coastal and non-coastal areas is not very big. This is closely related to the fact that there is a limited number of non-coastal regions, but also highlights that they are very similar both in terms of pressures from tourism (high levels of tourism demand and infrastructure in Andalusian hinterland) and level of biodiversity protection.

Comparing coastal regions in the different marine ecoregions across the Mediterranean, they show the same patterns as the overall regional comparison (see above), i.e. with an increasing level of vulnerability from west to east, with the exception of Cyprus.

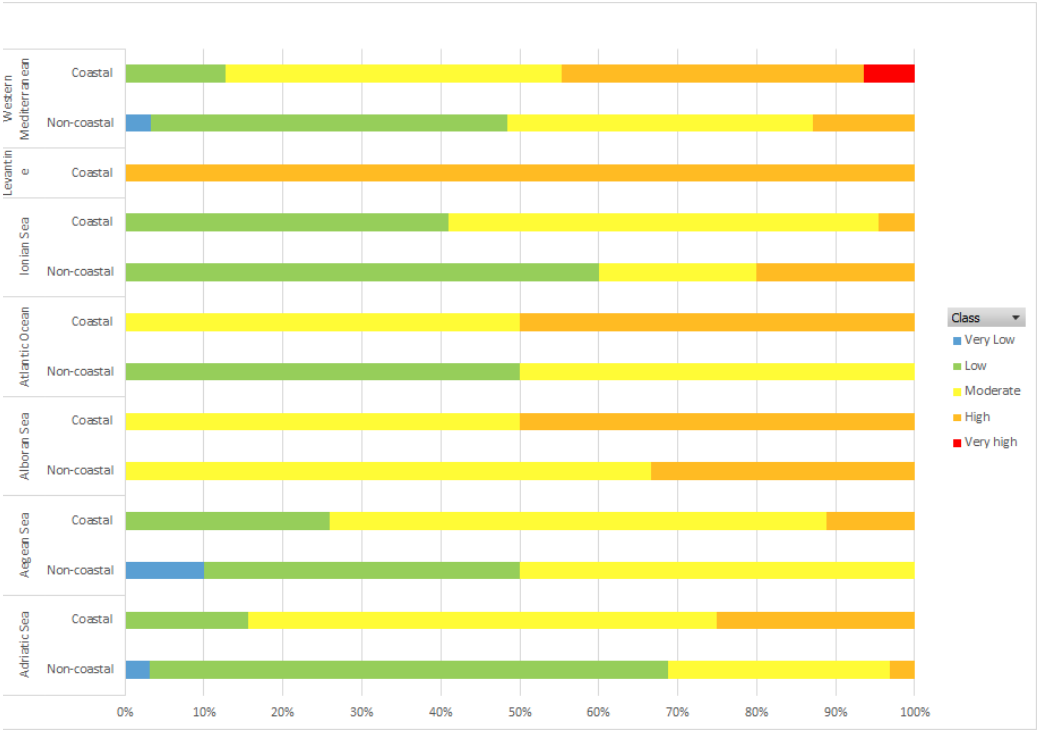

Figure 12: Distribution of different levels vulnerability of coastal and non-coastal regions per marine ecoregions

3.3.2. Marine vulnerability map

Similar to the terrestrial vulnerability map, a marine map was produced combining the only indicator available for strictly marine tourism activity (i.e. recreational boating activity) and marine protected areas (incl. in this layer the Key Biodiversity Areas). In contrast to the terrestrial part, the analysis for the marine areas was done at MPA level, to indicate the areas with highest vulnerability. For each protected area the total hours per year and square kilometre was calculated.

Figure 13 provides an overview of the vulnerability in absolute terms, i.e. the total recreational boating activity per year per MPA. Apart from the Pelagos Sanctuary many small MPAs in coastal waters can be identified as highly vulnerable to the identified pressure, particularly in the areas per ecoregion listed in Table 5.

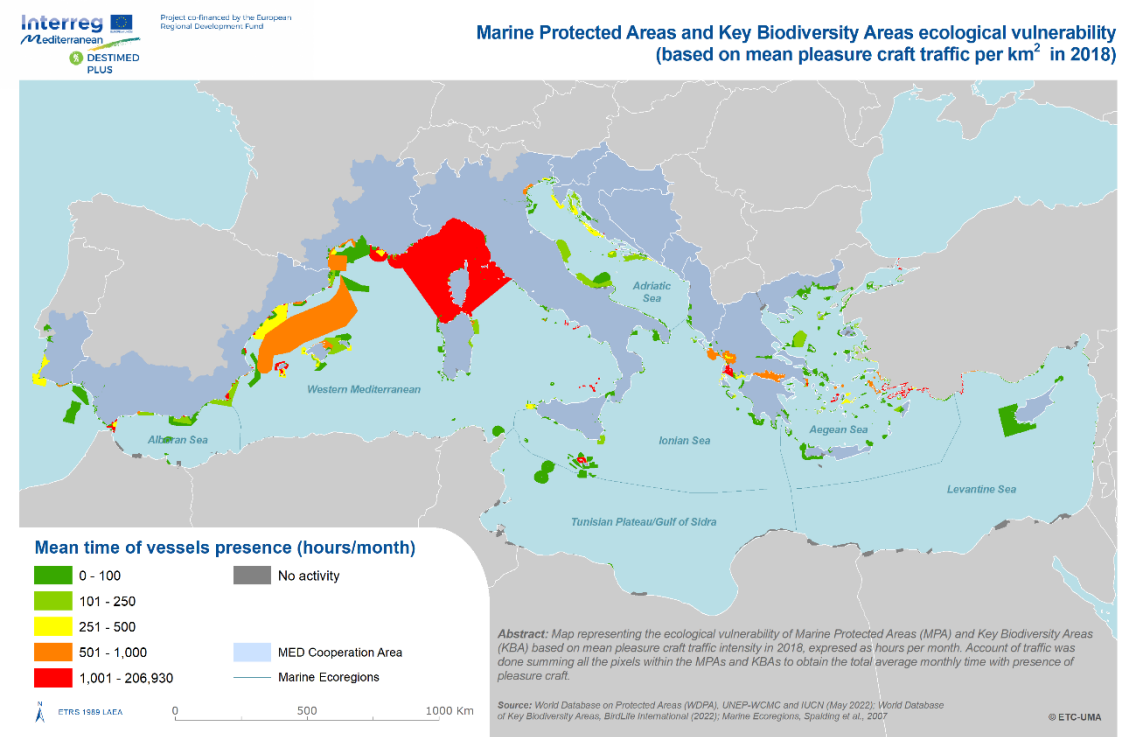

Figure 13: Vulnerability in Marine Protected Areas and Key Biodiversity Areas in the Mediterranean

Table 5: Overview of most affected MPAs per ecoregion

Ecoregion	Affected MPAs
Alboran Sea	Strait of Gibraltar
Western Mediterranean	- Around Formentera, - Bay of Marseille - Mar Menor - Valencia - Gulf of Naples (incl. Capri and Ischia) - Arcipelago delle Eolie
Adriatic Sea	- Small areas around Hvar Island
Ionian Sea	- Malta - Esoteriko Archipelago
Aegean Sea	- Paros island

If the vulnerability is calculated in relative terms, i.e. recreational boating effort in relation to the size of the MPA the situation is quite different as can be seen from the Table 6 of ten most vulnerable sites.

Table 6: List of 10 most vulnerable MPAs in the Mediterranean

MPA	Category and location
1. Fortifikazzjonijiet Tal-Port (MT)	Area of High Landscape Value in the port area of Valetta
2. Fons Marins Del Cap De Sant Antoni (ES)	Nature reserve on the coast of Denia (Valencia)
3. Fondali Golfo di Rapallo (IT)	Special Areas of Conservation on a coastal strip of the coast in Genoa
4. Penyal d'Ifac (ES)	Sites of Community Importance along the coast of Valencia
5. Kanal – Luka (HR)	Significant Landscape in the Croatian coast north of Split
6. Grapissar de la Masia Blanca (ES)	Special Areas of Conservation on the coast of Tarragona
7. Montgo (ES)	Sites of Community Importance on the coast of Denia (Valencia)
8. Krknjaši (HR)	Sites of Community Importance in the Croatian coast north of Split
9. Portocolom (ES)	Sites of Community Importance in an port area of Mallorca.
10. Fondali Arma di Taggia - Punta San Martino (IT)	Special Areas of Conservation on the Italian Riviera close to Sanremo

The common features of these MPAs are the location on the shore, close to marina port areas or major urban areas, and a relatively small size of maximum 10 square kilometres. Even though they partially are under strong legal protection (e.g. Sites of Community Importance) the high presence of recreational boats makes them very vulnerable to many kind of external threats, like anchoring, small oil spills and noise impacts, that can harm the fragile ecosystems of these sensitive areas.

4. Summary assessment and conclusions

Coastal, terrestrial and marine environments are exposed to strong pressures and threats by human activities. Many tourism related uses (e.g. transport, water and energy use, waste and waste water disposal, land occupation, tourism-specific infrastructure) and activities (e.g. recreational boating, golf) are present in many areas of the Mediterranean both inland and on the coast, but show a specific pattern based on the spatial and temporal concentration of tourism offer, demand and infrastructures.

The assessment of the Mediterranean protected area's vulnerability to tourism pressure map has identified regions that show high to very high vulnerability with characteristics that need to be tackled in upcoming policy and management initiatives. The most vulnerable regions are coastal regions in the Western Mediterranean with a high coverage of protected area (>30% of its territory), and characterised by high to very high demand (e.g. number of nights spent) and very high tourism offer (high number of bed places and establishments), leading to potentially high pressure on sensitive ecosystems. These regions are linked to major tourism hubs in the Western Mediterranean (e.g. Marseille, Cote d'Azur) that are considered as predominantly urban regions. On the other hand regions with lower intensity in tourism offer, such as the

Croatian Adriatic coast and Greek Islands are also included in the wider list of highly vulnerable territories due to the high level of demand and activities, and of protection in these locations.

These areas would require a series of actions to reduce the threats (e.g. spatial and temporal de-concentration of tourism flows, improved use of renewable resources, and better waste and waste water treatment) and means to prevent them (e.g. better and more effective protection of sensitive ecosystems). In addition, regional planning regulations are required to prevent tourism related constructions to occupy protected areas as well as smart destination management to channel and limit visitors' flows. Furthermore, some of these regions include important cruise destinations or high density of tourism infrastructure (golf courses and marina ports). Adapted management and regulations linked to international maritime traffic and urban and coastal planning instruments, respectively, need to be enforced or improved to mitigate pressures and impacts of these infrastructures

At the other end of the spectrum, the predominantly rural regions in the Mediterranean hinterland are less exposed to the threats and count with very high levels of protection, particularly in the mountainous areas. Effective, forward-looking planning of tourism development is needed in these cases. This includes a clear focus on low-intensity ecotourism practices that provide income to rural areas, but at the same time do not jeopardise the natural capital it relies on. A focus on the development of public transport infrastructure, for example, could help regulating access and avoiding contamination.

The DestiMED PLUS Project implemented an analysis of the Sustainability Baselines for Ecotourism Packages[5] using the Ecological Footprint and biocapacity concepts to compare the performance of ecotourism products in relation to the natural resources at destination. In addition, the project produced a complementary assessment on the environmental impacts of tourism in DestiMED Plus destinations[6] to compare quantitatively the Ecological Footprint of various tourist typologies with the average Footprint of eco-tourists experiencing the DestiMED Plus products and thus to "prove with numbers" whether ecotourism actually places a lower impact on ecosystems. During the implementation of the present study, it was discussed to what extent the Footprint analysis conducted in DestiMED Plus project could be combined with the vulnerability map of this study to develop an integrated assessment of the pressures and impacts of tourism at the destinations' territories in general and protected areas in particularly. However, given the timeframe of the implementation of the vulnerability map and its regional focus versus the pilot area focus of the Ecological Footprint work within DestiMED Plus, as well as the different granularity of the data sources, this integration was not feasible. Nevertheless, several options do exist to integrate both approaches in the future. For instance, the eco-balance assessment could be applied at regional scale to explore which countries and regions are more exposed to natural resource deployment; the research on the "standard tourist" Footprint in DestiMED PLUS project, which showed the pressure of international and domestic tourism at country level, could be replicated with regional data sources; finally, the biocapacity density assessment showing which regions (and PAs) are more abundant in terms of natural resources could be up-scaled using the vulnerability mapping approach. In any case, these analyses and assessments require additional streamlining of methodological procedures

[5] Barioni et al. (2021): The Ecological Footprint and Biocapacity Balance of DestiMED PLUS Destinations: Analysis of the Sustainability Baselines for Ecotourism Packages.
[6] Barioni et al., (2022): Ecotourism impact report. Assessment of the environmental impact of tourism in DestiMED PLUS destinations.

and, above all, additional data collection to align both approaches and to allow upscaling to the regional level.

When looking at potential improvements of this vulnerability assessment, the availability of data covering the Euro-Mediterranean area needs to be addressed. The completeness and availability of adequate datasets, especially on tourism activities, is still a limitation. Hence, the assessment would highly benefit from the integration of more data on the different tourism pressures and activities, such as:

- Spatially-explicit data on local tourism activities over areas of sensitive biodiversity, i.e., diving and leisure boat anchoring, pesca-tourism, boat rentals, aquatic sports, bathhouses and others, both the location of the activities and the intensity (e.g. number of divers)
- Data on visitors at PA scale and regional scale
- Data on second residences and apartments (e.g. Airbnb)
- Data on cruise routes

Closely linked to the issue of data availability, the expansion of this study's coverage to the whole Mediterranean basin should be approached, including the countries and regions on the eastern and southern shore. Different projects have already started working on tourism indicators in these regions in the context of the ENI CBC MED programme (e.g. Co-EVOLVE 4BG). But a comprehensive, regional wide mapping and assessment still is not available.

Finally, a connection to other observatory initiatives linked to sustainable tourism might be made, e.g. to UNWTO's International Network of Sustainable Tourism Observatories (INSTO)[7] and BEST MED NSTO[8], to strengthen synergies to existing work on indicators.

5. References

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[7] https://www.unwto.org/sustainable-development/unwto-international-network-of-sustainable-tourism-observatories

[8] https://best-med.interreg-med.eu/info-hub/tourism-observatories/

6. Annexes

The annexes include supporting material developed as part of the study:

6.1 Data list

6.2 Indicator fiches

6.3 Large results maps

6.1. Data list

Theme/category	Indicator	Dataset	Format	Resolution / Scale	Reference date	Spatial coverage	Source	Reference data	Data availability	Details	Gaps/Issues
Administrative	-	GISCO statistical units	Vector	NUTS0 to NUTS3; 1:1M and 1:20M	2021	EU	Eurostat	national reporting	Public access	Distribution of European countries aby NUTS regions, including all levels: NUTS0, NUTS1, NUTS2 and NUTS3	-
Administrative	-	GISCO world countries	Vector	NUTS0; 1:1M and 1:20M	2020	World	Eurostat	national reporting	Public access	Distribution of world countries	-
Administrative	-	GISCO transport network, port location	Vector	Points	2013	World	Eurostat	national reporting	Public access	Location, id and name of main world ports	-
Ecology	-	Marine Ecoregions of the World	Vector	Ecoregion	2007	World	WWF	scientific results	Public access	Biogeographic classification of the world's coastal and continental shelf waters, following a nested hierarchy of realms, provinces and ecoregions.	
Tourism offer	Number of bed places (per km2, per habitants, coastal/non-coastal, Nuts2)	Number of establishments, bedrooms and bed-places by NUTS 2 regions (tour_cap_nuts2c)	Tabular	NUTS2	2018-2019	EU27	Eurostat	national reporting	Public access	These database includes data on number of establishments, bedrooms an bed-places by NUTS2. Available information can be disaggregated by degree of urbanisation, and coastal and non-coastal area.	Do not cover Balkans and Northern African Countries. Gaps might be filled with new data.
Tourism offer	Number of tourism establishments (per km2, per habitants, coastal/non-coastal, Nuts2)										
Tourism demand	Number of nights spent at tourist accommodation (coastal/non-coastal, Nuts2)	Nights spent at tourist accommodation establishments by NUTS 2 regions (tour_occ_nin2c)	Tabular	NUTS2	2018-2019	EU27	Eurostat	national reporting	Public access	These database includes data on nights spent at tourist establishments by NUTS2. Available information can be disaggregated by country/world region, degree of urbanisation, and coastal and non-coastal area.	Do not cover Balkans and Northern African Countries. Gaps might be filled with new data.
Tourism demand	Number of cruise passengers per port	Passengers embarked and disembarked in all ports by direction - annual data (mar_pa_aa)	Tabular	Points	2018-2019	EU27	Eurostat	national reporting	Public access	Cruise passengers transport in European ports, measured in thousand passengers. Data can be disaggregated by cruise passengers starting/ending a cruise or on excursion.	Do not cover Balkans and Northern African Countries. Gaps might be filled with new data.
Tourism demand	Number of arrivals (NUTS2)	Arrivals at tourist accommodation establishments by NUTS 2 regions (tour_occ_arn2)	Tabular	NUTS2	2018-2019	EU27	Eurostat	national reporting	Public access	This database represents the number of tourists (thousand arrivals) arriving in NUTS2-regions indicating the demand of regional tourism infrastructure.	Coarse scale. It is not indicative of the actual occupation. Do not cover Balkans and Northern African Countries. Gaps may be filled with new data.
Tourism activities	Marina port capacity (NUTS2/3)	Marinas and recreational shipping, number of moorings	Vector	Points	2014	Mediterranean	ETC-UMA	Plan Bleu, AdriPlan, Spanish Federation of Associations of Tourist Marinas, Portbooker.com	Under request *Reference data is public*	Database on location of marinas and their capacity (number of moorings).	Data might be outdated. Pending revision...
Tourism activities	Density of pleasure craft (1km pixel)	EMODnet maritime traffic (pleasure craft)	Raster	1 km	2017-2020	EU Seas	EMODnet	modelled data based on AIS data	Public access	Maritime traffic intensity maps. EMODnet data is expressed as total time with traffic per cell per month (hours/cell/time frame). Data available by month and year averages.	Very aggregated data. No data on vessels speed or accurate number of vessels. Data is mainly limited to big vessels (due to AIS regulations).
Tourism activities	Density of golf courses (NUTS2/3)	Density of golf courses (NUTS2/3)	Vector	NUTS2/3	2016	World	EEA	calculated using golf courses raw surface data	Under request *Reference data is public*	Density is calculated according to the percentage occupied by golf courses (total sum of hectares) with respect to the size of the reference NUTS (level 2 or 3).	Reference unit (NUTS2 and 3) is coarse for a local scale analysis.
Protected areas	Vulnerability	World Database on Protected Areas (WDPA), May 2022	Vector	Local	2022	World	UNEP-WCMC and IUCN	national reporting	Public access	Distribution of protected areas world wide and related information (designation types, management, etc.).	-
Protected areas	Vulnerability	Key Biodiversity Areas	Vector	Local	2022	World	BirdLife International	ecological assessment + reporting	Under request	Distribution of key biodiversity areas anre related information	-

6.2. Indicator fiches

Indicator fiches template

Indicator name	
Driver	Type of driver that produces the pressure
Description	Variable measured by the indicator
Data source	The data to be used to measure the indicator
Updating	Scientific or technical recommended time interval for the regular measurement of the indicator based on available data.
Valuation scale	Type of scale used to interpret the indicator's intensity values.
Calculation and interpretation	Methodological details on the calculation of the indicator and how the resulting data should be interpreted.
Explanatory notes	Additional, descriptive information on the indicator's terms or concepts for the precise replication of its measurement
Trend	Progress in the indicator's values (x). It is considered *positive* if x is smaller than in the previous evaluation, *stable* if x is similar to the previous evaluation, and *negative* if x is greater than in the previous evaluation.
Gaps and limitations	Description of limitations of the indicator due to lack of data coverage or data quality, or due to the methodology itself.

1. Number of bed places (per km2 in coastal/non-coastal areas)	
Driver	Tourism offer
Description	The indicator measures the number of bed places in coastal and non-coastal areas per km^2, as an indicator of the local intensity of tourism capacity.
Data source	Number of establishments, bedrooms and bed-places by NUTS 2 regions (tour_cap_nuts2c), EUROSTAT, 2022 Copernicus Coastal Zones and Corine Land Cover, Copernicus Land Monitoring Service 2018, European Environment Agency (EEA)
Updating	Yearly
Valuation scale	Data can be represented as categories or as continuous values. Five categories from very low to very high are suggested. - *Very Low: 0 – 100* - *Low: 101 – 250* - *Moderate: 251 – 500* - *High: 501 – 1,000* - *Very high: > 1,000*
Calculation and interpretation	The total number of bed places at NUTS2 region is disaggregated to the most urban intensity at $1km^2$ data assuming that most bed places and establishments are located in areas with high urban density. The land cover data is previously aggregated at 1 km^2 in order to calculate the percentage of urban areas in each cell with respect to the total of the NUTS2 region. Copernicus Coastal Zones was used for counting urban coverage in the coastal area, while Corine Land Cover was used in the non-coastal area. Results are showing low to high intensive tourism capacity and demand per km^2 pixel.
Explanatory notes	All available establishment types are included. Tourism statistics differentiate between coastal and non-coastal areas within a NUTS2 region, based on the EUROSTAT definition.
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	This indicator is based on the disaggregation of data at NUTS2 level with its corresponding uncertainty. Although urban data give a good estimate of population density/urbanization of an area, the distribution of tourism represented by the indicator may not correspond with the reality in many cases.

2. Number of tourism establishments (per km2 in coastal/non-coastal areas)	
Driver	Tourism offer
Description	The indicator measures the number of establishments in coastal and non-coastal areas per km^2, as an indicator of the local intensity of tourism capacity.
Data source	Number of establishments, bedrooms and bed-places by NUTS 2 regions (tour_cap_nuts2c), EUROSTAT, 2022 Copernicus Coastal Zones and Corine Land Cover, Copernicus Land Monitoring Service 2018, European Environment Agency (EEA)
Updating	Yearly
Valuation scale	Data can be represented as categories or as continuous values. Five categories from very low to very high are suggested. - *Very Low: 0 – 1* - *Low: 2 – 10* - *Moderate: 11 – 50* - *High: 50 – 100* - *Very high: > 100*
Calculation and interpretation	The total number of establishments at NUTS2 region is disaggregated to the most urban intensity at $1km^2$ data assuming that most bed places and establishments are located in areas with high urban density. The land cover data is previously aggregated at 1 km^2 in order to calculate the percentage of urban areas in each cell with respect to the total of the NUTS2 region. Copernicus Coastal Zones was used for counting urban coverage in the coastal area, while Corine Land Cover was used in the non-coastal area. Results are showing low to high intensive tourism capacity and demand per km^2 pixel.
Explanatory notes	All available establishment types are included. Tourism statistics differentiate between coastal and non-coastal areas within a NUTS2 region, based on the EUROSTAT definition.
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	This indicator is based on the disaggregation of data at NUTS2 level with its corresponding uncertainty. Although urban data give a good estimate of population density/urbanization of an area, the distribution of tourism represented by the indicator may not correspond with the reality in many cases.

3. Number of nights spent at tourist accommodation establishments (per km2 in coastal/non-coastal areas)	
Driver	Tourism demand
Description	The indicator measures the nights spent at tourist accommodation establishments in coastal and non-coastal areas per km^2, as an indicator of the local intensity of tourism demand.
Data source	Nights spent at tourist accommodation establishments by NUTS 2 regions (tour_occ_nin2c), EUROSTAT, 2022 Copernicus Coastal Zones and Corine Land Cover, Copernicus Land Monitoring Service 2018, European Environment Agency (EEA)
Updating	Yearly
Valuation scale	Data can be represented as categories or as continuous values. Five categories from very low to very high are suggested. - *Very Low: 0 – 10,000* - *Low: 10,001 – 25,000* - *Moderate: 25,001 – 50,000* - *High: 50,001 – 100,000* - *Very high: > 100,000*
Calculation and interpretation	The total number of nights spent at tourist accommodation establishments at NUTS2 region is disaggregated to the most urban intensity at $1km^2$ data assuming that most bed places and establishments are located in areas with high urban density. The land cover data is previously aggregated at 1 km^2 in order to calculate the percentage of urban areas in each cell with respect to the total of the NUTS2 region. Copernicus Coastal Zones was used for counting urban coverage in the coastal area, while Corine Land Cover was used in the non-coastal area. Results are showing low to high intensive tourism capacity and demand per km^2 pixel.
Explanatory notes	All available establishment types are included. Tourism statistics differentiate between coastal and non-coastal areas within a NUTS2 region, based on the EUROSTAT definition.
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	This indicator is based on the disaggregation of data at NUTS2 level with its corresponding uncertainty. Although urban data give a good estimate of population density/urbanization of an area, the distribution of tourism represented by the indicator may not correspond with the reality in many cases.

4. Number of cruise passengers per port	
Driver	Tourism demand
Description	The indicator measures the number of cruise passengers in Mediterranean ports, as an indicator of the local intensity of tourism demand.
Data source	Passengers embarked and disembarked in all ports by direction - annual data (mar_pa_aa), EUROSTAT, 2022
Updating	Yearly
Valuation scale	Data are represented as thousand passengers. Five categories from very low to very high are suggested. - *Very Low: 1 – 50* - *Low: 51 – 250* - *Moderate: 251 – 500* - *High: 501 – 1,000* - *Very high: > 1,000*
Calculation and interpretation	No calculation required. Raw data is represented by port. Results are showing low to high intensive tourism demand and pressure in port surrounding areas.
Explanatory notes	Indicator includes both those who start/end a cruise and those who are on excursion.
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	This indicator is based on port location data. The pressure of tourism can occur in areas far from the disembarkation area of the cruise passengers. Nor does it take into account the type of cruise ships or the management and maintenance tasks carried out in the ports, which can be a source of environmental pressure.

5. Number of arrivals (per NUTS2)	
Driver	Tourism demand
Description	The indicator measures the number of tourists arriving in NUTS2 regions indicating the demand of regional tourism infrastructure
Data source	Arrivals at tourist accommodation establishments by NUTS 2 regions (tour_occ_arn2), EUROSTAT, 2022
Updating	Yearly
Valuation scale	Data are represented as thousand arrivals. Five categories from very low to very high are suggested: - *Very Low: < 1,000* - *Low: 1,001 – 2,500* - *Moderate: 2,501 – 5,000* - *High: 5,001 – 10,000* - *Very high: > 10,000*
Calculation and interpretation	No calculation required. Raw data is represented by NTUS2 region. Results are showing low to high intensive tourism demand.
Explanatory notes	
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	Further downscaling was not possible due to missing differentiation between coastal and non-coastal areas.

6. Marina port capacity (per NUTS3 and km of coast)	
Driver	Tourism activities
Description	The indicator measures the number of moorings in marina ports per kilometre of coastline for each NUTS3 region.
Data source	Portbooker.com, 2022; Plan Bleu,2014; Spanish Yachting Port Federation, 2014; EEA, 2014
Updating	Yearly
Valuation scale	Mooring per km of coastline is represented as five categories from very low to very high: - *Very Low: 1 – 10* - *Low: 11 – 35* - *Moderate: 36 – 60* - *High: 61 – 100* - *Very high: > 100*
Calculation and interpretation	Number of moorings in marina ports are summed per each NUTS3 region and divided by the total km of coast. The indicator is an estimate of the potential pressure of this activity on the coastal strip.
Explanatory notes	The dispersal of yachting port-derived pollution is included as ancillary data as a diffusive plume up to 20 km based on an exponential decay and the data on mooring capacity of each yachting port. The spatial proximity of yachting ports increases the overall pressures.
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	Data used are not actual pollution data but an estimate of the potential pressure based on the number of moorings. The demand is not assessed. The indicator data sources present gaps for ports in Balkans, North African and Middle Eastern due to lack of data. Port influence does not consider dispersion of pollution produced by ocean currents.

7. Density of pleasure craft (per 1km pixel)	
Driver	Tourism activities
Description	The indicator measures the intensity of pleasure craft traffic in the study area
Data source	EMODnet Human Activities, Vessel Density Map, 2022
Updating	Yearly
Valuation scale	Data are represented as continuous values from 0 to the maximum value. Units are hours/year per km^2
Calculation and interpretation	Not required. Indicator is a representation of raw data. Inidicator represents the degree of pressure based on the intensity of pleasure craft traffic. Data AIS data aggregated at $1km^2$ and expressed as total time with presence of vessels in each cell throughout the year. The indicator provides an estimate of the amount of pollution vessels produce (via fuel leaks, oil discharge, waste disposal, etc.), under the assumption that traveling ships primarily affect their immediate waters.
Explanatory notes	Traffic data only include vessels with AIS.
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	Data used are not actual pollution data but an estimate of the potential pressure based on the traffic intensity.

8. Density of golf courses (per NUTS3)	
Driver	Tourism activities
Description	The indicator measures the density of golf courses expressed as the surface percentage of the region occupied by golf courses
Data source	Density of golf courses by NUTS3 regions, EEA, 2016
Updating	Yearly
Valuation scale	Data are represented as five categories from very low to very high: - *Very Low: 0%* - *Low: 0.01 – 0.05%* - *Moderate: 0.06 – 0.10%* - *High: 0.11 – 0.5%* - *Very high: > 0.51*
Calculation and interpretation	Not required. Indicator is a representation of raw data. It provides a proxy for the environmental pressure of this tourist activity.
Explanatory notes	
Trend	Progress in the indicator's values (x). It is considered positive if x is smaller than in the previous evaluation, stable if x is similar to the previous evaluation, and negative if x is greater than in the previous evaluation.
Data gaps and limitations	Data used are not actual data on pollution or water footprint but an estimate of the potential environmental pressure based on the extent of golf courses.

6.3. Large result maps

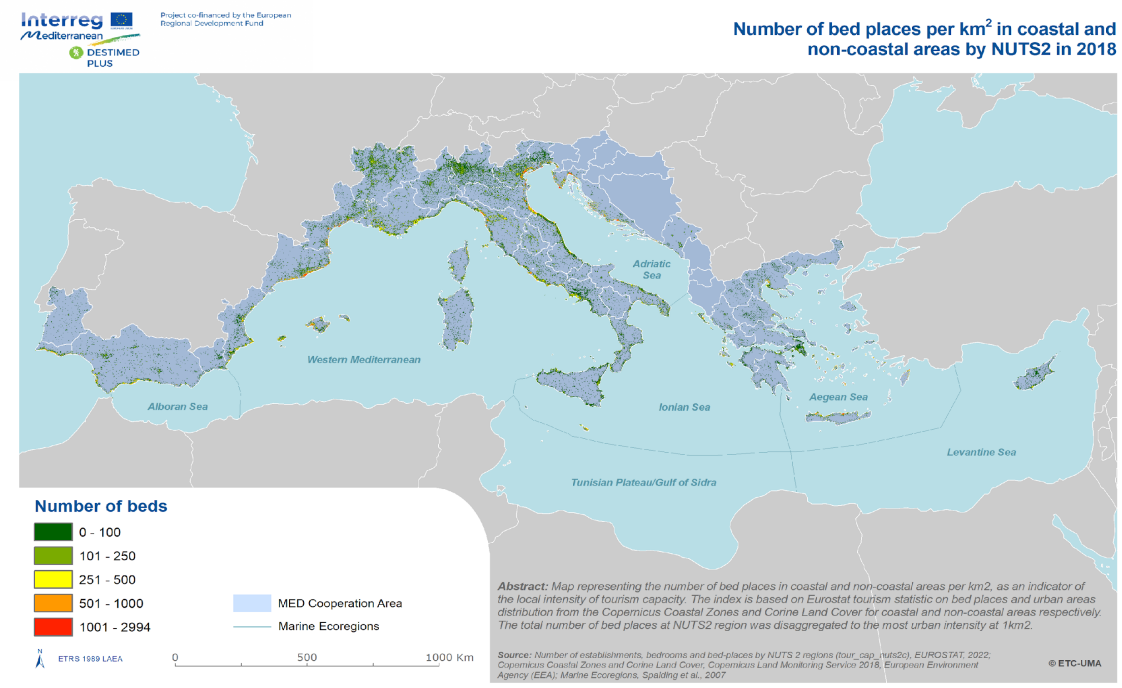

Figure 14: Map on number of bed places per km² in coastal and non-coastal areas by NUTS2.

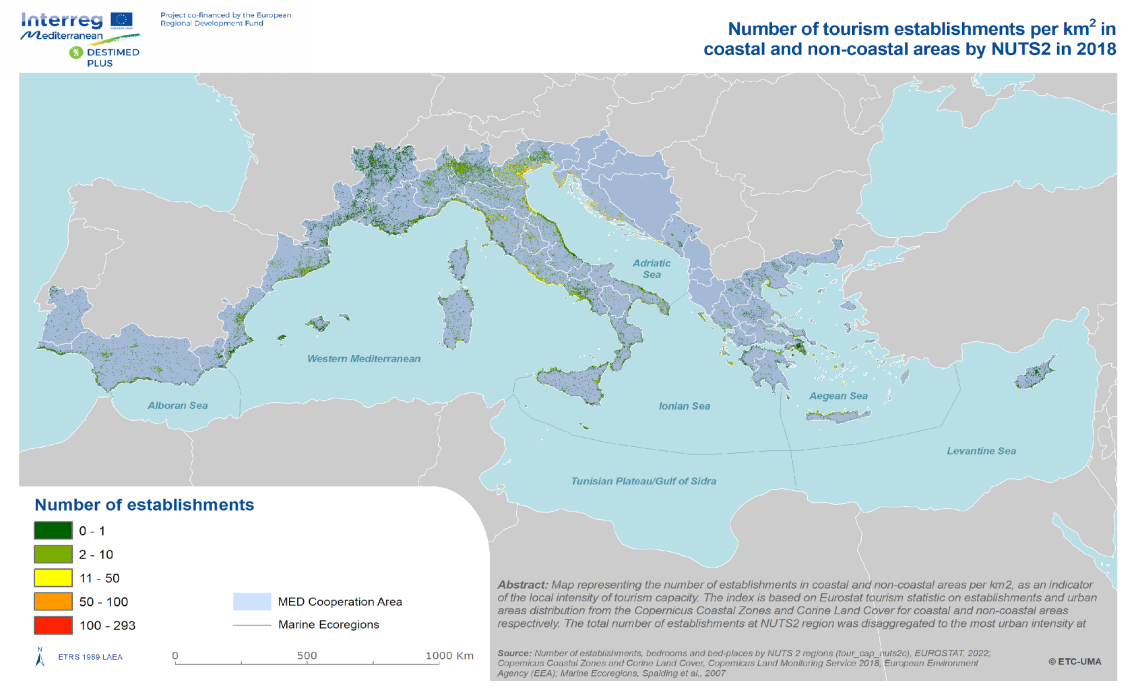

Figure 15: Map on number of tourism establishments per km² in coastal and non-coastal areas by NUTS2.

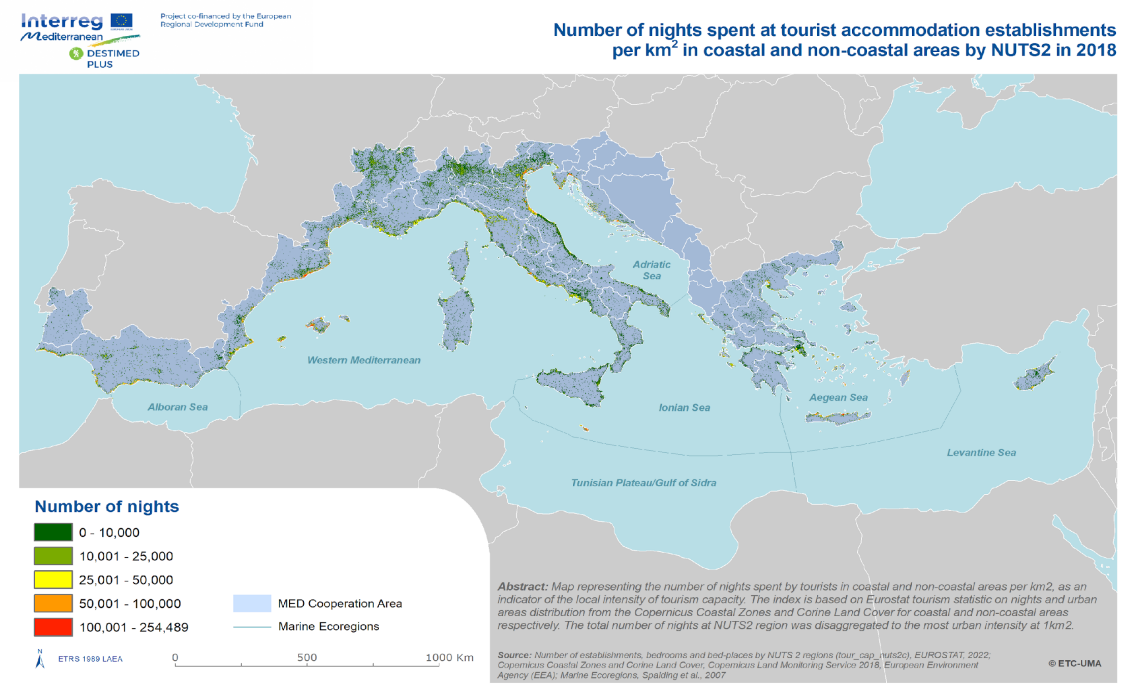

Figure 16. Map on number of nights spent at tourist accommodation establishments per km² in coastal and non-coastal areas by NUTS2.

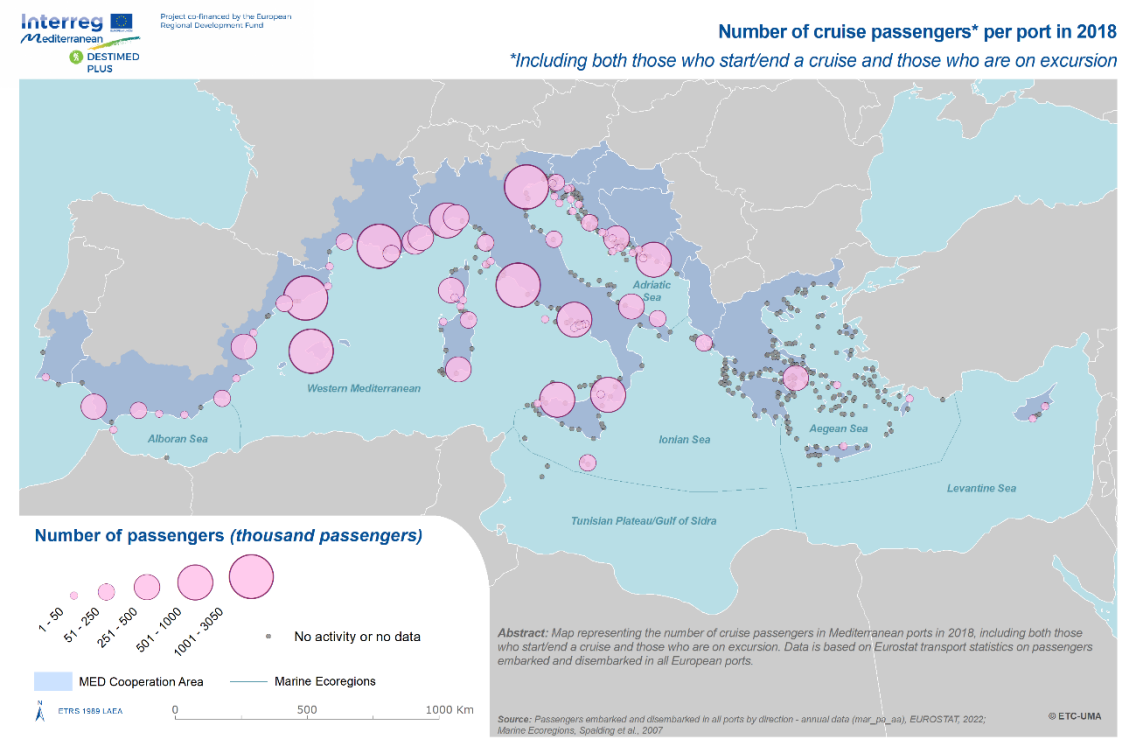

Figure 17. Map on number of cruise passengers per port.

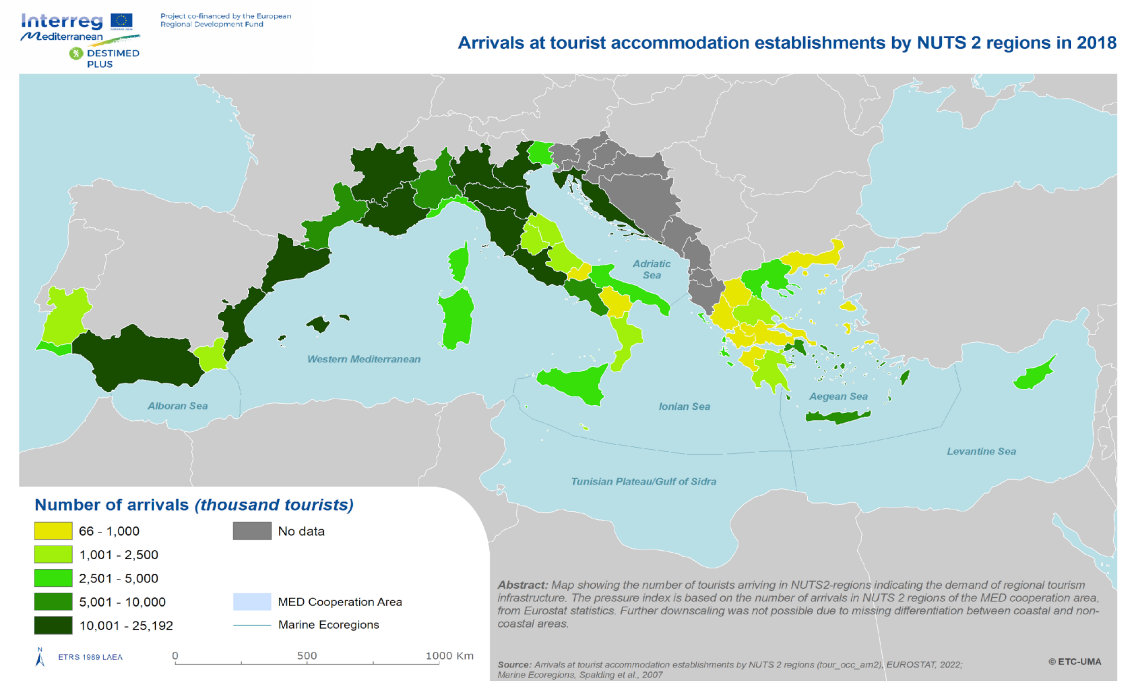

Figure 18. Map on number of tourist arrivals

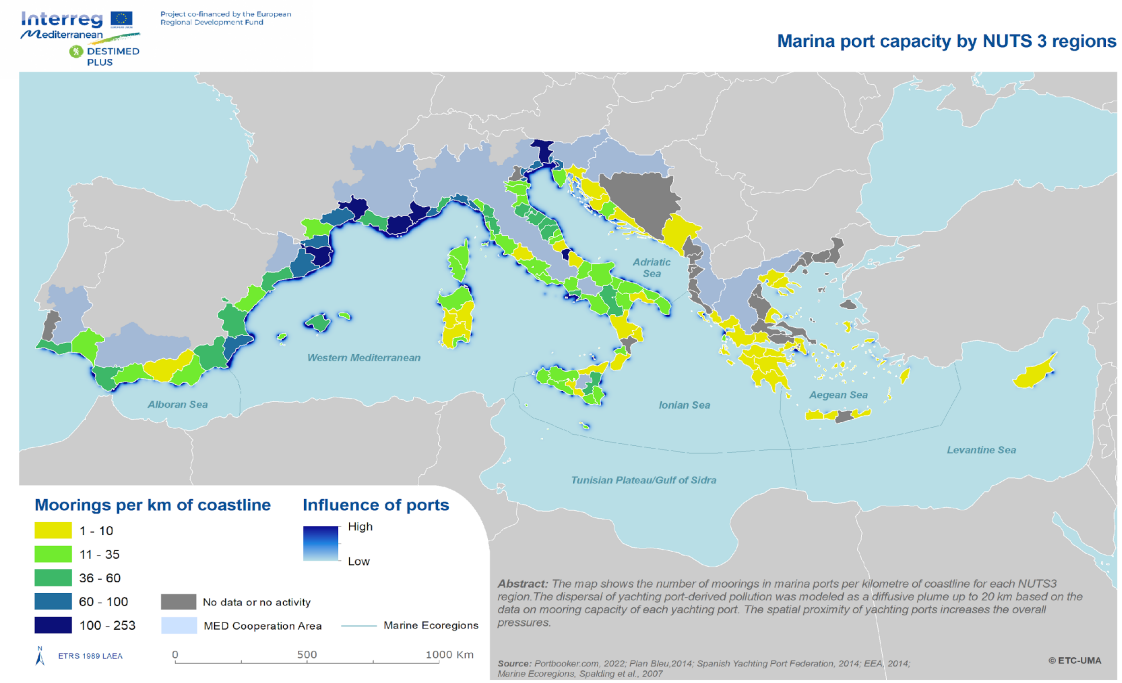

Figure 19. Map on marina port capacity by NUTS3.

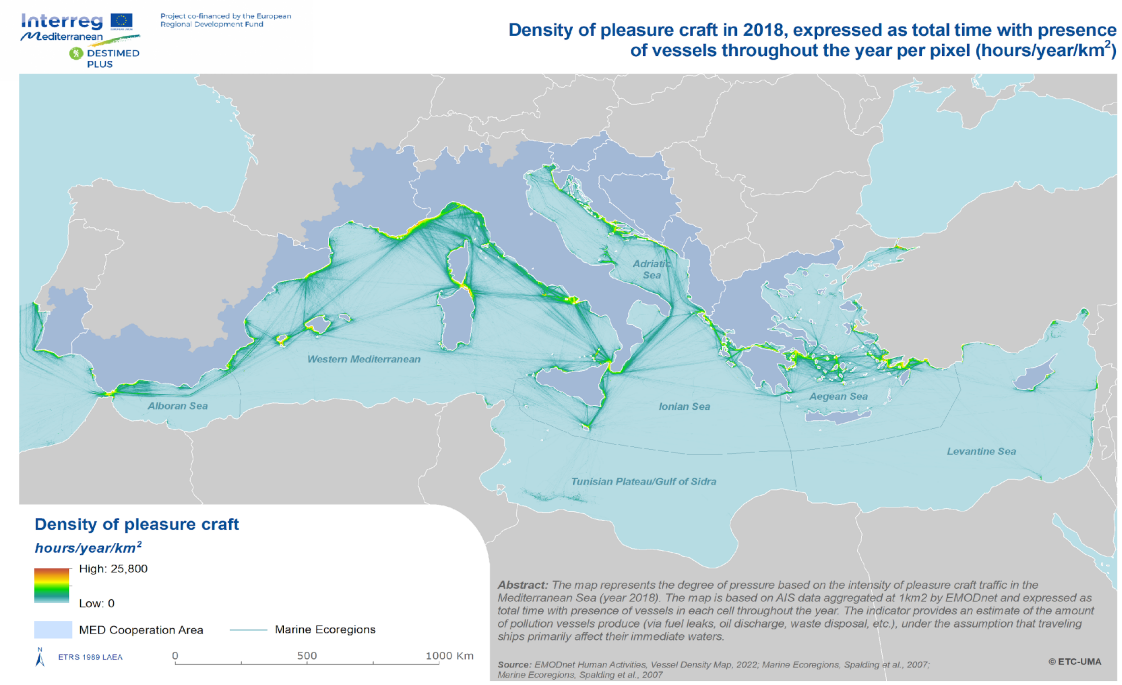

Figure 20. Map on density of pleasure craft traffic.

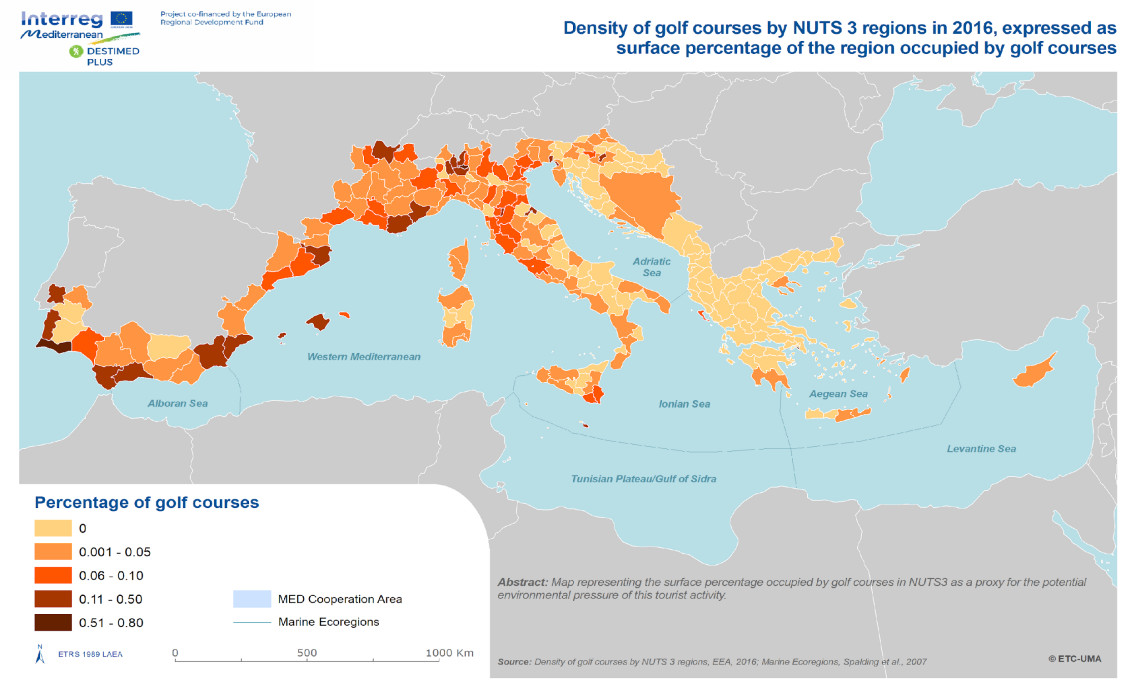

Figure 21. Map on density of golf courses by NUTS3.

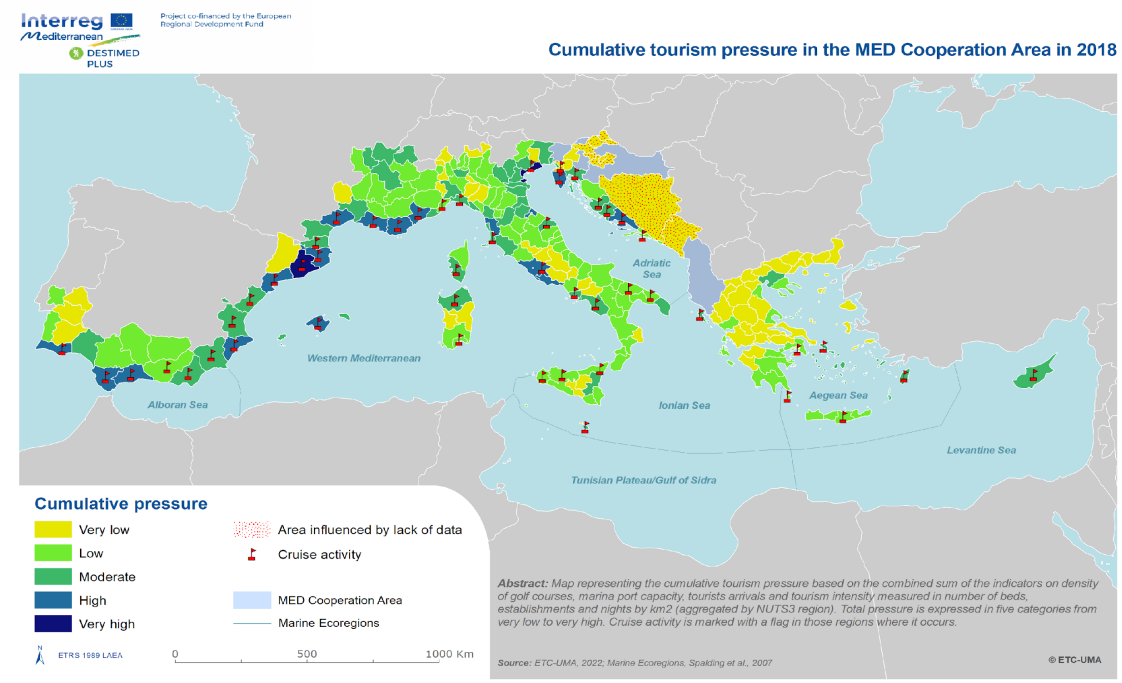

Figure 22. Map on cumulative tourism pressure.

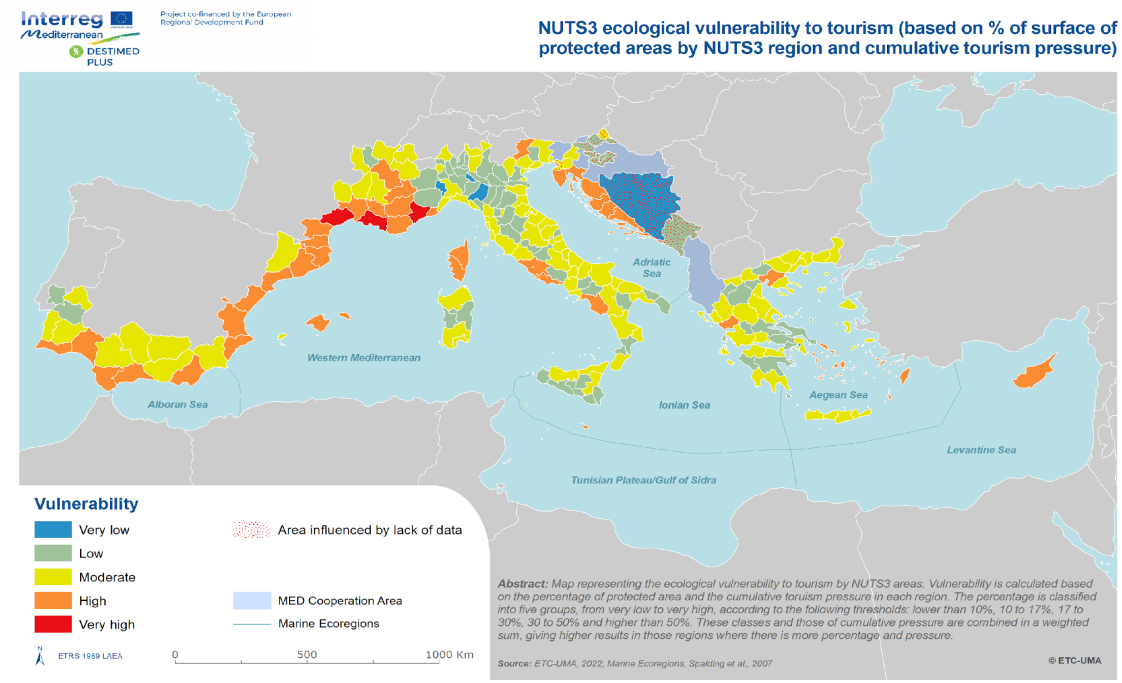

Figure 23. Map on land ecological vulnerability by NUTS3.

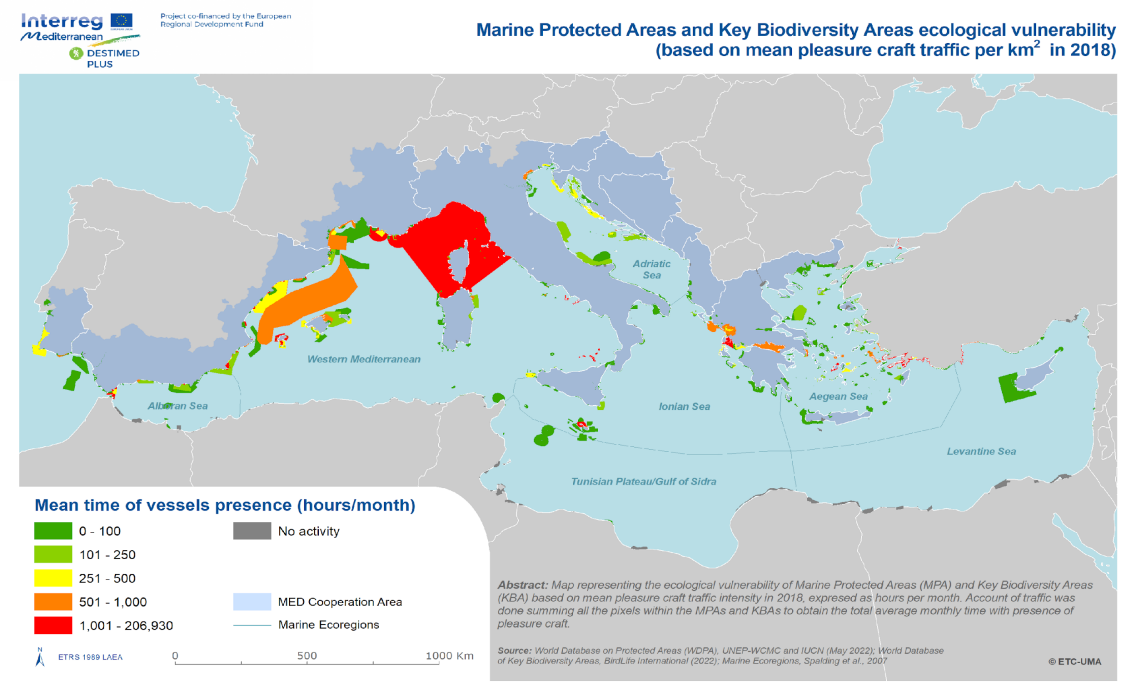

Figure 24. Map on marine ecological vulnerability by MPA and KBA.

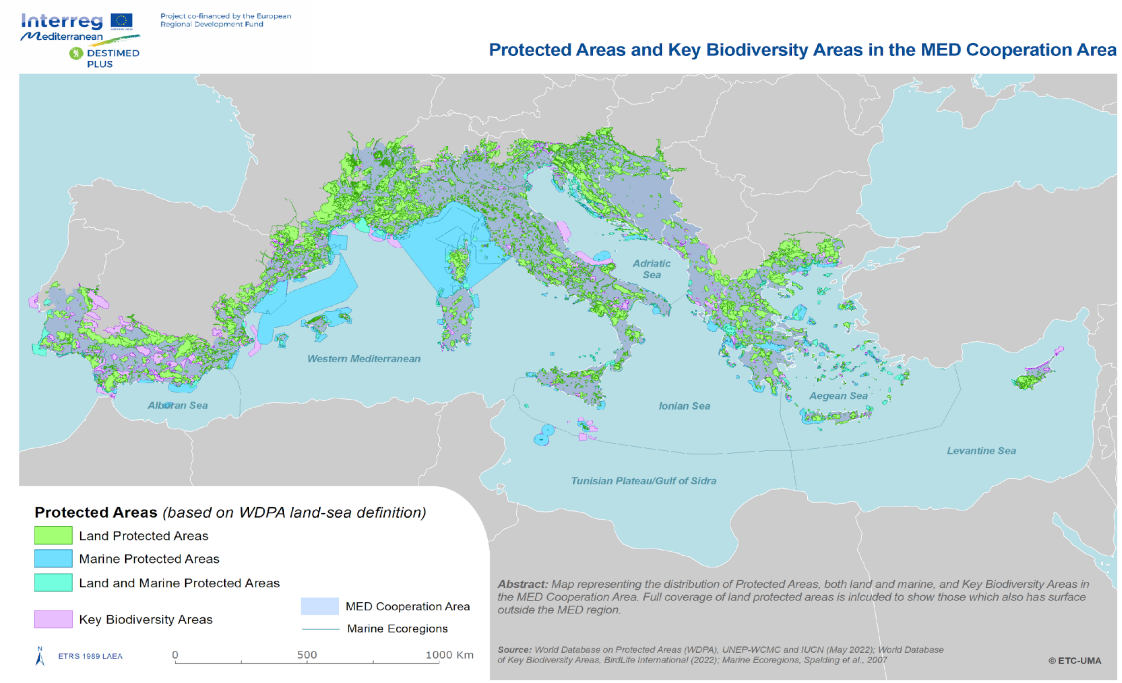

Figure 25. Map on distribution of protected areas and KBAs in the MED Cooperation Area.